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# Diversity and abundance of Hymenoptera families in vegetable crops in north-eastern District of Tamil Nadu, India.

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**Abstract**
Order Hymenoptera is an important group in class insecta as they contain agriculturally, ecologically and economically valuable species. They are also ecological indicators. Hymenopteran parasitoids are potential biocontrol agents in agricultural fields. Ants, honey bees and bumble bees are very good pollinators. Studies on diversity and distribution of fauna are pre-requisites for biodiversity conservation. In the present study, the biological diversity of hymenopteran families was studied in vegetable crops in Tiruvallur District, Tamil Nadu. The study was conducted from Janualry 2009 to December 2012. The study revealed the presence of 100 species and 37 families of hymenoptera in the area. Totally 4994 individuals were sampled during the study period. Formicidae was the most dominant family in the study area. Braconidae, Encyrtidae, Eulophidae and Platygastridae were also found to be dominant in the vegetable fields. The months July to December was found to be favourable to the hymenopteran insects since the population and diversity indices namely Shannon index and evenness were very high during these months. In summer, which comes in the first half of the year, the diversity and population were very low.

**Keywords:** Parasitoids, Ants, Shannon-Wiener index, species richness, Simpson's index of diversity, Tiruvallur District.

## 1. Introduction
Order Hymenoptera is an important group of insects to man, because they contain pollinators, predators, parasitoids and honey bees which help human beings to improve the economy and agricultural production. They are very essential for natural pest control. So agro ecosystems should have a rich diversity of hymenopteran insects. Hymenoptera is a diverse group of insects in terms of structure, size, numbers, habits and food preference. They are the most evolved and probably most diverse of all the terrestrial organisms [12].
Honey bees have recently been used as indicators of biodiversity or landscape structure in ecological studies due to their high habitat requirements [22, 19, 20, 5]. They need habitats rich in flowering plants, as a large proportion of the species only collect pollen from certain plants [16, 24]. In addition, bees have specific nesting sites, such as dead wood, baresoil, plant stems, or rock fissures. Hymenopterans are also important to the balancing and functioning of most ecosystems in the planet. The current study was conducted to analyze the diversity of hymenoptera in vegetable crops (brinjal, okra and tomato) in Tiruvallur district.

## 2. Materials and Methods
### 2.1 Study area
The study was conducted in Tiruvallur District in Tamil Nadu. Tiruvallur district is located between 12˚15and 13˚.5`N Latitude and 79˚15` and 80˚20′E Longitude. Hymenopteran insects were collected from five different villages namely Vayalanallur, Parivakkam, Thandurai, Thamaraipakkam and Palavakkam. The insects were collected only from vegetable crops namely brinjal, okra and tomato. In each of the five villages, one acre field was surveyed.

### 2.2 Insect sampling
Hymenopteran insects were randomly collected by sweep netting. The collected insects were killed by ethyl acetate vapour. Larger insects were pinned and dry preserved and small insects were preserved in 70% ethanol.

### 2.3 Identification of insects
The insects were grouped into families based on their morphological characteristics using identification keys provided by Borror *et al.* [4], Bingham [2, 3] and Morley [15]. Some online sources were also used for identification. The genera and species names of some specimens were identified with the help of taxonomists namely Dr. T.C. Narendran and Dr. J. Poorani.

### 2. 4 Diversity indices and Data Analysis
Shannon-Wiener index, Simpson's index of diversity, evenness, dominance, Margalef Index, Menhinick, Fisher alpha and Berger-Parker indices were calculated by the software PAST 3.x (version 2013).

## 3. Results
### 3.1 Meteorological data
The mean temperature (minimum and maximum) and mean rainfall data during the study period are given in table 1. The temperature was higher in January-June seasons in all the four study years. The year 2010 experienced the highest maximum temperature of 35.42°C in January-June seasons. Lowest temperature was recorded during July-December seasons in 2011. Average rainfall was maximum in July-December 2010 (205.65mm) and minimum in January-June 2009 (11.1mm)

**Table 1:** Average rainfall and mean temperature recorded in Tiruvallur District from 2009 to 2012

| Months | Mean temperature (°C) | | Mean rainfall (mm) |
|---|---|---|---|
| | Minimum | Maximum | |
| January – June 2009 | 24.25 | 33.61 | 11.1 |
| July – December 2009 | 24.21 | 32.28 | 147.1 |
| January – June 2010 | 25.37 | 35.42 | 40.35 |
| July – December 2010 | 24.82 | 32.72 | 205.65 |
| January – June 2011 | 25.21 | 34.58 | 34.55 |
| July – December 2011 | 23.48 | 32.88 | 198.51 |
| January – June 2012 | 25.33 | 34.86 | 11.7 |
| July – December 2012 | 24.66 | 32.78 | 160.43 |

### 3.2 Taxonomic composition
In the present study, 37 different families of hymenoptera, which included 82 genera and 100 species, were collected during the study period in vegetable fields (Table 2). Of the total 100 species, 69 were identified up to species level, 16 were identified up to genus level and 15 were identified up to family level. Totally 4994 individuals were collected from the vegetable crops. Among the different families, Scelionidae was the most dominant family in terms of number of species. Family Scelionidae was represented by 12 genera and 18 species (Fig.1). Pteromalidae with 13 genera and 16 species was the second largest family in the study area. Scolidae was represented by 8 genera and 15 species. More than 50% of the families were parasitoids of pest insects.

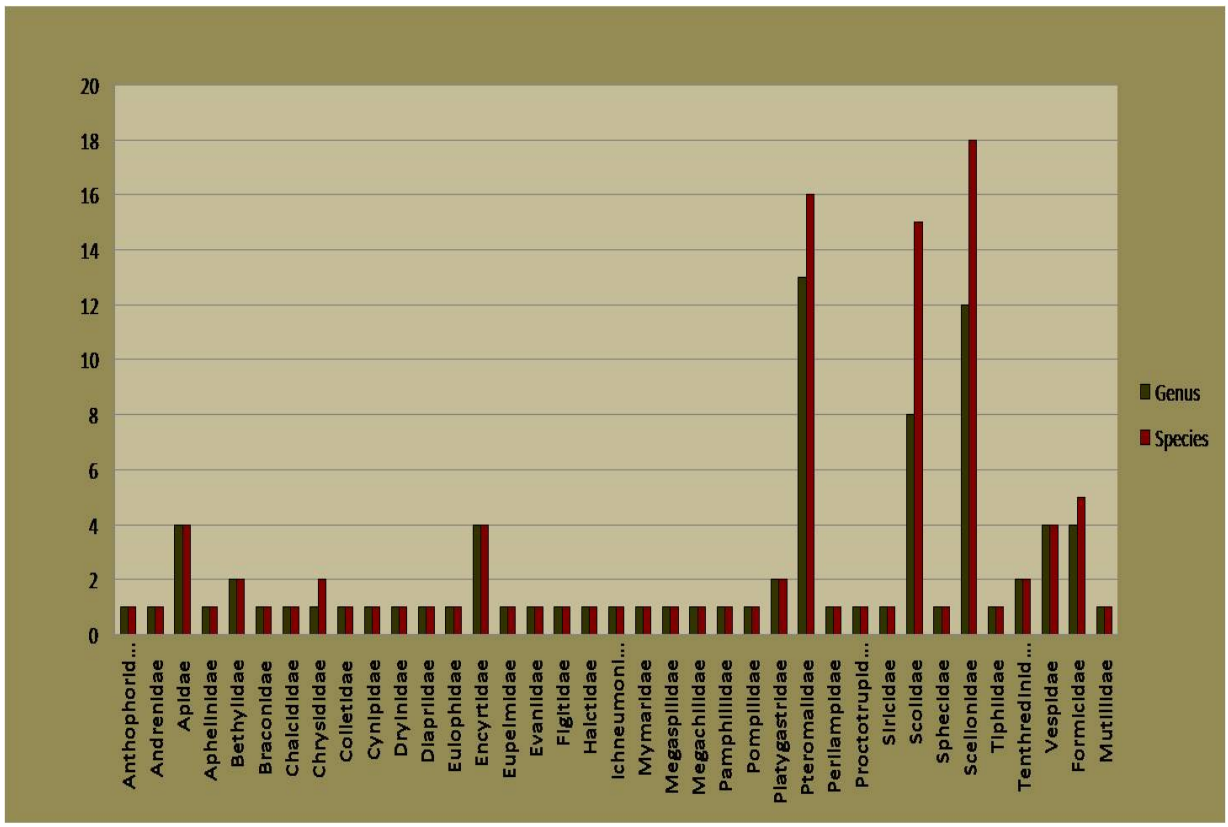


**Fig 1:** Total number of genera and species recorded under each family of Hymenoptera from vegetable fields in Tiruvallur district from January 2009 to December 2012

**Table 2:** Hymenopteran insects collected from vegetable fields in Tiruvallur District, Tamil Nadu

| S. No. | Species | Family |
|---|---|---|
| 1 | Unidentified sp.1 | Anthophoridae |
| 2 | Unidentified sp.2 | Andrenidae |
| 3 | *Apis mellifera* Linn. | Apidae |
| 4 | *Bombus diversus* Smith | Apidae |
| 5 | *Eucera nipponensis* Perez | Apidae |
| 6 | *Amegilla cingulata* (Fab.) | Apidae |
| 7 | Unidentified sp.3 | Aphelinidae |
| 8 | *Holepyris* sp | Bethylidae |
| 9 | *Acrepyris* sp | Bethylidae |
| 10 | *Coelinidea elegans* (Curtis) | Braconidae |
| 11 | Unidentified sp.4 | Chalcididae |
| 12 | *Stilbum cyanurum* (Forster) | Chrysididae |
| 13 | *Stilbum* sp. | Chrysididae |
| 14 | Unidentified sp. 5 | Colletidae |
| 15 | Unidentified sp. 6 | Cynipidae |
| 16 | Unidentified sp. 7 | Dryinidae |
| 17 | *Trichopria* sp | Diapriidae |
| 18 | *Tetrastichus* sp | Eulophidae |
| 19 | *Anagyrus chrysos* Noyes & Hayat, | Encyrtidae |
| 20 | *Blepyrus annulobliqus* Kaul and Agarwal | Encyrtidae |
| 21 | *Homalotylus indicus* Agarwal | Encyrtidae |
| 22 | *Prochiloneurus indicus* Shafee, Alam & Agarwal, | Encyrtidae |
| 23 | *Neanastatus trochantericus* Gahan | Eupelmidae |
| 24 | Unidentified sp. 8 | Evaniidae |
| 25 | Unidentified sp. 9 | Figitidae |
| 26 | *Lasioglossum* sp. | Halictidae |
| 27 | *Diplazon laetatorius* Fab. | Ichneumonidae |
| 28 | *Mymar taprobanicum* Ward | Mymaridae |
| 29 | Unidentified sp. 10 | Megaspilidae |
| 30 | *Megachile* sp. | Megachilidae |
| 31 | *Darylabris* sp. | Mutillidae |
| 32 | Unidentified sp. 11 | Pamphiliidae |
| 33 | Unidentified sp. 12 | Pompilidae |
| 34 | *Leptacis* sp. | Platygastridae |
| 35 | *Ceratobaeus* sp. | Platygastridae |
| 36 | *Baryconus* sp. | Platygastridae |
| 37 | *Acrolisoides indicus* | Pteromalidae |
| 38 | *Choetospilisca* sp. | Pteromalidae |
| 39 | *Cyrtoptyx latipes* Rondani | Pteromalidae |
| 40 | *Herbertia indica* Burks | Pteromalidae |
| 41 | *Macroglenes sivani* Narendran & Sureshan | Pteromalidae |
| 42 | *Pachycrepoides arcotensis* Mani & Kurian | Pteromalidae |
| 43 | *Pachyneuron soliterium* Hartig | Pteromalidae |
| 44 | *Pachyneuron leucopiscida* Mani | Pteromalidae |
| 45 | *Pteromalus groenlandicus* Holmgren | Pteromalidae |
| 46 | *Pteromalus puparum* | Pteromalidae |
| 47 | *Scutellista hayati* Farooqi | Pteromalidae |
| 48 | *Solenura keralensis* (Narendran) | Pteromalidae |
| 49 | *Spalangia gemina* Boucek | Pteromalidae |
| 50 | *Sphegigaster brunneicornis* Ferriere | Pteromalidae |
| 51 | *Sphegigaster indica* Sureshan & Narendran | Pteromalidae |
| 52 | *Theocolax elegans* Westwood | Pteromalidae |
| 53 | Unidentified sp. 13 | Perilampidae |
| 54 | *Exallonyx ligatus* Nees | Proctotrupidae |
| 55 | Unidentified sp. 14 | Siricidae |
| 56 | *Austroscolia nudata* Smith | Scoliidae |
| 57 | *Campsomeriella collaris* Fab. | Scoliidae |
| 58 | *Megacampsomeris* sp. | Scoliidae |
| 59 | *Megacampsomeris reticulata* (Cameron) | Scoliidae |
| 60 | *Megascolia azurea* | Scoliidae |
| 61 | *Megascolia* sp. | Scoliidae |
| 62 | *Micromeriella marginella* (Klug) | Scoliidae |
| 63 | *Phalerimeris phalerata turneri* | Scoliidae |
| 64 | *Scolia affinis* Guerin | Scoliidae |
| 65 | *Scolia bilunata* Saussure | Scoliidae |
| 66 | *Scolia coimbatorensis* Gupta & Jonathan | Scoliidae |
| 67 | *Scolia mixta* Fab. | Scoliidae |
| 68 | *Scolia rubrosinuata* Betrem | Scoliidae |
| 69 | *Scolia vivida* Betrem | Scoliidae |
| 70 | *Sericocampsomeris stygia* (Illiger) | Scoliidae |
| 71 | *Isodontia* sp. | Sphecidae |
| 72 | *Aholcus euproctiscidis* Mani | Scelionidae |
| 73 | *Calliscelio coromandelensis* Sharma | Scelionidae |
| 74 | *Calliscelio orientalis* Sharma | Scelionidae |
| 75 | *Gryon brevifunicularis* Mani & Mukerjee | Scelionidae |
| 76 | *Gryon fulviventris* (Crawford) | Scelionidae |
| 77 | *Gryon mudugeriensis* Sharma | Scelionidae |
| 78 | *Gryon hogenakalense* Sharma | Scelionidae |
| 79 | *Idris triangularis* Mukerjee | Scelionidae |
| 80 | *Lepidoscelio viatrix* Brues | Scelionidae |
| 81 | *Liophanurus samuelii* Mani | Scelionidae |
| 82 | *Paratelenomus* sp. | Scelionidae |
| 83 | *Phanurus* sp. | Scelionidae |
| 84 | *Psix abnormis* Kozlov & Lê | Scelionidae |
| 85 | *Psix saccharicola* (Mani) | Scelionidae |
| 86 | *Scelio nilamburensis* Mukerjee | Scelionidae |
| 87 | *Telenomus beneficiens* (Zehntner) | Scelionidae |
| 88 | *Telenomus* sp. | Scelionidae |
| 89 | Unidentified sp. 15 | Tiphiidae |
| 90 | *Athalia japonica* Klug | Tenthredinidae |
| 91 | *Tenthredo* sp. | Tenthredinidae |
| 92 | *Eumenes* sp. | Vespidae |
| 93 | *Polistes* sp. | Vespidae |
| 94 | *Symmorphus gracilis* Brulle | Vespidae |
| 95 | *Vespa analis* Fab. | Vespidae |
| 96 | *Camponotus compressus* Fab. | Formicidae |
| 97 | *Camponotus rufoglaucus* (Jerdon) | Formicidae |
| 98 | *Meranoplus bicolor* (Guérin-Méneville) | Formicidae |
| 99 | *Monomorium indicum* Forel | Formicidae |
| 100 | *Solenopsis geminate* (Fab.) | Formicidae |

### 3.3 Diversity indices

The diversity indices were calculated for families. Different indices are given in table 3. Results clearly showed that total number of families was higher in July-December periods in 2010 and 2012. In January-June 2012, the number of families

was low (35). Total number of individuals was also higher in July-December months. In the year 2011, very high number of individuals (863) was recorded during July-December period. The diversity indices namely Shannon-Wiener index, Simpson's index of diversity and evenness were also higher in July-December periods in all the four study years. Maximum evenness (0.7188) was recorded during July-December, 2011 and the lowest evenness (0.5129) was recorded during January-June, 2010.

**Table 3:** Diversity indices for hymenopteran insects in vegetable fields in Tiruvallur District.

| Diversity Indices | Jan.-June (2009) | July-Dec. (2009) | Jan.-June (2010) | July- Dec. (2010) | Jan.-June (2011) | July- Dec. (2011) | Jan.-June (2012) | July- Dec. (2012) |
|---|---|---|---|---|---|---|---|---|
| Taxa (S) | 36 | 36 | 36 | 37 | 36 | 36 | 35 | 37 |
| Individuals | 402 | 553 | 592 | 764 | 563 | 863 | 407 | 850 |
| Dominance (D) | 0.05694 | 0.05603 | 0.1031 | 0.04783 | 0.09219 | 0.04738 | 0.1117 | 0.05434 |
| Shannon (H) | 3.211 | 3.113 | 2.916 | 3.233 | 3.002 | 3.253 | 2.934 | 3.157 |
| Simpson's Index of Diversity (1-D) | 0.9431 | 0.944 | 0.8969 | 0.9522 | 0.9078 | 0.9526 | 0.8883 | 0.9457 |
| Evenness (e^H/S) | 0.6891 | 0.6245 | 0.5129 | 0.6856 | 0.5591 | 0.7188 | 0.5372 | 0.6352 |
| Menhinick | 1.796 | 1.531 | 1.48 | 1.339 | 1.517 | 1.225 | 1.735 | 1.269 |
| Margalef | 5.837 | 5.542 | 5.483 | 5.423 | 5.526 | 5.177 | 5.658 | 5.337 |
| Equitability (J) | 0.8961 | 0.8686 | 0.8137 | 0.8955 | 0.8377 | 0.9078 | 0.8252 | 0.8743 |
| Fisher_alpha | 9.571 | 8.619 | 8.442 | 8.124 | 8.572 | 7.591 | 9.175 | 7.891 |
| Berger-Parker | 0.1617 | 0.09584 | 0.2787 | 0.08377 | 0.2575 | 0.0927 | 0.3022 | 0.1094 |

## 4. Discussion

Hymenoptera is one of the few mega diverse insect orders. Approximately 3, 00,000 to 2.5 million hymenopteran species are estimated to be present worldwide and nearly 1, 15,000 species of hymenoptera have been described so far [21, 13, 7, 9]. Parasitic hymenoptera constitutes nearly 25% of all arthropods in both temperate and tropical ecosystems [21].

The present study showed that the hymenopteran fauna in vegetable crops was diverse in higher and lower levels of taxa. Their population fluctuated with seasons. Hymenopteran insects were abundant during the months of July to December in all the study years. During these months, temperature falls below 25°C and plants and weeds around the agro ecosystems flourished due to monsoon rain. Due to the availability of abundant nectar and host insects, the parasitoids and other hymenoptera were increased in numbers. Even though there was not much difference in the total number of families between two seasons in a year, the total number of individuals varied significantly. More than 50% families recorded in this study were parasitoids of eggs, larvae and pupae of lepidopteran and hemipteran pests. Parasitoids are important natural enemies and are essential components in integrated pest management (IPM). Parasitoid families such as Aphelinidae, Braconidae, Encyrtidae, Eulophidae, Pteromalidae and Scelionidae are very good biocontrol agents of eggs and larvae of lepidopteran and hemipteran insects. Their population increased in monsoon and winter seasons. These parasitoids are used for the biological control of cassava mealybug, olive scale, citrus blackfly, and purple scale [6].

Many hymenopterans were good pollinators. Itioka *et al.* [11] reported that the number of honey bee colonies rapidly increased during the flowering period. The seasonality of insects depends upon the floral species diversity [18], diet [1] and shade [17]. Effect of pollination on self-pollinated crop was studied by Greenleaf & Kremen [8] and found that the insect pollinators increased the yield and production of tomato (a self-pollinated crop). They suggested that the natural habitat should be preserved on the farm to increase number and diversity if insect pollinators on the farm. Herren & Ochieng [10] reported *Xylocopa* sp. and *macronomia* sp. as effective pollinators of eggplant (*Solonum melongena*) on the basis of floral visits and fruit set. He also suggested that the wild habitat near the cultivated land increase the pollination of crop by wild bees.

The diversity indices especially Shannon-Wiener index and Simpson's index of diversity clearly indicated that the diversity of hymenoptera was in good state in vegetable fields in the study area. Simpson's index of diversity varied from 0.88 to 0.95. An increase in the value of the index indicates an increase in diversity. Biodiversity in crops can be summarized with two of its components, species richness and evenness. The richness indicates the number of species present in a designated area whereas evenness stands for the relative abundance of each species [23]. Species richness provides an extremely useful measure of diversity when a complete catalogue of species in the community is obtained [14].

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## 6. References

1. Assad YOH, Torto B, Hassanali A, Njagi PGN, Bashir NHH, Mahamat H. Seasonal variation in the essential oil composition of *Commiphora quadricincta* and its effect on the maturation of immature adults of the desert locust, *Schistocerca gregaria*. Phytochemistry 1997; 44:833-841.
2. Bingham, CT. Wasps and Bees. The Fauna of British India including Ceylon and Burma. Hymenoptera I, Taylor and Francis, London, 1897; 1-413.
3. Bingham, CT. Ants and cuckoo wasps. The Fauna of British India including Ceylon and Burma. Hymenoptera II, Taylor and Francis, London, 1903; 1-506
4. Borror DJ, Triplehorn CA, Jonson NF. An introduction to the study of Insects. Saunders College Publishing (6th Edition) 1989; 1(875):665-774.
5. Dauber J, Hirsch M, Simmering D, Waldhardt R, Otte A, Wolters V. Landscape structure as an indicator of biodiversity: matrix effects on species richness.

Agricultural Ecosystem and Environmental 2003; 98:321-329.
6. DeBach P, Rosen D. Biological control by natural enemies, 2nd ed. Cambridge: Cambridge University press, 1991, 440.
7. Gauld ID, Gaston KJ. The Costa Rican Hymenoptera fauna. In: Hanson, P., and Gauld, I. D. (Eds.), the Hymenoptera of Costa Rica. Oxford, University Press, Oxford, 1995, 40-45.
8. Greenleaf SS, Kremen C. Wild bee species increase tomato production and respond differently to surrounding land use in Northern California. Biological Conservation, 2006; 133:81-87.
9. Grissell EE. Hymenoptera biodiversity: some alien notions. American Entomologist 1999; 45:235-244.
10. Herren GB, Ochieng AO. Role of native bees and natural habitats in eggplant (*Solanum melongena*) pollination in Kenya. Agriculture, Ecosystems & Environment 2008; 127:31-36.
11. Itioka T, Inone T, Kaliang H, Kato M, Nagamitsu T, Momose K *et al*. Six-year population fluction of the giant honeybee *Apis dorsata* (Hymenoptera:Apidae) In a tropical lowland dipterocarp forest in Sarawak. Ecology and Population Biology 2001; 9:545-549.
12. LaSalle J, Gauld ID. Hymenoptera: their diversity, and their impact on the diversity of other organisms. 1-26. In: LaSalle, J and I. D. Gauld (Eds.). Hymenoptera and Biodiversity. CAB International, Wallingford, UK, 1993, 348.
13. Lasalle J, Gauld ID. Parasitic Hymenoptera and the biodiversity crisis. REDIA-Journal of Zoology 1992; 74:315-334.
14. Magurran AE. Ecological Diversity and Measurement. Princeton University Press. Princeton.N.J and Schowalter, T.D. (Ed.). Insect Ecology: An Ecosystem Approach. Academic Press USA 1988; 221-247.
15. Morley C. Ichneumonidae. The Fauna of British India including Ceylon and Burma. Hymenoptera III, Taylor and Francis, London, 1913; 1-531
16. Muller A. Host-plant specialization in western *Palearctic anthidiine* bees (Hymenoptera: Apoidea: Megachilidae). Ecological Monographs 1996; 66:235-257.
17. Sparks TH, Greatorexdavies JN, Mountford JO, Hall ML, Marrs RH. The effects of shade on the plant communities of rides in plantation woodlands and implications for butterfly conservation. Forest Ecology and Management 1996; 80:197-207.
18. Sparks TH, Parish T. Factors affecting the abundance of butterflies in field boundaries in Swavesey fens, Cambridgeshire, UK. Biological conservation 1995; 73:221-227.
19. Steffan-Dewenter I, Munzenberg U, Burger C, Thies C, Tscharntke T. Scale-dependent effects of landscape context on three pollinator guilds. Ecology 2002; 83:1421-1432.
20. Steffan-Dewenter I, Leschke K. Effects of habitat management on vegetation and above-ground nesting bees and wasps of orchard meadows in Central Europe. Biodiversity and Conservation 2003; 12:1953-1968.
21. Stork NE. Insect diversity: facts, fiction and speculation. Biological Journal of the Linnean Society 1988; 35:321-337.
22. Tscharntke T, Gathmann A, Steffan-dewenter I. Bioindication using trap-nesting bees and wasps and their natural enemies: community structure and interactions. Journal of Applied Ecology 1998; 35:708-719.
23. Vanclay JK. Species richness and Productive Forest Management. Proceeding of Oxford Conference Tropical Forests. In: Agarwal, S.K., S. Trewali and P.S. Dubey (Eds.), Biodiversity and Environment, A. P. H. Publication Corporation, New Delhi, India, 1992, 18-31.
24. Wcislo WT, Cane JH. Floral resource utilization by solitary bees (Hymenoptera: Apoidea) and exploitation of their stored food by natural. Annual Review of Entomology 1996; 41:257-86.