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Insects Associated with Mustard Crop as Observed in an Agro-Ecosystem in Rajasthan, India

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Abstract - Mustard (*Brassica campestris*) is a major Rabi crop. It is an oilseed and is primarily consumed in the states of Assam, Bihar, Haryana, H.P., J.K., M.P., N.E. States, Orissa, Punjab, U.P., W.B., Maharashtra and Rajasthan. Ecologically, insects play many different roles as pests, predators and parasites, pollinators, decomposers and scavengers and so forth. The present study was undertaken to survey the insect fauna associated with this crop in an agro-ecosystem situated in the Indian desert in Jhunjhunu district situated in western Rajasthan. The insect visitors were surveyed and collected every week from November 2012 to June 2013 and consecutively for three years during the same tenure. Cage net was used for insect collection. In all, eighty insect species were found to be associated with the crop. Of these, 9 were coleopterans, 25 were lepidopterans, 9 were hemipterans, 19 were hymenopterans, 7 were dipterans, 5 were orthopterans, 3 were odonates and one was dictyopteran, neuropteran and embiopteran each.

Key words: Entomo-fauna, diversity, mustard, desert.

I. Introduction

The study concentrated on insects associated with mustard (*Brassica campestris*), a plant of economic importance and belonging to plant family Brassicaceae. Rajasthan and Uttar Pradesh produce the major share of mustard contributing to over 50% of the total Indian produce, which stands at an average of 5 million tons. In Rajasthan, the production of this crop is highly monsoon oriented. The districts in Rajasthan that produce mustard are Jaipur, Bhartpur, Alwar, Ganganer, Jhunjhunu and Bikaner. Mustard seeds are blackish colored, small and are a source of oil, oilcake and are also used as a spice.

Looking into the importance of this oil seed crop, the present study was undertaken to survey insects associated with mustard crop in an agro-ecosystem in Jhunjhunu, Rajasthan. Earlier, Bhardwaj et al.

(2012), Sima et al. (2012), Sima & Srivastava (2012) and Bhardwaj et al. (2014) have documented different insects from various crops in the agro-ecosystems of the region.

II. Materials and methods

The study area

The state of Rajasthan is the largest state of Indian republic. The study area is located at 28°08'N, 75°24' E and 28.13°N 75.4°E having an average elevation of 323 m (1059 feet) in the district Jhunjhunu. The agro-ecosystem in the form of crop field studied lies about 5 km away from the city of Jhunjhunu, covering an area of 1000 x 500 m. The field is irrigated by well water.

(a) Collection and preservation of entomo-fauna

The present study was based on the collection of insects associated with mustard crop cultivated in an agro-ecosystem in Jhunjhunu. The study of entomo-fauna was carried out in the agro-ecosystem from November 2012 to June 2013 and again during the same months in the consecutive year. An indigenously designed cage net of 1m×1m×1m of nylon mesh as also used by Saigal (2002), was used for the purpose. The cage covered the 1m³ volume while holding the crop inside. The fauna trapped within the cage was mechanically picked up. Using the cage insects were collected between 7a.m to 11a.m, and again in the afternoon from 5 p.m. to 7 p.m. Sampling was done fortnightly. Ten sampling sites in fields were selected at random during each collection at a time. Light-trap collections were made using 260 Watt mercury bulb in the field twice during each month and overnight collection was taken.

The insects collected by the above method were transferred to killing bottles containing ethyl acetate and the sacrificed insects were preserved. Large winged insects were put to dry preservation by pinning them in insect boxes, while, smaller insects were preserved in 70% alcohol.

The fauna were sorted into groups and identifications were made following pertinent literature. Help from the section of Entomology, Department of Agriculture, Bikaner and Desert Regional Station of the Zoological Survey of India, Jodhpur was also taken for identification and for confirmation.

The count of insect fauna collected using cage was averaged for each month and expressed as No/m³. As the study also incorporated pollinators, the flowering period of mustard crop was also recorded.

III. Results

During the present survey, insects were collected employing cage net. The cage net collection comprised of nine coleopteran, twenty five lepidopteran, nine hemipteran, nineteen hymenopteran, seven dipteran, five orthopteran, three odonates, one dictyopteran, neuropteran and embiopteran each.

Based on density, insects documented from the study area were categorized into dominant, frequent and rare forms, the observations of which have been presented in Table1. While comparing the densities of various insects, during different months of the surveyed period, maximum density was observed in the month of March followed by February while, minimum in the month of November.

In all, 80 insects belonging 10 orders and 39 families were collected and based on their number sixteen were dominant, thirty four were frequent and thirty one were rare. The highest density as well as diversity was observed in the month of March, while lowest was noted in the month of November.

Of the nine coleopteran species document two (*C. septempunctata* and *M. sexmaculatus*) were dominant, six (*A. bengalensis*, *Adoretus* sp., *P. nasutus*, *A. ferruginea*, *Cicindella* sp., *Mylocerus* sp. and *H. truncatulus*) were frequent and only *Ochodeus* sp. a rare form. Further, *A. bengalensis*, *Adoretus* sp. *C. septempunctata*, *M. sexmaculatus*, *Mylocerus* sp., *H. truncatulus* and *Cicindella* sp. were noted throughout the cropping period of mustard. *A. ipsilon*, *M. separata* and *Tephрина* sp. were the three dominant lepidopteran species; *C. vestalis*, *C. fieldii*, *E. hecabe*, *L. boeticus*, *D. chrysippus*, *J. orithya*, *E. insulana*, *M. separata*, *C. chalcites*, *H. peltigera*, *S. caffer*, *E. zinckenella* *H. recurvalis* and *C. indica* were the fourteen frequent forms while, *C. pomona*, *A. aurota*, *H. ornata*, *S. exigua*, *C. medinalis*, *U. pulchella*, unidentified species A and B were the rarely noted species. Also, *C. vastalis*, *D. chrysippus*, *E. insulana*, *M. separata*, *T. orichalcea*, *A. ipsilon*, *C. chalcites*, *H. peltigera*, *H. recurvalis*, *E. zineckenlla* and *Tephрина* sp. were noted to be regular visitors on the crop.

Of the nine hemipteran species collected, two (*N. viridula* and *L. erysimi*) were dominant, three (*B. hilaris*, *Piezodorus* sp. and *D. cingulatus*) were frequent and four (*A. spinidens*, *Aphenus* sp., *Clavigrella* sp. and *M. persicae*) were rare forms. Further, *N. viridulla* and *Piezodorus* sp. were always noted associated with this crop.

A. cerana, *A. florea*, *A. mellifera* were the three dominant hymenopteran species reckoned from this crop, while the six frequent forms included, *X. fenestrata*, *A. dorsata*, *D. affinis*, *Formica* sp., *S. brunneum* and *Enicospilus* sp. and ten rare forms documented were *A. cingulata*, *X. violacea*, *Polistes* sp., *D. campaniforme*, *A. proxima*, *C. dugesi*, *Delta* sp. and Unidentified spp. B, D, E. Also, *X. fenestrata*, *A. cerana*, *A. mellifera*, *A. dorsata*, *D. affinis*, *Formica* sp. and *Enicospilus* sp. were always noted on the crop during the survey. *M. religiosa* was noted as a rare dictyopteran. Among five orthopteran species documented, two (*Chrotogonus* sp. and *Ochrilidia* sp.) were dominant, two (*O. chinensis* and *G. assimiles*) were frequent and only one *Acrida* sp. was a rare form. Seven dipteran species were reckoned which included two dominant (*M. domestica* and *C. quinquefasciatus*), two frequent (*C. megacephala* and *C. rufifacies*) and three (*Musca nibulo*, *Anthrax* sp. and *Stichopogon* sp.) rare forms. Five orthopteran species documented were *Chrotogonus* sp., *Ochrilidia* sp., *O. chinensis*, *G. assimiles* and *Acrida* sp.; Among three odonate species observed, *P. flavascens* was frequent, while *A. femina*, *B. geminata* and *R. nursei* were rarely documented. *C. carnea* was observed to be a dominant neuropteran visiting the crop, while *Oligotoma* sp. was a rare embiopteran noted on the crop. The inflorescence of mustard was found to be visited by 25 species of insects which included *C. septempunctata*, *M. sexmaculatus*, *Mylocerus* sp., *C. pomana*, *C. vestalis*, *C. fieldii*, *E. hecabe*, *A. aurota*, *D. chrysippus*, *L. boeticus*, *J. orithya*, *S. exigua*, *H. recurvalis*, *U. pulchella*, *Tephрина* sp., *X. fenestrata*, *X. violacea*, *A. cerana*, *A. mellifera*, *A. dorsata*, *A. florea*, *Polistes* sp., *C. megacephala*, *C. rufifacies* and *C. carnea*

IV. Discussion

Mustard has been noted to be attacked by different pests which include *Lipaphis erysimi*, *A. proxima*, *Bagrada cruciferarum*, *Myzus persicae*, *Bemisia tabaci*, *Phyllotreta cruciferae*, *Plutella xylostella*, *Crocidolomia binotalis*, *Diacrisia obliqua*, *Agrotis ypsilon*, *Phytomyza atricornis* as reported by Kumar & Nigam (1991). Mustard crop has been observed to be attacked by various pests which include *Lipaphis erysimi*, *Myzus persicae*, *Brevicoryne brassicae*, *Bemisia tabaci*, *Bagrada cruciferarum*, *Aeolothrips collairs*, *Thrips flavus*, *Plutella xylostella*, *Crocidolomia binotalis*, *Hellula undalis*, *Pieris*

brassica, *Diacrisia obliqua*, *Agrotis ipsilon*, *Phytomyza atricornis*, *Athalia lugens proxima* and *Phyllotreta cruciferae* has been suggested by Nayar *et al.* (1998) and support the present findings.

Coleoptera

C. septumpunctata and *M. sexmaculatus* both belonging to family Coccinellidae have also been observed by Bhardwaj (2009). Thapa (2006) reported lady beetle *Coccinella* on cucumber, pumpkin and brinjal. Goodman *et al.* (2001) observed *Coccinella* on buck wheat, Dunne (2001) on *Foeniculum vulgare*, Ahmed (1976) on Alfalfa and Singh (1983) on mango. Heiser (1997) observed cucumber beetle on bottle gourd. *M. sexmaculatus* as visitors of mango has been reported by Sung *et al.* (2006), while, Patt (2000) and Anbrisomo *et al.* (2006) reported coccinellids as pests of *C. sativum*. Tybirk (1989) recorded beetles as visitors of *Acacia*. Gottsberger (1990) studied the relationship between flowers and beetles in the South American tropics. Sakai and Inone (1999) recorded beetles on *Orchidantha inouei*. Coleopterans were noted as pollinators of an umbelliferous plant carrot by Ahmed & Aslam (2002). Samantha (2003) found pollen feeding beetle to be attracted towards the flowers of oil seed rape. Njorage *et al.* (2004) observed beetles as pollinators of *Citrullus lanatus*. Coleopterans were noted on the heads of Mikania by Cerena (2004). Stork & Grimbacher (2006) captured 39% and 20% of beetle species exclusively in the canopy or near the ground, respectively. In contrast, about an equal proportion of beetle species were captured exclusively in the canopy (29%) or near the ground (31%) in the study.

Lepidoptera

C. pomona, *P. edusa* and *P. brassicae* were the three pierids collected from the region by Bhardwaj (2009). Bruysna *et al.* (2008) observed them on flowers of *Brassica nigra* and support the present findings. *Hymenia recurvalis* was one of the major forms documented and its population was found to increase May onwards and remained quite high up to December by Bhardwaj (2009). Hussain *et al.* (2011) associated increase in number of butterfly species with winter seasons and their abundance fluctuation to be positively correlated with richness. Kunte (2001) studied the butterfly diversity of Pune city along the human impact gradient; Rane & Ranade (2004) studied butterflies of Tamhini-Dongarwadi area, Mulshi, Maharashtra; Padhye *et al.* (2006) studied season and landscape wise distribution of butterflies in Tamhini, northern Western Ghats of India; Sharma (2009) studied the fauna of Bhīma Shankar Wildlife Sanctuary, Maharashtra; Tiple *et al.* (2009) investigated butterfly-flower morphological interrelationships for 108 butterfly species and 20 plants at Nagpur. Butterfly species abundance was highly correlated with altitude, temperature, relative humidity, fire signs, and livestock abundance observed by Bhardwaj *et al.* (2011). All the above studies support the present observations.

Hemiptera

N. viridula was found to visit *T. erecta* by Bhardwaj (2009). Thapa (2006) also reported *N. viridula* to visit the flowers of rape seed which corroborate the present findings and Rovira *et al.* (2003) suggested stink bug as pollinator of *Seseli ferrenyi*. The population of *D. cingulatus* was found to be more during June -July, while, that of *D. koenigii* was seen in the month of April by Bhardwaj (2009). *D. cingulatus* in general, preferred to visit the flowers of *C. melo*, *L. siceraria* and *L. cylindrica*, while, *D. koenigii* mostly was noted on *T. erecta* as noted by the authors. Bug as a pollinator of *L. siceraria* has also been observed by Srivastava (2000) supporting the present observations. Hemipterans are less suited for pollination. Hemipterans were noted on the heads of Mikania by Cerana (2004). Sung *et al.* (2006) reported hemipterans as floral visitors of mango. In all, six hemipteran species viz. *Lipaphis erysimi*, *Myzus persicae*, *Dysdercus cingulatus*, *Bagrada hilaris*, *Lapricus varicornis* and *Nezara graminea* were reported earlier by Dhas (2007).

Hymenoptera

Agarwal & Rastogi (2008) noticed hymenopterans on the flowers of *L. cylindrica*. According to Hodges & Baxendale (2007) cucumber flowers are exclusively pollinated by honeybees and it takes at least 9 honeybee visits / flower to pollinate cucumber adequately. Carrillo *et al.* (2007) observed honeybees as pollinators of *C. melo* which is also in conformation to the present findings. Morimoto *et al.* (2004) observed honeybee *A. mellifera* as active floral visitor of *L. siceraria*. Defni & Ducas (1986) recorded *Polistes gellicus* as pollinator of *Urginea maritima* (Liliaceae), Hannan (2007) found *Polistes* to visit *Sesamum* flowers. Tangmitcharoen *et al.* (2006) noted *P. stigma* as potential pollinator of teak flowers or inflorescence. Milk weed has been found to be pollinated by *Polistes* as reported by Kephart (1983) and Ivey *et al.* (2003). Hannan (2007) found wasps mostly during April and May. According to Martin (1993) *Polistes* sp. are very common floral visitors of *Acacia* with little pollen movement. Valdivia & Niemeyer (2006) also reported *Polistes buyssoni* as diurnal floral visitor. Patt (2000) found that umbels such as coriander, dill, fennel, caraway are very attractive beneficial insects like wasp. Visitation rate of *P. carolina* was noticed from 1–27 visits / man / h. *S. duvia* as insect pollinator of milk weed, *Scolia* sp. as flower visitors of *Sesamum* and *S. ruficeps* as potential pollinators of teak flowers were suggested by Ivey *et al.* (2006) respectively.

Vir *et al.*, (2002) reported 13 species of hymenopterans from leguminous trees of Thar Desert. Ichneumon wasps are parasites and mostly the hosts are lepidopterans. Many can also be seen feeding on flowers in the sunshine particularly umbelliferae. Vespidae wasps are basically carnivorous and feed on a wide range of insects and other invertebrates, but also seek nectar, honey and bite holes in ripe fruit to suck the sugary sap. Their role in agriculture is complex. They kill many crop pests and occasionally assist in pollination. Sphecidae wasps is a group which prey upon lepidopteran caterpillars, hemipterans, orthopterans and some have been recorded on thrips, may flies, spring tails, cockroaches, bees and even other wasps. All these findings support the present observations where a number of hymenopterans were collected from the crop under study.

Diptera

Small flies may be instrumental in the forest for shrubs with numerous, small inconspicuous, often dioeciously flowers was suggested by Larson *et al.* (2001) and Borkont & Harder (2007). Kaven (2002) suggested that pollination by very small flies deserves further study. According to Gilbert (1980) and Herrera (1988) flies exhibit marked diurnal activity patterns of flower visitation. Representatives of at least 25 Diptera families have been reported visiting flowers in the Oriental Region (Corbett, 2004). *Musca* sp. and *Calliphora* sp. pollinate umbelliferous plants (USDA, 2007). According to Kearns (2001) and Kevan (2002) in some instance plants are dependent are flies for pollination. *C. quinquefasciatus* is a domestic mosquito common in India found to breed in rain barrels, ground pools, ditches, pits, and drains, tanks, in standing water near houses and in sewers with high organic pollution. The adults take shelter in cow sheds, dark corners and also under fallen leaves. The male members of Culicidae are floral visitors which feed on nectar and other plant juices Borror & DeLong (1992). *Musca domestica* of family Muscidae was also collected from the study area. Houseflies are cosmopolitan in distribution and are found in abundance in hot and humid conditions. Presence of manure in agricultural fields is a preferred site for houseflies. Larson *et al.* (2001) reported at least 21 families of Diptera to contain flower visiting flies and also have been suggested to be pollinators of onion; while, Mitra & Banerjee (2007) reported cauliflower, mustard, carrots and apples to be pollinated by flies. Amongst dipterans *Culex pipiens* (Culicidae), *Musca domestica* and *M. nebulosa* (Muscidae), *Eristalis* sp. (Syrphidae), *Dacus cucurbita* (Tephritidae), *Tabanus* sp. (Tabanidae) and *Sarcophaga bravicornis* (Sarcophagidae) were documented by Bhardwaj (2009). Calliphoridae which includes blow flies; blue bottles and green bottles etc. adults

take liquid food, feed on nectar from flowers and therefore are important pollinators more open-flowered crops. During the present study dipterans were documented on mustard crop and therefore are in conformation with the above findings.

Dictyoptera

Dhas (2007) has also earlier reported *Mantis* sp. from the region as a rare form. Not much literature is available on dictyopterans in agro-ecosystems.

Orthoptera

Gryllacridinae are nocturnal foragers, climbing on branches and foliage while exploring the surroundings with their tremendously long antennae. *Chrotogonus* sp. and *Ochrilidia* sp., both belonging to family Acrididae were also reported by Bhardwaj (2009). Commonly known as short horned grasshoppers, these are plant feeders and are very destructive to vegetation. Orthopterans as visitors of sunflower have also been reported by Sarrag *et al.* (1993). *Mantids* are a part of the general natural insect predator complex and therefore can be regarded as natural control agents of insect pests. Crickets generally are detritivorous and omnivorous and some are herbivorous and can be pests of some importance. *Acheta domesticus* is cosmopolitan and present throughout the warmer parts of the world. *Chrotogonus* sp. is polyphagous surface grasshoppers found in the desert area of Asia and damage cotton, sorghum and millets. Locusts prefer diet of Gramineae family, grasses and crops but eat all plants during dry seasons. *Oxya* spp. is a small rice grasshopper and it feed on grasses and rice. All these reports by earlier workers support the present findings.

Odonata

Only one member of order Odonata, *Lestes* sp. (Lestidae), a rare form was observed during Kharif crop season by Dhas (2007). Odonates were also reported earlier by Saigal (2002) from tube-well irrigated field around Bikaner. *Pantala flavescens* and *Agriocnemis femina* were the two Odonates belonging to families Libellulidae and Coenagrionidae respectively observed by Bhardwaj (2009). The number of both the species was found to be high in the month of October by the author. Sarrag *et al.* (1993) have also recorded Odonates as visitors of sunflowers. These works by earlier authors are in conformation with the present findings.

Neuroptera

The present reports get support from the earlier studies of Dhas (2007), who also noted only *Chrysopa* sp., although Ghosh (1977) has reported 13 species of Neuroptera from the Indian desert of western Rajasthan. The commonly known green lacewing fly is a predaceous insect and preys upon aphids, jassids, psyllids, coccids, thrips, mites etc. In India *C. scelestes* is reported to be very common species by Pruthi (1969). Other related species found in India are *C. cymbele* and *C. madestes* and are found to prey upon leaf hopper in Punjab and *C. madestes* is a predator of lac insect Nayar *et al.* (1998). *Chrysopa* sp. was a rare species documented from December to May, maximum in the month of April by Bhardwaj (2009). All these studies support the present observations.

Embioptera

The nymphs and adult embiopteran females are herbivorous and feed on leaf litter, moss, bark and lichen. According to Ananthakrishnan & Ananthasubramanian (1956), of the eight families into

which Embioptera is divided, only two viz., Embiidae and Oligotomidae are represented in India. Earlier Imms (1913) and Davis (1940) have contributed to the knowledge of Indian Embioptera. Web spinners, although thought to be harmless and of no economic importance may become a significant pest in agriculture had been suggested by Argaman & Mendel (1991), who observed *Oligotoma* sp. to damage various fruits.

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Table 1. Entomofauna documented on mustard crop during the period of study

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	STATUS
Order: Coleoptera									
Family: Scarabaeidae									
<i>Anomala bengalensis</i>	5	7	4	6	13	-	-	-	F
<i>Ochodeus</i> sp.	-	-	-	-	1	-	-	-	R
<i>Peltonotus nasutus</i>	3	5	6	6	9	-	-	-	F
<i>Apogonia ferruginea</i>	-	7	6	4	8	-	-	-	F
Family: Coccinellidae									
<i>Coccinella septempunctata</i> *	11	17	25	55	71	-	-	-	D
<i>Menochilus sexmaculatus</i> *	10	11	13	20	27	-	-	-	D
Family: Curculionidae									
<i>Myloccerus</i> sp.*	9	8	11	15	19	-	-	-	F
<i>Hypolixus truncatulus</i>	6	4	2	8	5	-	-	-	F
Family: Cicindelidae									
<i>Cicindella</i> sp.	3	6	9	10	11	-	-	-	F
Order: Lepidoptera									
Family: Pieridae									
<i>Catopsila pomona</i> *	-	-	-		1	-	-	-	R
<i>Colotis vestalis</i> *	11	1	8	9	15	-	-	-	F
<i>Colias fieldii</i> *	-	4	7	8	7	-	-	-	F
<i>Eurema hecabe</i> *	-	3	4	6	5	-	-	-	F
<i>Anaphaes aurota</i> *	-	-	-	-	1	-	-	-	R
Family: Nymphalidae									
<i>Junonia orithya</i> *	-	1	1	3	9	-	-	-	F
Family: Lycaenidae									
<i>Lampides boeticus</i> *	-	-	2	6	5	-	-	-	F
Family: Crambidae									
<i>Hymenia recurvalis</i> *	6	17	14	12	18	-	-	-	F
<i>Cnaphalocrocis medinalis</i>	-	-	-	-	3	-	-	-	R
Family: Danaidae									
<i>Danaus chrysippus</i> *	2	6	4	3	10	-	-	-	F
Family: Hesperidae									
<i>Hesperilla ornata</i>	-	-	-	-	1	-	-	-	R
Family: Noctuidae									
<i>Earias insulana</i>	1	5	4	5	10	-	-	-	F
<i>Mythimna separata</i>	9	10	11	15	14	-	-	-	F
<i>Agrotis ipsilon</i>	10	10	15	20	34	-	-	-	D
<i>Chrysodeixis chalcites</i>	10	8	9	8	11	-	-	-	F
<i>Thysanoplusia orichalcea</i>	30	36	39	35	46	-	-	-	D
<i>Heliothis peltigera</i>	17	16	15	11	19	-	-	-	F
<i>Spodoptera exigua</i> *	-	-	-	1	2	-	-	-	R
Family: Pyralidae									
<i>Sphenarches caffer</i>	1	2	1	4	5	-	-	-	F
<i>Etiella zinckenella</i>	10	9	10	7	11	-	-	-	F

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	STATUS
Family:Arctidae									
<i>Utethesia pulchella</i> *	-	-	3	4	3	-	-	-	R
Family:Geometridae									
<i>Tephрина sp.*</i>	12	24	27	37	50	-	-	-	D
Unidentified species A	-	2	2	-	-	-	-		R
Unidentified species B	-	-	-	-	1	-	-	-	R
Order:Hemiptera									
Family:Pentatomidae									
<i>Nezara viridula</i>	16	17	15	18	38	-	-	-	D
<i>Bagrada hilaris</i>	-	16	24	15	19	-	-	-	F
<i>Andrallus spinidens</i>	-	-	-	1	4	-	-	-	R
<i>Piezodorus sp.</i>	5	4	8	5	6	-	-	-	F
Family:Pyrhocoridae									
<i>Dysdercus cingulatus</i>	-	5	7	9	14	-	-	-	F
Family:Lygaeidae									
<i>Aphanus sp.</i>	-	-	-	3	4	-	-	-	R
Family:Coeridae									
<i>Clavigrella sp.</i>	-	-	-	-	2	-	-	-	R
Family:Aphididae									
<i>Lipaphis erysimi</i>	-	11	22	29	51	-	-	-	D
<i>Myzus persicae</i>	-	-	-	-	1	-	-	-	R
Order:Hymenoptera									
Family:Apidae									
<i>Xylocopa fenestrata</i> *	3	4	4	8	6	-	-	-	F
<i>Xylocopa violacea</i> *	1	2	2	-	-	-	-	-	R
<i>Apis cerana</i> *	21	24	20	21	29	-	-	-	D
<i>Apis mellifera</i> *	22	25	29	30	33	-	-	-	D
<i>Apis dorsata</i> *	10	12	14	15	10	-	-	-	F
<i>Apis florea</i> *	15	18	22	30	36	-	-	-	D
<i>Amegila cingulata</i>	-	-	3	5	3	-	-	-	R
Family:Formicidae									
<i>Dolichoderus affinis</i>	4	5	6	10	17	-	-	-	F
<i>Formica sp.</i>	4	5	6	10	13	-	-	-	F
Family:Vespidae									
<i>Polistes sp.*</i>	3	5	-	-	-	-	-	-	R
<i>Delta campaniforme</i>	-	1	-	2	-	-	-	-	R
<i>Delta sp.</i>	-	-	6	5	-	-	-	-	R
Family:Tenthredinidae									
<i>Athalia proxima</i>	-	-	1	2	3	-	-	-	R
Family:Sphecidae									
<i>Sceliphron brunneum</i>	-	-	9	9	6	-	-	-	F
Family:Chrysomididae									
<i>Chrysis dugesi</i>	-	-	-	-	1	-	-	-	R
Family:Ichneumonidae									

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	STATUS
<i>Enicospilus</i> sp.	10	15	11	10	9	-	-	-	F
Unidentified species A	-	-	1	2	4	-	-	-	R
Unidentified species B	1	2	2	-	5	-	-	-	R
Unidentified species C	1	2	2	-	-	-	-	-	R
Order:Diptera									
Family:Muscidae									
<i>Musca nibulo</i>	5	6	8	-	-	-	-	-	R
<i>Musca domestica</i>	25	20	22	44	64	-	-	-	D
Family:Bombyliidae									
<i>Anthrax</i> sp.	-	2	1	5	2	-	-	-	R
Family:Culicidae									
<i>Culex quinquefasciatus</i>	23	25	24	26	20	-	-	-	D
Family:Calliphoridae									
<i>Chrysomya megacephala</i> *	5	3	5	6	10	-	-	-	F
<i>Chrysomya rufifacies</i> *	5	-	3	2	6	-	-	-	F
Family:Asilidae									
<i>Stichopogon</i> sp.	-	-	1	2	3	-	-	-	R
Order:Dictyoptera									
Family:Mantidae									
<i>Mantis religiosa</i>	-	-	-	2	-	-	-	-	R
Order:Orthoptera									
Family:Acrididae									
<i>Chrotogonus</i> sp.	26	39	42	54	55	-	-	-	D
<i>Ochridia</i> sp.	10	25	31	33	56	-	-	-	D
<i>Oxya chinensis</i>	-	-	1	5	20	-	-	-	F
<i>Acrida</i> sp.	-	-	-	-	1	-	-	-	R
Family:Gryllidae									
<i>Gryllus assimilis</i>	-	2	7	6	10	-	-	-	F
Order:Odonata									
Family:Libellulidae									
<i>Bradinyopyga geminata</i>	4	2	4	6	-	-	-	-	F
Family:Coenagrionidae									
<i>Agriocnemis femina</i>	-	-	-	-	1	-	-	-	R
<i>Rhodischnura nursei</i>	-	-	1	1	-	-	-	-	R
Order:Neuroptera									
Family:Chrysopidae									
<i>Chrysopa carnea</i> *	20	15	21	51	50	-	-	-	D
Order:Embioptera									
Family:Oligotomidae									
<i>Oligotoma</i> sp.	-	-	-	1	1	-	-	-	R

D-Dominant, D>100 ; F-Frequent , 100>F>16; R-Rare, R≥16; *- Flower visitors