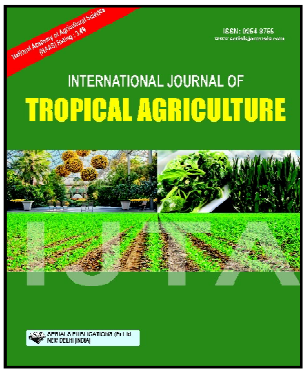

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Is an Invasive Species a Threat to Crop Pollination in Agroecosystem?: A Case Study with *Mikania micrantha* (l) Kunth

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Abstract: Study on insect pollinators in an invasive plant species Mikania micrantha was done in the agroecosystem in Wayanad, Kerala, a part of Western Ghats. The pollinators were collected from various parts of the study area by random sampling method. They were representing three major orders such as Hymenoptera, Lepidoptera and Coleoptera. Peak of foraging was found varying with diurnal variations.

Key words: Agroecosystem, Pollinator, Invasive species

Many ecosystems, including many agro-ecosystems, depend on pollinator diversity to maintain overall biological diversity (Sandland *et al.*, 1999). The introduction of a new species to a community can have important consequences for the structure of the plant-pollinator network (Vila *et al.*, 2009). It has long been established that alien plants can interfere with native plants through direct competition for abiotic resources, *i.e.*, soil nutrients, water, space and light (Levine *et al.*, 2003). The inhibition of native species could be due to competition for resources such as light, nutrients, or water (Belote and Weltzin, 2006). Alien plants invade many ecosystems worldwide and have substantial negative eûects on community and function (Higgins, *et al.*, 1996). Invasive plants often are able to utilize local pollinators so that they can produce seed in foreign environments. The spread of nonindigenous insects also allows nonindigenous plants to spread.. They occur on every continent, especially in disturbed habitats (Drayton and Primack, 1996; Lake and Leishman, 2004), and have caused great economic costs and environmental problems (Alpert, *et al.*, 2000; Richardson, *et al.*, 2000).

MATERIALS AND METHODS

The study was conducted on plant *Mikania micrantha* (Asteraceae) which is a perennial creeping climber known for its vigorous and rampant growth. The inflorescence is terminal or axillary panicled corymb. Individual florets are white to greenish-white. It reproduces sexually by seeds and vegetatively by rooting at nodes (Holm *et al.*, 1991). *M. micrantha* grows best where fertility, organic matter, soil moisture and humidity are all high. It occurs in agricultural areas, coast land, natural forests, planted forests, riparian zones, disturbed, scrub/shrub lands, urban areas, wet lands. This plant is an important weed of newly planted plantation crops, such as tea, oil palms, coconuts, cacao, and coffee. It covers the crops with a dense mat of foliage, shading them and even causing breakage (Abraham and Abraham, 2005). *M. micrantha* damages or kills other plants by cutting out the light and smothering them. In this respect it is especially damaging in young plantations and nurseries. It also competes for water and nutrients, but perhaps even more importantly, it is believed that the plant releases substances that inhibit the growth of other plants (Day *et al.*, 2016).

The study was conducted in Agro ecosystems in Wayanad district of Kerala, India.Wayanad lies between North latitude 11^0 26' 28" and 11^0 58' 22" and East longitude 75^0 46' 38" and 76^0 26' 11".Climate of the area is tropical with hot summer and cold winter. The Agro Ecosystems in this study consists of several agricultural crops around. The crops planted here were mainly banana, rice, coconut, coffee and vegetables.

Random sampling method was used to find out potential pollinators of *M. micrantha* in the study area. Observations were made on selected plants in 8 patches. Each inflorescence in a plant was observed for 10 minutes in each time interval. Thus 24 inflorescences were observed in each diurnal phase. The three diurnal phases were initial diurnal phase-idp (0700-1100 hr), middle diurnal phase-mdp (1100 hr-1500 hr) and late diurnal phase-ldp (1500-1900 hr). Observations were carried out in these different time intervals of four hour duration in alternative days over the course of floral anthesis.

To study pollinator diversity, species were collected alive from the field. After that, preservation and identification were done for the study of specimens. **C**ollection was done throughout the flowering season using hand net and collected pollinators were narcotized with chloroform and were kept in the insect box. The collected pollinators were identified to the lowest taxonomic level by using standard identification keys.

To study temporal variations in pollinator diversity, visitation frequency of insect pollinators on each inflorescence in different time intervals were taken. The type and number of insects visited, and their frequencies of visit were noted. The insect was counted as a pollinator if it went so far into the flower that contact with anthers and pistils was probable.

All observations were made on warm sunny days. The data were pooled for statistical analysis. The statistical analyses were executed using pictograms such as bar diagrams, pie diagrams, etc. These were done with the help of Microsoft Excel software package. The diversity differences were found using diversity indices with the help of Biodiversity Pro and Past software packages. Using ANOVA significance was found out. Diversity indices used to analyze the data were, Simpson's index or Simpson's density index (Simpson, 1949) & Shannon index or Shannon-Wiener index (Shannon-Wiener,1963). Species richness (SR) was calculated using the formula given by Menhinick (1964)

RESULTS

The diversity and visitation frequency of pollinators of *M.micrantha* in different diurnal phases varied. Higher frequency was found in the ldp which was followed by mdp and idp. It was found that there were 20 % of species present in idp, 37.5 % in mdp

and 42.5% in ldp. However no significant difference was found between orders, families and species of pollinators in different diurnal phases ($p>0.05$).

Among the pollinators Hymenopterans were abundant (97.18%) which was followed by Lepidopterans (2.35%) and Coleopterans (0.47%). There were ten insect Families such as Apidae (73.88%), Halictidae (5.12%), Formicidae (17.36%), Sphecidae (0.17%), Scolidae (0.17%), Vespidae (0.14%) Chrysididae (0.34%), Papilionidae (0.67%), Nymphalidae (1.35%) and Pieridae (0.33%). It was found that seven bee species' were visiting *M. micrantha* such as *Apis Cerana* (6.67%), *Trigona iridipennis* (66.53%), *Halictus timidus* (4.1%), *Ceratina smaragdula* (0.85%), *Halictus taprobanae* (0.17%), *Apis dorsata* (0.51%), *Apis florea* (0.17%). There were 4 ants such as *Camponotus japonicus* (5.58%), *Anoplolepis gracilipes* (4.44%), *Anochetus risii* (2.56%) and *Oecophylla smargdina* (4.78%). Also seven wasps were found such as *Vespa orientalis* (0.07%), *Scolia soror (0.06%), Vespa mandarinia* (0.05%), *Sceliphron caementarium* (0.17%), *Colpa sexmaculata* (0.11%), *Zethus spinipes* (0.02%) and *Pseudomalus auratus* (0.34%). The seven butterflies found were *Graphium sarpedon* (0.36%), *Papilio polymnestor* (0.31%), *Junonia iphita* (0.34%), *Delias eucharis* (0.16%), *Ypthima baldus* (0.42%), *Euploea core* (0.34%) and *Eurema hecabe* (0.17%).There were two beetles such as *Trichius zonatus* (0.14%) and *Charidotella sexpunctata* (0.33%). Amongst the different species *T. iridipennis* recorded maximum number of visit in keeping with their status as the predominant group of insect visitors in the *M. micrantha* in the agroecosystem. The least abundant and rare species was *Zethus spinipes* (Fig. 1).

As per the Simpson Index higher number of dominant species were found in the late phase (0.64) than middle phase (0.57) and initial phase (0.47). That is greater abundance of species was in the late phase which was followed by middle phase and initial phase (Fig. 2).

As per Shannon Index actual high pollinator diversity (H') was found in the late diurnal phase (0.73) followed by middle diurnal phase (0.64)and initial diurnal phase(0.5). Species Richness was

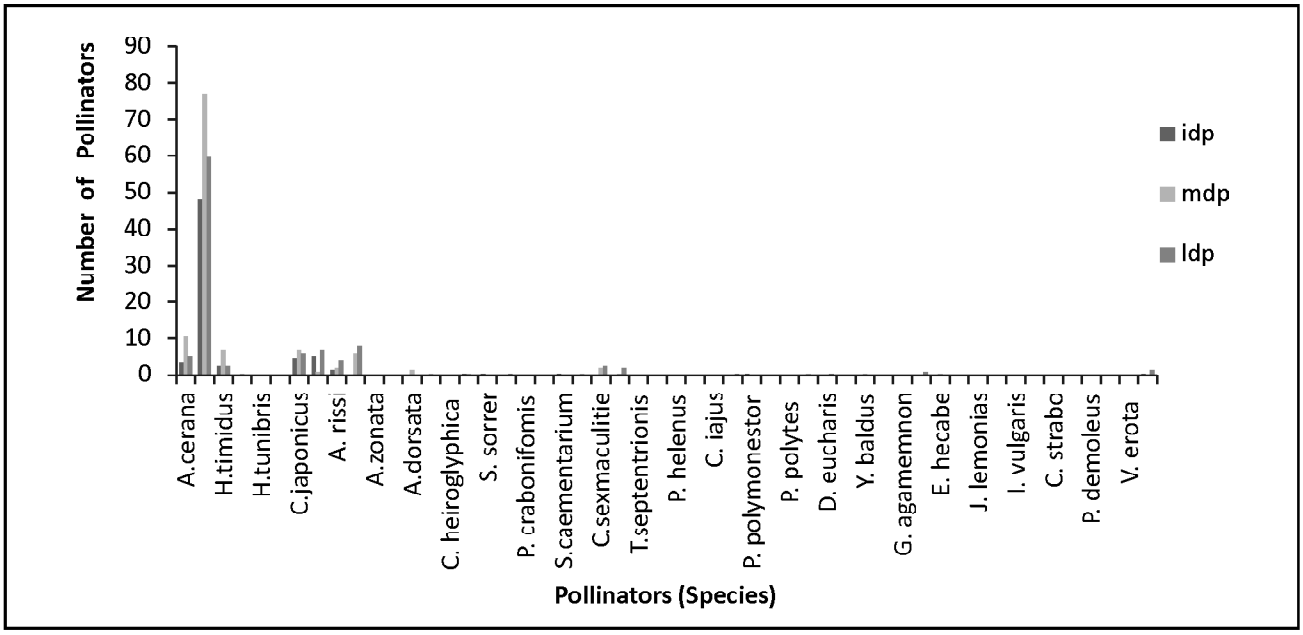

Figure 1: Frequency of pollinator (species) visit during diurnal phases/ day

idp-initial diurnal phase: 0700-1100 hr; mdp- middle diurnal phase :1100-1500 hr ; ldp –late diurnal phase:1500-1900hr

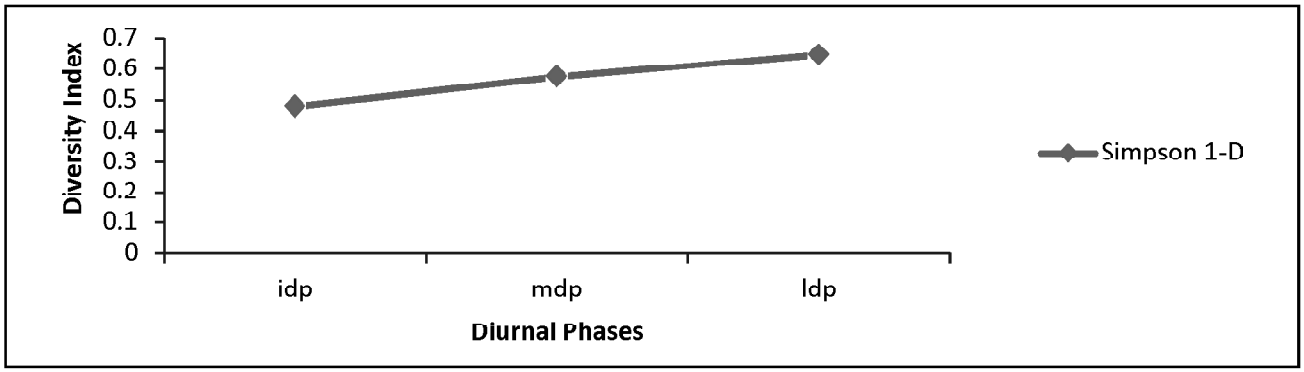

Figure 2: Simpson Index for pollinator diversity in different diurnal phases

idp-initial diurnal phase: 0700-1100 hr; mdp- middle diurnal phase :1100-1500 hr; ldp –late diurnal phase:1500-1900hr

greater in ldp (SR=2.68) than mdp (SR=2.37) and idp (SR=1.25). Maximum possible diversity (H_{max}) would be in the mdp (1.27) followed by ldp (1.2) and idp (1.04). Maximum evenness (J') was in the idp (0.6) followed by mdp (0.5) and minimum in ldp (0.48) (Fig. 3).

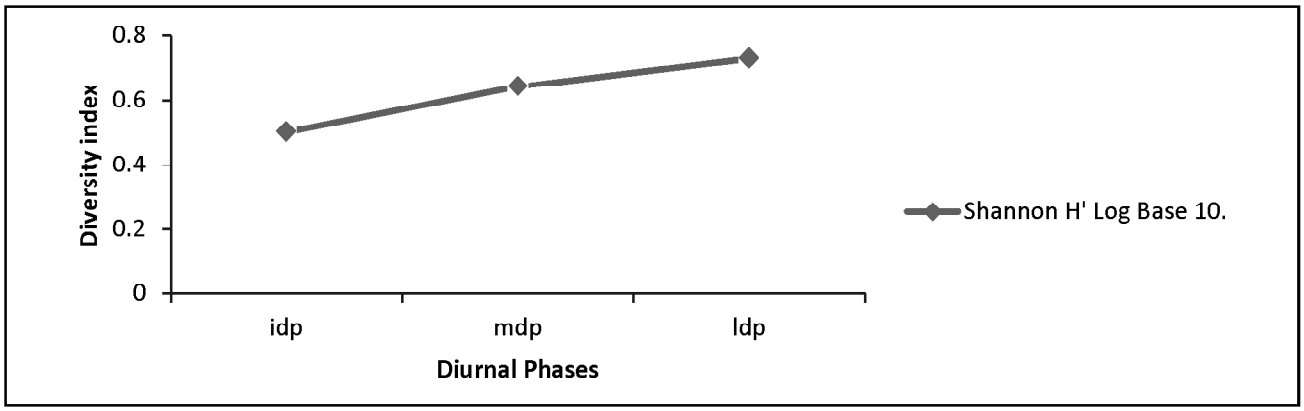

Figure 3: Shannon indices for pollinator diversity in different diurnal phases

idp-initial diurnal phase: 0700-1100 hr; mdp- middle diurnal phase :1100-1500 hr; ldp –late diurnal phase:1500-1900hr

DISCUSSION

Mikania micrantha is an invasive plant that is decreasing plant biodiversity across India (Zhang *et al.*, 2003). Biological invasions caused by the intentional or accidental introduction of alien species are threatening the conservation of biodiversity through the local displacement of native species, changes in community structure and the modiûcation of ecosystem function (Vitousek, 1994). The current global pollination crisis highlights the advantages of the provision of pollination services by a suite of which to assess any potential economic gain or loss provided by unmanaged taxa. This is because the intrinsic differences between taxa and their ecological tolerances should result in populations of individual species responding diûerently to environmental change, such that changes in abundance will not be temporally or spatially coordinated across species (Herrera, 1990; Hoehn *et al.,* 2008).

The results of the present study demonstrate the importance of insects in the pollination of *Mikania*. It was found that insects belonging to three

different orders such as Hymenoptera, Lepidoptera and Coleoptera were visiting the flowers of this plant species. Hymenopterans are most abundant followed by Lepidoptera and Coleoptera. Matzenbacher (1985) verified that *M. micrantha* was visited by honey bees. Moreover, Gentry (1991) considered that *Mikania* species, because of their small white flowers, might be pollinated by various small insects including small bees, and even butterflies. In this study Hymenopterans represented about seven families such as Apidae, Halictidae, Forminidae, Vespidae, Scolidae, Sphecidae and Chysididae Among them Apidae was found most abundant. The contribution of Hymenoptera was major compared to other species of pollinators. The bees *Apis Cerana*, *Trigona iridipennis*, *Halictus timidus*, *Ceratina smaragdula*, *Halictus taprobanae*, *Apis dorsata* and *Apis florea* were the major species of bees found in this study and they showed higher frequency of flower visitation in *Mikania*. The most dominated species was *Trigona*. This may be a threat to the agroecosystem as bee species found in this study were recorded as major pollinators of agricultural crops especially vegetables (Leena *et al.*,2010). It was found that four types of ant species were pollinating this weed *Mikania micrantha*. They were *Componotus japonicus, Anochetus risii, Anoplolepis gracilipes, and Oecophylla smaragdina.* The umber was found varying in different diurnal phases. According to Kotch *et al.*, (2001) ant numbers can be modulated by variable nectar production, allowing defense to direct toward vulnerable or threatened parts of the plant. It was found that, seven wasp species belonging to four families such as Sphecidae, Scolidae, Vespidae, Chysididae were visiting this plant. Compared to other families, wasps were not frequent visitors in *Mikania*. They were complementary visitors. Order Lepidoptera constituted 2.35% of the total visitors. Three families such as Papilionidae, Pieridae and Nymphalidae were coming under this order. *Ypthima baldus* was most frequent one. They were highly active in day time. It may be because of the temperature and other environmental factors. Butterflies do not feed indiscriminately from any flowers that they may find; they have preferences for nectar with regard to its chemical composition, corolla tube length and height of flower (Gadgil and Kunte, 2000). There were two beetles, *Trichius zonata* and *Charidotella sexpunctata* which were not active pollinators of *Mikania micrantha.* This is in contradictory to the results obtained by Carolin *et al.* (2006). In the present study the peak of visiting frequency was at late diurnal phase (15 00 hr – 19 00hr) which was followed by middle diurnal phase (11 00hr – 15 00hr).Environmental factors and the plants having the same floral period had certain influence on the visiting frequency of *M. micrantha*. This is in concordance with the studies on *Mikania micrantha* H.B.K. in South China (Hong *et al.*, 2011). Some other studies (Ghazoul *et al.* 1998) demonstrate that disturbance can disrupt pollination processes by causing changes to the foraging behaviour of pollinators rather than to their abundance. This conclusion has relevance beyond the circumstances of this study, and particularly where invasive species have caused ecological change (Gigord *et al.* 1999). This will be a serious threat to the agroecosystem. According to Abraham *et al.* (2002) the growth and dry matter production of crop plants free of competition from *Mikania* were significantly better than those overgrown by the weed. In many other studies also *M.micrantha* was found to cause yield losses (Day *et al.,* 2012) and has been reported to have a negative impact upon many species of agricultural crops (Macanawal *et al.*, 2012)

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