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(RESEARCH ARTICLE)

Diversity of foliage insects around different canal territories: A case study of Dingroo and Kamal Pur canal, Faisalabad, Pakistan

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Abstract

Diversity Indices are key components to draw the natural lines regarding taxa composition pertaining to any managed or unmanaged landscaping. They consist of diversity, evenness, dominance and richness of inhabiting taxa in that area. This study was carried out to check the diversity among species of class insecta near Kamal Pur canal and Dingroo canal of District Faisalabad, Punjab, Pakistan. Total 117 specimens were collected belonging to 7 orders, 17 families, 22 genera and 27 species from Dingroo canal while total 140 specimens were collected belonging to 7 orders, 23 families, 29 genera and 32 species from Kamal Pur canal. So, keeping in view the importance of these aspects, calculations were made as per Shannon Diversity Index and SPDIVERS.BAS software. Diversity was recorded maximum in Kamal Pur canal (1.0350) while least diversity was recorded for Dingroo canal (1.0293). Diversity maximum (H'_{max}) was recorded highest for Kamal Pur (2.1461), While least diversity maximum (H'_{max}) was recorded for Dingroo canal (2.0682). Evenness was recorded maximum for Kamal Pur (0.0163) while least was recorded for Dingroo canal (0.0141). Dominance (D) was recorded maximum for Kamal Pur canal (1.0163) While least recorded for Dingroo canal (1.0141). The value for richness was recorded maximum in Kamal Pur canal (9.8868) whereas least was recorded for Dingroo canal (9.1769). From Dingroo canal, relative abundance recorded maximum for genus *Empis* 19.66% (N = 23). From Kamal Pur canal, *Apis* was recorded as an extraordinary genus with relative abundance of 12.14% (N = 17).

Keywords: Diversity; Population; Water body; Insect; Wet territory

1. Introduction

Biodiversity is the capriciousness around living organisms including terrestrial, marine and other aquatic ecosystems. It is the variation in species, among species or communities in same or different ecosystems. Insects are so diverse, that they are about one third of overall population of different species inhibiting earth. It is the most diverse group of invertebrates may be found in nearly all environments, although only a small number of species reside in the oceans, a habitat dominated by another arthropod group, crustaceans [1].

They are the mainly eminent pollinators of agricultural ecosystem and 30% of production is favored by pollination. Bee pollination is the main sources for betterment of crop productivity and play important role in natural ecosystem conservation [2]. Thus, honey bees (*A. mellifera*), is the most vital as flower visitor and most proficient *B. napus* pollinator [3]. The role of insects in the improvement of natural vegetation is much more clearly demonstrated in the field of forestry than in agriculture [4].

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Silkworms and bees have been used extensively by humans to produce silk and honey, respectively [5]. Some insects damage crops as pest by feeding on sap, leaves or fruits. Of the 1 million described insect species, only 5000 can be considered harmful to crops, livestock or human beings [6].

They simultaneously attack on crop with two different stages vegetative stage (root grubs, mites, aphids, and thrips and ragi cut worm) and reproductive stage (flowering thrips, mites, aphids, cut worm) [7]. Their population increase in spring season and can be extremely injurious if present in large number [8]. Lepidoptera inhabit all terrestrial habitats ranging from grasslands to mountain plateaus, desert to rainforest but it is mostly associated with flowering plants [9]. Order Hemiptera or true bugs live in majority of habitats, generally terrestrial and some species live their life in or on the surface of fresh water. Coleoptera or beetle is largest order of insects having 350,000-400,000 species that make up 40% of all insect species i.e. 30% of all animals. They are found in all-natural environments such as in freshwater and marine habitats, where vegetative foliage is found [10].

Order Hymenoptera is third largest order of insects which is further classified in two suborders: Symphyta and Apocrita [11]. 150,000 species of sawflies, wasps, bees and ants [12]. The most primordial forms are characteristically herbivorous, feeding on leaves or pine needles while stinging wasps are predators and bees feed on nectar and pollen [13]. Pheromones are chemicals that are secreted by the organisms to restrict them in their own territory [14]. This study was designed to evaluate the abundance of different families which belong to class insecta. Our foicus was on those insects which reside near water bodies such as canals. Most of the insect that were collected during sampling belongs to two families Empididae, Acrididae and three orders Coleoptera, Orthoptera, Diaptera, respectively.

Keeping in view the ecological interaction of foliage insects with vegetation alongside the water bodies; the present study was proposed to find the diversity and relative abundance of foliage arthropods along wet territories.

2. Materials and methods

2.1. Study area

Present study was conducted around the vegetation of Dingroo and Kamal pur, Faisalabad, Punjab, Pakistan in 2016 and study was consisting of rolling flat plains, between longitude 73°74 E, latitude 30° 31.5° N, with an elevation of 184 meters (604 ft) above sea level including area 58.56 km^2. It is bound on the North by Chiniot, on the East by Sheikhupura and Sahiwal, on the South by Sahiwal and Toba Tek Singh and on the West by Jhang Districts. Vegetation was consisting of different herbs/ shrubs, grasses and different crops: *Triticum aestivum* (wheat), *Brassica compestris* (mustard), *Trifolium alexandrium* (barseen) and *Saccharum officinarum* (sugarcane).

Figure 1 Dingroo canal

A B

Figure 2 Vegetation along A) Dingroo canal B) Kamal Pur canal

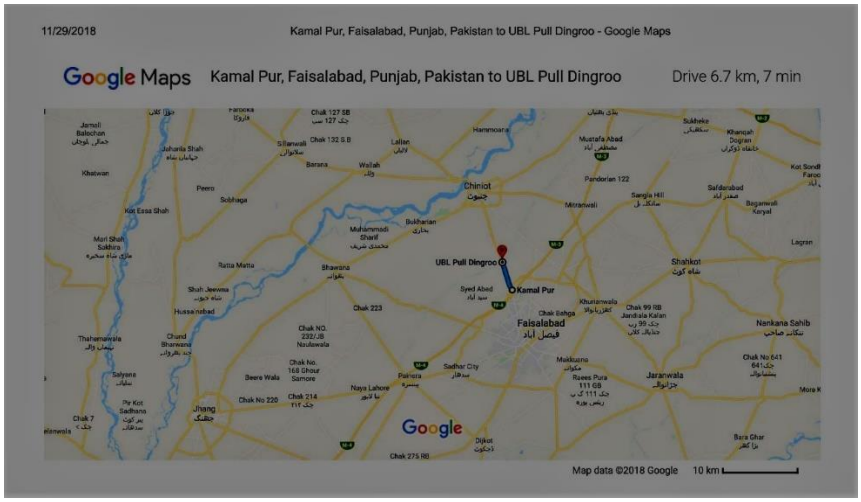

Figure 3 Location of both sampling sites on Google map

2.2. Collection of data

To collect the foliage insects fauna from both canal territories were sampled weekly for two hours from 6:00 am to 8:00 am during months by following methods: Direct hand picking, by using sweep net and by using forceps. Total 117 specimens were collected. Collected specimens were stored in jars containing 70:30% alcohol and glycerin solution and thereafter collected specimens were shifted to Biodiversity Laboratory, Department of Zoology, Wildlife and Fisheries, University of Agriculture, Faisalabad for further systematic studies. Here, the specimens were separated and preserved in separate glass vials, containing 70:30% alcohol and glycerin solution for further identification. The glass vials were labeled as sampling number, canal name, date and time of sampling. The collected specimens were identified and sorted with the aid of naked eye, magnifying glass and microscope. The identifications were conducted based on morphological characters. All the specimens were identified up to species level according to the taxonomic/ reference material [15].

2.3. Statistical analysis

Thereafter, all the observed specimens were arranged in table form according to their morphological and taxonomic characters e.g. order, family, genus and species. To determine the various aspects of diversity, Shannon Diversity Index was used [16].

$$Diversity\ (H'): H' = -\sum pi\ ln\ pi$$

Where p_i is the proportion of individuals found in the ith species. The value of p_i is estimated as n_i/ N.

2.3.1. Maximum diversity

$$H_{max} = -\sum_{i=1}^{S} \frac{1}{S} \ln \frac{1}{S} = \ln S$$

2.3.2. Evenness "Hill's Modified Ratio (E)"

$$E = \frac{\left(\frac{1}{\lambda}\right)}{e^{H-1}} = N^{2-1}/N^{1-1}$$

Where, E is the index of evenness, λ is the Simpson's index of diversity and N1 and N2 are the number of abundant and very abundant species respectively in the sample. The richness, diversity and evenness indices were computed by using the Program SPDIVERS.BAS.

2.3.3. Richness

$$S = n + (n - 1/n)^k$$

Where, S = species richness, n = total number of species present in sample population, k = number of "unique" species (of which only one organism was found in sample population).

2.3.4. Dominance

$$D = 1\text{-}E$$

Where, "E" is evenness.

3. Results and discussion

After completing the whole research trials as per methodology, total 117 specimens were collected belonging to 7 orders, 17 families, 22 genera and 27 species from Dingroo canal while, total 140 specimens were collected belonging to 7 orders, 23 families, 29 genera and 32 species from Kamal Pur canal (Table 1).

Table 1 Overall taxa composition around Dingroo and Kamal Pur canals

Categories	Frequency	
	Dingroo canal	Kamal Pur canal
Order	7	7
Families	17	23
Genus	22	29
Species	27	32

Abundance, density, biomass and diversity of insects were recorded from the fish ponds. A total of 27.381 individuals belonging to 64 taxa, 25 families and 7 orders (Hymenoptera, Diptera, Lepidoptera, Hemiptera, Orthoptera, Coleoptera, Odonata were collected). Around these seven orders, Hemipterans dominated species were *Anisops sardea* Kirkaldy 1904 (64.17%), *Plea pullula stal* 1855 (5.87%), *Eurymetra* Spp. (3.87%), *Ampphiops* spp. (3.79%), *Mesovelia* spp. (3.41 percent) and *Cloeon bellum* Navas (2.21 percent). A spatiotemporal variation was observed for the different record parameter (density biomass and diversity). The maximum abundance, density, and biomass were recorded throughout the showery period [17-19].

From the overall data of Dingroo canal (Table 2), *Empis livida* (Diptera: Empididae) was recorded as an extraordinary contributing species with relative abundance of 19.66% (N = 23), followed by *Episyrphus balteatus* (Diptera: Syrphidae), 11.11% (N = 13), *Coccinella magnifica* (Coleoptera: Coccinellidae) 8.55% (N = 10), *Valanga irregularis* (Orthoptera: Acrididae) and *Conocephalus longipennis* (Orthoptera: Tettigoniidae) 6.84% (N = 8), *Musca domestica* (Diptera: Muscidae), 5.92 (N = 7), *Pieris rapae* (Lepidoptera: Pieridae), 5.13% (N = 6).

Table 2 Overall relative abundance of recorded species around Dingroo and Kamal Pur canals

Order	Family	Species	Relative Abundance (%)	
			Dingroo canal	Kamal Pur canal
Hymenoptera	Formicidae	*Lasius niger*	0.85(1)	0.71(1)
	Apidae	*Apis dorsata*	4.28(5)	12.14(17)
	Vespidae	*Polistes watti*	3.42(4)	4.29(6)
	Pompilidae	*Auplopus mellipes*	0.00(0)	0.71(1)
Diptera	Syrphidae	*Episyrphus balteatus*	11.11(13)	6.44(9)
	Tipulidae	*Nephrotoma appendiculata*	0.00(0)	1.42(2)
	Muscidae	*Musca domestica*	5.98(7)	10.00(14)
	Culicidae	*Aedes atropalpus*	0.85(1)	0.00(0)
	Empididae	*Empis livida*	19.66(23)	11.45(16)
Lepidoptera	Pieridae	*Pieris rapae*	5.13(6)	2.15(3)
	Nymphalidae	*Limenitis archippus*	4.27(5)	7.87(11)
		Danaus chrysippus	0.00(0)	0.71(1)
Hemiptera	Lygaeidae	*Spilostethus pandurus*	0.85(1)	0.00(0)
		Oncopeltus fasciatus	2.58(3)	0.00(0)
	Coreidae	*Homoeocerus* spp.	0.00(0)	0.71(1)
	Pentatomidae	*Dolycoris baccarum*	0.85(1)	0.71(1)
		Nezara viridula	0.85(1)	0.00(0)
	Scutelleridae	*Chrysocoris stolli*	0.00(0)	1.42(2)
Orthoptera	Acrididae	*Chortophaga viridifasciata*	0.00(0)	5.72(8)
		Acrida conica	0.85(1)	0.00(0)
		Acrida exaltata	0.85(1)	0.00(0)
		Valanga irregularis	6.84(8)	1.42(2)
		Melanoplus punctulatus	0.85(1)	0.00(0)
		Melanoplus bivittatus	0.00(0)	0.71(1)
		Melanoplus femurrubrum	1.72(2)	0.00(0)
		Melanoplus packardii	4.27(5)	4.31(6)
		Melanoplus dawsoni	0.85(1)	0.00(0)
		Chorthippus brunneus	0.85(1)	0.71(1)
	Tettigoniidae	*Conocephalus longipennis*	6.84(8)	2.14(3)
		Conocephalus brevipennis	1.72(2)	0.71(1)
	Gryllidae	*Teleogryllus commodus*	0.00(0)	0.71(1)
Coleoptera	Coccinellidae	*Coccinella magnifica*	8.56(10)	9.29(13)
	Dermestidae	*Attagenus unicolor*	0.85(1)	2.14(3)
	Carabidae	*Broscus cephalotes*	0.00(0)	2.14(3)
		Brachinus spp.	0.00(0)	2.88(4)
	Staphylinidae	*Paederus riparius*	0.00(0)	1.42(2)
	Cantharidae	*Chauliognathus lugubris*	0.85(1)	1.42(2)
	Tenebrionidae	*Gonocephalum rusticum*	0.00(0)	0.71(1)
Odonata	Libellulidae	*Orthetrum sabina*	3.42(4)	1.42(2)
		Erythemis plebeja	0.00(0)	0.71(1)
		Erythemis mithroides	0.00(0)	0.71(1)
Total			117	140

However, least relative abundance (N ≤ 5) was recorded for *Lasius niger* (Hymenoptera: Formicidae), *Apis dorsata* (Hymenoptera: Apidae), *Polistes watti* (Hymenoptera: Vespidae), *Aedes atropalpus* (Diptera Culicidae), *Limenitis archippus* (Lepidoptera: Nymphalidae), *Spilostethus pandurus* (Hemiptera: Lygaeidae), *Oncopeltus fasciatus* (Hemiptera: Lygaeidae), *Dolycoris baccarum* (Hemiptera: Pentatomidae), *Nezara viridula* (Hemiptera: Pentatomidae), *Acrida conica* (Orthoptera: Acrididae), *Acrida exaltata* (Orthoptera: Acrididae), *Melanoplus punctulatus* (Orthoptera: Acrididae), *Melanoplus femurrubrum* (Orthoptera: Acrididae), *Melanoplus packardii* (Orthoptera: Acrididae), *Melanoplus dawsoni* (Orthoptera: Acrididae), *Chorthippus brunneus* (Orthoptera: Acrididae), *Conocephalus brevipennis* (Orthoptera: Tettigoniidae), *Attagenus unicolor* (Coleoptera: Dermestidae), *Chauliognathus lugubris* (Coleoptera: Cantharidae) and *Orthetrum sabina* (Odonata: Libellulidae).Wherein following taxa:*Auplopus mellipes* (Hymenoptera: Pompilidae), *Nephrotoma appendiculata* (Diptera: Tipulidae), *Danaus chrysippus* (Lepidoptera: Nymphalidae), *Homoeocerus* spp. (Hemiptera: Coreidae), *Chrysocoris stolli* (Hemiptera: Scutelleridae), *Chortophaga viridifasciata*(Orthoptera: Acrididae), *Melanoplus bivittatus* (Orthoptera: Acrididae), *Teleogryllus commodus* (Orthoptera: Gryllidae), *Broscus cephalotes* (Coleoptera: Carabidae), *Brachinus* spp.(Coleoptera: Carabidae), *Paederus riparius* (Coleoptera: Staphylinidae), *Gonocephalum rusticum* (Coleoptera: Tenebrionidae), *Erythemis plebeja* (Odonata: Libellulidae) and *Erythemis mithroides* (Odonata: Libellulidae) were not recorded from Dingroo canal.

From Kamal Pur (Table 2), *Apis dorsata* (Hymenoptera: Apidae) was recorded as an extraordinary contributing species with relative abundance of 12.14% (N = 17), followed by *Empis livida* (Diptera: Empididae) 11.43% (N = 16), *Musca domestica* (Diptera: Muscidae)10.00% (N = 14), *Coccinella magnifica* (Coleoptera: Coccinellidae) 9.29% (N = 13), *Limenitis archippus* (Lepidoptera: Nymphalidae) 7.86% (N = 11), *Episyrphus balteatus* (Diptera: Syrphidae) 6.43% (N = 9), *Chortophaga viridifasciata* (Orthoptera: Acrididae) 5.71% (N = 8), *Polistes watti* (Hymenoptera: Vespidae) and *Melanoplus packardii* (Orthoptera: Acrididae), 4.29% (N = 6). However, least relative abundance (N ≤ 5) was recorded for *Lasius niger* (Hymenoptera: Formicidae), *Auplopus mellipes* (Hymenoptera: Pompilidae), *Nephrotoma appendiculata* (Diptera: Tipulidae), *Pieris rapae* (Lepidoptera: Pieridae), *Danaus chrysippus* (Lepidoptera: Nymphalidae), *Homoeocerus* spp. (Hemiptera: Coreidae), *Dolycoris baccarum* (Hemiptera: Pentatomidae), *Chrysocoris stolli* (Hemiptera: Scutelleridae), *Valanga irregularis* (Orthoptera: Acrididae), *Melanoplus bivittatus* (Orthoptera: Acrididae), *Chorthippus brunneus* (Orthoptera: Acrididae), *Conocephalus longipennis* (Orthoptera: Tettigoniidae), *Conocephalus brevipennis* (Orthoptera: Tettigoniidae), *Teleogryllus commodus* (Orthoptera: Gryllidae), *Attagenus unicolor* (Coleoptera: Dermestidae), *Broscus cephalotes* (Coleoptera: Carabidae), *Brachinus* spp. (Coleoptera: Carabidae), *Paederus riparius* (Coleoptera: Staphylinidae), *Chauliognathus lugubris* (Coleoptera: Cantharidae), *Gonocephalum rusticum* (Coleoptera: Tenebrionidae), *Orthetrum sabina* (Odonata: Libellulidae), *Erythemis plebeja* (Odonata Libellulidae) and *Erythemis mithroides* (Odonata: Libellulidae). Wherein following taxa: *Aedes atropalpus* (Diptera Culicidae), *Spilostethus pandurus* (Hemiptera: Lygaeidae), *Oncopeltus fasciatus* (Hemiptera: Lygaeidae), *Nezara viridula* (Hemiptera: Pentatomidae), *Acrida conica* (Orthoptera: Acrididae), *Acrida exaltata* (Orthoptera: Acrididae), *Melanoplus punctulatus* (Orthoptera: Acrididae), *Melanoplus femurrubrum* (Orthoptera: Acrididae), *Melanoplus dawsoni* (Orthoptera: Acrididae) were not recorded from Kamal pur canal.

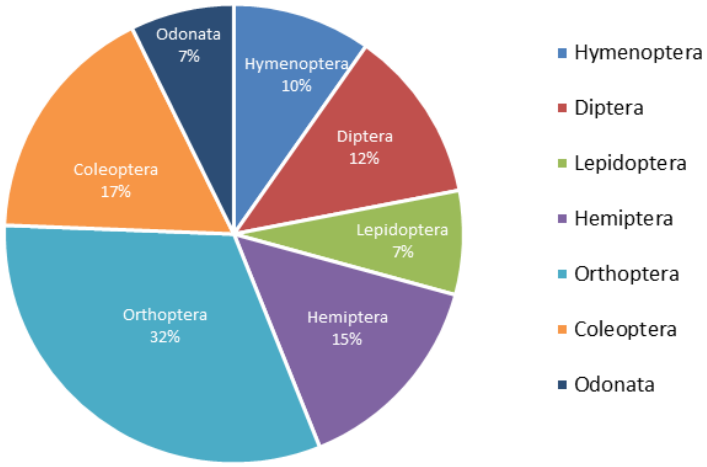

Figure 4 Species diversity of different orders

The orders with respect to the number of individuals in the different sites were as follows: Orthoptera (32%), Coleoptera (17%), Hemiptera (15%), Diptera (12%), Hymenoptera (10%), Odonata (7%) and Lepidoptera (7%). A maximum number of species was recorded that belonged to Orthoptera and others respectively and these species were found in the both sites (Figure 4). This trend has also been recorded previously, [20], who studied insect diversity in the mangroves of Andaman and Nicobar islands of India, reported the following results: Lepidoptera, w50%; Coleoptera, w20%; Hemiptera, w15%; Diptera, 5%; Hymenoptera, 3%; Orthoptera, 5%; Thysanoptera, 2%.

Kathiresan and Bingham [21] reported that herbivorous insects can cause considerable damage to vegetation. The presence of Coleoptera and Leptoptera in our study areas is indicated, which prefer moist soil, litter, and rotting wood, and are a potential bioindicator of moist habitats [21-23].

Table 3 Diversity indices recorded from Dingroo and Kamal Pur canals

Diversity Indices	Dingroo	Kamal Pur
Diversity (H)	1.0293	1.0350
Diversity $_{Maximum}$ (H'_{max})	2.0682	2.1461
Evenness (J)	0.0141	0.0163
Dominance (D)	1.0141	1.0163
Richness (R)	9.1769	9.8868

Diversity indices are key components to draw the natural lines regarding taxa composition pertaining to any managed or unmanaged landscaping. They consist of diversity, evenness, dominance and richness of inhabiting taxa in that area. So, keeping in view the importance of these aspects, calculations were made as per Shannon Diversity Index [24]. In the discussion of future direction, it may be assumed that the region has diversity of described orders and these results may help in the proceeding of research for further work. Different other techniques and methodologies may be directed to evaluate better results. Diversity was recorded maximum in Kamal Pur canal (1.0350) while least diversity was recorded for Dingroo canal (1.0293). Diversity maximum (H'_{max}) was recorded highest for Kamal Pur (2.1461), While least diversity maximum (H'_{max}) was recorded for Dingroo canal (2.0682). Evenness was recorded maximum for Kamal Pur (0.0163) while least was recorded for Dingroo canal (0.0141). Dominance (D) was recorded maximum for Kamal Pur canal (1.0163) While least recorded for Dingroo canal (1.0141). The value for richness was recorded maximum in Kamal Pur canal (9.8868) whereas least was recorded for Dingroo canal (9.1769) (Table 3).

From the overall data presentation and discussion, it is confirmed that results of previous scientists and researchers in different areas over the world were analogous to our present findings, but sometime deviations were recorded due to variations in ecological conditions and skill power, handling expertise and documentation of data [25, 17, 18, 8].

4. Conclusion

From the overall data it is concluded that diversity among different orders of insects is present. As hypothesized, diversity may vary among different orders it is noted that species varied of different insect orders while pretending significance of results.

Compliance with ethical standards

Disclosure of conflict of interest

All authors equally contributed in this research work. The authors declare that there are no competing interests.

References

[1] Novotny V, Yves B, Scott M and Wailed. (2002). Low host specificity of herbivorous insects in a tropical forest. Nature, 416, 841-844.

[2] Mahmoud MF and Shebl M. (2014). Insect fauna of canola and phenology of the diamond back moth, *Plutella xylostella* L. (Lepidoptera: Plutellidae) as a key pest. Radiology, 97, 125-132.

[3] Sabbahi R, Oliveira D and Marceau J. (2005). Influence of honey bee (Hymenopetra: Apidae) density on the production of canola (Cruciferae: Brassicaceae). Journal of Ecology and Entomology, 98, 367-372.

[4] Huffaker CB. (1962). Some concepts of the ecological basis on biological control of weeds. Entomology, 94, 507-14.

[5] Edwards JS. (1998). The coming age of insect development. Journal of Developmental Biology, 42, 471-473.

[6] Lenteren JCV. (2006). Ecosystem services to biological control of pests: Why are they ignored? Proceedings of Netherland Entomological Society Meeting, 17, 103-111.

[7] Khan A, Ali T and Aslam M. (1991). Comparative efficacy of Tenekil against plant parasitic nematodes attacking chilli in Pakistan. Afro-Asian Journal of Nematology, 1, 64-66.

[8] Aslam M, Razaq M, Akhter W, Faheem M and Ahmad F. (2005). Effect of sowing date of wheat on aphid (*Schizaphis gramium*) population. Pakistan Entomology, 27, 79-82.

[9] Rau P. (1941). Observations on certain lepidopterous and hymenopterous parasites of Polistes wasps. Annual Entomological Society of America, 34, 355-366.

[10] Foottit R, Adler G and Holdridge P. (2009). Insect biodiversity. Science and society. John Wiley and Sons, 1, 4051-5142.

[11] Hunt HJ. (2007). The evolution of social wasps. Oxford University Press, USA, 12.

[12] Kunin WE. (1997). Population size and density effects in pollination: Pollinator foraging and plant reproductive success in experimental arrays of Brassica kaber. Journal of Ecology, 85, 225-234.

[13] Hoell HV, Doyen JT and Purcell AH. (1998). Introduction to insect biology and diversity, (2nd Eds.), Oxford Uni. Press, 570-579.

[14] Kleerebezem M and Quadri LE. (2001). Peptide pheromone-dependent regulation of antimicrobial peptide production in gram-positive bacteria: A case of multicellular behavior. Peptides, 22(10), 1579-96.

[15] Borror DJ and Delong DM. (2005). An introduction to the study of insects. Columbus, Ohio, 812.

[16] Magurran AE. (1988). Ecological diversity and its measurement. Princeton Uni. Press, New Jersey, 34-37.

[17] Yapo L and Kouassi MP. (2013). Composition, abundance and diversity of aquatic insects in fish ponds of Southern lvory Coast, West Africa. Entomology, 66, 123-133.

[18] Abdelsalam K and Tanidab M. (2013). Diversity and spatial temporal distribution of aquatic macro-invertebrate's communities in spring flows of Tsuya stream, Gifu preferences and central Japan. Egyptian Journal of Aquatic Research, 39, 39-50.

[19] Boix D, Sala J, Gascon S, Martinoy M, Gifre J, Brucet S, Badosa A, Flores RL and Quintana XD. (2007). Comparative biodiversity of crustaceans and aquatic insects from various water body types in coastal Mediterranean wetlands. Hydrobiologia, 584, 347-359.

[20] Veenakumari K, Mohanraj P and Bandyopadhyay AK. (1997). Insects herbivores and their natural enemies in mangals of the Andaman and Nicobars Islands. Journal of Natural History, 31, 1105-1126.

[21] Kathiresan K and Bingham BL. (2001). Biology of mangroves and mangrove ecosystems. Advances in Marine Biology, 40, 81-251.

[22] Hall WE. (2001). Ptiliidae. In: Arnett RH, Thomas MC, editors. American beetles, Vol. 1. Boca Raton, FL: CRC Press, 233-246.

[23] Sorensson M. (2003). New records of feather wing beetles (Coleoptera: Ptiliidae) in North America. Coleopterists Bulletin, 57, 369-381.

[24] Shannon CE. (1948). A mathematical theory of communication. Journal of Bell. Systematic Technology, 27, 379-423.

[25] Robinson WS, Nowogrodski R and Morse RA. (1989). Pollination parameters. Gleanings in bee culture, 117, 148-152.

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