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Ant-treehopper mutualism affecting biocontrol of *Parthenium hysterophorus* by Mexican beetle, *Zygogramma bicolorata* Pallister

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ABSTRACT: Infestation of a treehopper, *Gargara malabarica* Ananthasubramanian and Ananthakrishnan (Membracidae, Homoptera) on *Parthenium hysterophorus* L. and also a myrmicine ant, *Lophomyrmex quadrispinosus* (Jerdon) (Hymenoptera, Formicidae) tending these treehoppers is reported for the first time. The ant-treehopper association interferes with the biological control of *P. hysterophorus* by Mexican beetle, *Zygogramma bicolorata* Pallister (Coleoptera, Chrysomelidae). The *Parthenium* plants with ants supported significantly lesser number of grubs and adults of Mexican beetle compared to plants without ants. Mean number of Mexican beetle eggs was low on plants with ants, but it was non-significant. Further, the ants were observed to be disturbing the adult Mexican beetles from settling on the *Parthenium* plants, and this presumably led to the less Mexican beetle population.

KEY WORDS: Weed, myrmicine ant, herbivory hindrance, mutualism

Parthenium hysterophorus L. (Asteraceae) is considered as one of the 'most invasive species in the world' by the Invasive Species Specialist Group of IUCN SSC (GISD, 2020). It is a common noxious weed in agricultural and urban areas of India. Mexican beetle, *Zygogramma bicolorata* Pallister was introduced from Mexico to India for biological control of *Parthenium* weed (Jayanth, 1987) and had established itself in many parts of India (Sushilkumar, 2009). Adults and grubs of Mexican beetle feed voraciously on *Parthenium* weed and satisfactorily reduce its density under natural field conditions. Other than Mexican beetle, other insect pests have been recorded on *Parthenium* plants. Among them, four species of treehoppers *viz*., *Coccosterphus minutus* (F.), *Oxyrhachis tarandus* (F.), *Telingana campbelli* Dist., and *Leptocentrus taurus* F. have been found feeding on *Parthenium* plants in India (Kumar *et al.,* 1979; Thangavelu, 1980). The treehopper, *Gargara malabarica* Ananthasubramanian and Ananthakrishnan (Membracidae, Homoptera) has been reported from the southern part of India feeding on Indian gooseberry, *Phyllanthus emblica* L. (Phyllanthaceae) (Ananthasubramanian and Ananthakrishnan, 1975). However it has not been

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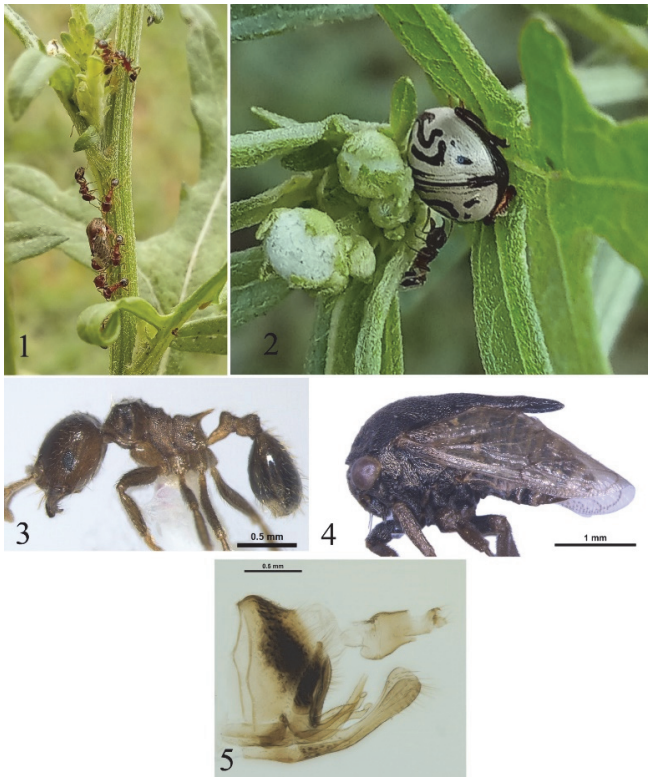
reported from Madhya Pradesh and its feeding on *Parthenium* plants. Ants are eusocial insects (Hymenoptera, Formicidae) that perform numerous ecological services like predation of a wide range of organisms, works as scavengers, help in nutrient cycling and enrichment of soils, myrmecochory, enhancing agricultural and horticultural productivity by biological control of herbivores (Way and Khoo, 1992; Choate and Drummond, 2011; Offenberg, 2015) and pathogens (Offenberg and Damgaard, 2019). *Lophomyrmex* Emery is a small, well-defined myrmicine ant genus represented by seven species in India. *Lophomyrmex quadrispinosus* (Jerdon) is the most widely distributed species of the genus in India (Bharti *et al.,* 2016). Workers of *Lophomyrmex* ants can be easily identified by the presence of 11 segmented antennae, masticatory margin of mandible with more than 8 teeth, anterior clypeal margin with a median anteriorly protruding point, pronotum with lateral irregular marginations or with anterolaterally directed dorsal teeth, propodeal spiracle well behind the margin of declivity in profile view, etc. These ants prey on small arthropods, act as scavengers of other organisms, harvest cotyledons from seeds, and they also respond strongly to bait like cooking oil, sugar water (Moffett, 1986).

Ant-treehopper mutualism is well known and widely reported phenomenon in nature. Their mutualism depends highly on the availability of honeydew (a sugar-rich nutritious liquid secreted by treehoppers). Ant tends treehoppers for their honeydew and in turn protect the treehoppers from their predators, parasitoids, and also the plant from other herbivores. The present study for the first time records the treehopper, *G. malabarica* from Madhya Pradesh, and *P. hysterophorus* as its new host record. The myrmicine ant, *L. quadrispinosus* was reported to be tending *G. malabarica* on *Parthenium* plants. The effect of this association, between treehopper and a myrmicine ant, on the population of biological control agent, *Z. bicolorata* of *Parthenium* plants has been statistically investigated here.

Observations were recorded on an area of 10×10 m^2 colonized by *Parthenium* weed along the bank of Morar river (26°14’06"N; 78°13’15"E), Gwalior (Madhya Pradesh). The effect of *Lophomyrmex* ants on the Mexican beetle population on *Parthenium* plants was studied. Five *Parthenium* plants were randomly selected in the study plot with the continuous presence of *Lophomyrmex* ant’s population tending treehoppers (*G. malabarica*) and another five *Parthenium* plants were selected which did not have the ant population. On each group of plants the presence of Mexican beetle population was recorded based on the number of eggs, grubs, and adults. Observations were recorded at three-day intervals from 11th August 2020 to 23rd August 2020. Further, a few specimens of ants and treehoppers on the *Parthenium* plants were collected. They were processed and mounted on card points and studied under the Leica S8AP0 stereo microscope. Photography was done using LEICA MC190 HD digital camera attached to the LEICA M205 C stereozoom automountage microscope. The identification of species was done based on available taxonomic literature (Ananthasubramanian, 1996; Sheela and Ghosh, 2008; Bharti and Kumar, 2012). All data recorded were subjected to student’s ‘t’ test after $\sqrt{x+0.5}$ transformations, at 5 per cent level of significance and n-1 degrees of freedom.

The treehopper was identified as *Gargara malabarica* Ananthasubramanian & Ananthakrishnan and the ant as *Lophomyrmex quadrispinosus* (Jerdon) (Hymenoptera: Formicidae). This is the first report of *G. malabarica* to be feeding on *Parthenium* plants, and also the myrmicine ant, *L. quadrispinosus* tending nymphs and adults of this treehopper. Analysis of the recorded data indicated that *Lophomyrmex* ants influenced the population of Mexican beetle on *Parthenium* plants (Table 1). *Parthenium* plants with *Lophomyrmex* ant population harbored significantly less mean number of Mexican beetle grubs (6/five plants) and adults (1.4/five plants) compared to plants without ants (23.6/five plants and 10.4/five plants, respectively) with ‘t’ values of 4.56 and 4.17, respectively. While the mean number of beetle eggs was lower too on plants with ant population but was non-significant (t value=2.73). The ants were observed to annoy the adult beetles by biting them and not letting them



Figs. 1-5: 1. *Lophomyrmex* ants tending treehopper (*G. malabarica*) on *Parthenium* plants; 2. *Lophomyrmex* ants annoying *Z. bicolorata* adults from staying on *Parthenium* plants; 3. *L. quadrispinosus* worker in profile view; 4. *G. malabarica* ♂; 5. Genital capsule of *G. malabarica* ♂

settle on *Parthenium* plants. This behavior of ants presumably led to the lower population of Mexican beetle and ultimately less damage to *Parthenium* plants with presence of ants.

Table 1. Effect of *Lophomyrmex* ant's population on Mexican beetle population

No.	Date	Plants with ants			Plants without ants		
		Numbers/ five plants			Numbers/ five plants		
		Egg	Grub	Adult	Egg	Grub	Adult
1	11/8/2020	6	1	1	7	17	10
2	14/8/2020	12	6	2	89	10	7
3	17/8/2020	13	4	1	59	13	15
4	20/8/2020	28	8	1	40	33	16
5	23/8/2020	6	11	2	29	45	4
Mean		13	6	1.4	44.4	23.6	10.4
't' value		Eggs (2.73), Grubs (4.56), Adults (4.17)					

't' value calculated based on the √x+0.5 transformed values and 't' table value at 4 df- 2.78

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