Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(3): 541-546

Received: 19-03-2017
Accepted: 20-04-2017

J Alfred Daniel
Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore-3, Tamil Nadu, India

K Ramaraju
Director, Centre for Plant Protection Studies, Tamil Nadu Agricultural University, Coimbatore-3, Tamil Nadu, India

Correspondence
J Alfred Daniel
Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore-3, Tamil Nadu, India

Diversity of chalcidids (Chalcididae: Hymenoptera) among three rice growing zones of Tamil Nadu, India

J Alfred Daniel and K Ramaraju

Abstract
To explore the Chacididae fauna of rice ecosystems of Tamil Nadu, surveys were conducted from August 2015 to January 2016 in three rice growing zones *viz.,* Western Zone, Cauvery Delta Zone and High Rainfall Zone. The study recorded a total of 179 individuals that represents 4 subfamilies, 9 genera and 12 species. The species diversity, richness, evenness as well as beta diversity were computed for the three zones and it was concluded that all the indices *viz.,* Simpson's Index, Shannon-Wiener Index, Margalef index, Pielou's index indicated that the Cauvery delta zone was the most diverse zone among the three zones that are surveyed, while High Rainfall Zone was found to be the least diverse zone. But interestingly, least number of individuals (16 individuals belonging to 08 species) were only collected from Cauvery Delta Zone and Maximum number of individuals (142 individual belonging to a species) were collected from High Rainfall Zone.

Keywords: Chalcididae, parasitoids, Tamil Nadu, rice ecosystem, diversity, indices

1. Introduction
Rice, together with the associated irrigation ponds, ditches and ridges often constitute the traditional landscape in rural environments and are a key ecosystem of Asia. Moreover, rice is one of the most important grains for human nutrition, being the staple food of more than three billion people [1]. More than 100 species of insects are known to infest rice, of which about 20 species are of economic importance [29]. The overall losses due to insect pest damage in rice are estimated at 25 per cent [12]. Farmers use insecticides to combat these pest problem. Indiscriminate use of insecticides causes the loss of biodiversity of beneficial organisms. Recently, biodiversity in agricultural land has received growing attention because it plays a significant role in agro-ecosystem function [13, 20]. For example, beneficial organisms like parasitoids serve agro-ecosystem function by regulating pest populations [3, 16, 21]. If the use of insecticides is to be reduced through Integrated Pest Management, then the consequent reduction in pest control has to be augmented in some way and no doubt, parasitoids are the best alternatives to pesticides. To aid this means of pest control, it is essential that the diversity of parasitoids needs to be studied [11]. Members of the family Chalcididae are endoparasites of several pests of economic importance, therefore chalcidids are generally beneficial. They play significant role in bringing down the pest levels in the ecosystems of various economically important crops and thus, their role cannot be underestimated [9, 40]. Recent studies have demonstrated enhanced insect pest control in the presence of diverse species of parasitoids through their complementary function [22, 5, 10]. Despite their importance, our understanding of their diversity is clearly wanting, partly because of their small size and difficulty in collection and study [27]. Therefore, biodiversity surveys will enable the identification of hotspots of species richness [15]. Considering the importance of Chalcididae in biological control of insect pests, the present investigation is made to document the diversity of Chalcididae of rice ecosystem from different regions of Tamil Nadu, India

2. Materials and Methods
(i) Study area and field sites: The survey was carried out during 2015-16 in three different zones of Tamil Nadu State *viz.,* Western Zone (District representation- Coimbatore, 427 m, 10° 59' 43.24'' N 76° 54' 59.22'' E), Cauvery Delta Zone (District representation- Thiruvarur, 26 m, 10° 46' 23.93'' N 79° 25' 0.96'' E) and High Rainfall Zone (District representation – Kanyakumari, 17 m, 8° 12' 16.70'' N 77° 26' 57.84'' E).

Collection was done for about 20 days during August-September, 2015 in Western zone, October- November, 2015 in High rainfall zone and December, 2015 – January 2016, in Cauvery Delta Zone. The collections were made in such a way that there was synchronization in the growth stages of the crop between the sites.

(ii) Parasitoid sampling: Chalcidids were collected using standard insect collecting materials such as Sweep net, Malaise trap and Moericke trap (Yellow pan trap).

Sweep Net: The net employed for collecting is essentially similar to an ordinary insect net. Sweeping of vegetation was as random as possible from ground level to the height of the crop. Sweeping was done in early morning and late evening hours for about half an hour per day.

Malaise trap: It was constructed of a relatively fine mesh. Trap was always orientated North-South with the head facing as near as possible the sun's zenith. The trap is about 6 feet wide, 3 feet and 6 inches high at one end and 6 feet and 6 inches high at other end. Chalcidids fly into the sides of the trap by chance, crawl up to the roof where they enter a collecting bottle (situated in a direction of sunlight) containing 70 % of alcohol. It is emptied once in a day.

Moericke trap / Yellow pan trap: This trap is based on the principle that many insects are attracted to bright yellow colour. A minimum of 20 traps were used in each sampling site. The traps were placed on the bund at intervals of about 1.5-2 m in as straight a line. The traps were filled with water to which a few drops of detergent and pinch of salt were added to break the surface tension and to reduce the rate of evaporation, respectively. The pan is emptied once in a day using fine mesh net in order to filter the specimens.

(iii) Preservation and identification of the specimens: The Chalcididae thus collected were preserved in 70% ethyl alcohol. The dried specimens were mounted on pointed triangular cards and studied under a Stemi (Zeiss) 2000-C and Photographed under Leica M 205-A stereo zoom microscopes and identified through conventional taxonomic techniques by following the keys [26]. In addition, help was also taken from already identified collection of chalcidids at Parasitoid Taxonomy Lab, Annamalai University, Chidambaram. Identified collections are deposited at Insect Biosystematics lab, Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore.

(iv) Measurement of diversity: Relative density of the species was calculated by the formula, Relative Density (%) = (Number of individuals of one species / Number of individuals of all species) X 100. Species or alpha diversity of the sites was quantified using Simpson's diversity Index (SDI), [35] and Shannon-Wiener index [32]. SDI is a measure of diversity which takes into account the number of species present, as well as the relative abundance of each species. SDI is calculated using the formula, $D = \Sigma n\ (n\text{-}1)/\ N(N\text{-}1)$ where n=total number of organisms of a particular species and N=total number of organisms of all species. Subtracting the value of Simpson's index from 1, gives Simpson's Index of Diversity (SID). The value of the index ranges from 0 to 1, the greater the value the greater the sample diversity. Shannon-Wiener index (H') is another diversity index and is given as follows: $H' = - \Sigma Pi \ln(Pi)$, where $Pi=S / N$; S=number of individuals of one species, N=total number of all individuals in the sample, ln=logarithm to base e. The higher the value of H', the higher the diversity. Species richness was calculated for the three sites using the Margalef index [25] which is given as Margalef Index, $\alpha=(S-1) / ln(N)$; S=total number of species, N=total number of individuals in the sample. Species evenness was calculated using the Pielou's Evenness Index ($E1$) [30]. Pielou's Evenness Index, $E1=H'/ ln(S)$; H'=Shannon-Wiener diversity index, S=total number of species in the sample. As species richness and evenness increase, diversity also increases [24]. Beta diversity is a measure of how different (or similar) ranges of habitats are in terms of the variety of species found in them [24]. The most widely used index for assessment of Beta diversity is Jaccard Index (JI) [18], which is calculated using the equation: JI (for two sites) $=j / (a+b-j)$, where j=the number of species common to both sites A and B, a=the number of species in site A and b=the number of species in site B. We assumed the data to be normally distributed and adopted parametric statistics for comparing the sites.

(v) Statistical analysis: The statistical test ANOVA was also used to check whether there was any significant difference in the collections from three sites. The data on population number were transformed into square root before statistical analysis. The mean individuals caught from three different zones were analyzed by adopting Randomized block design (RBD) to find least significant difference (LSD). Critical difference values were calculated at five per cent probability level. All these statistical analyses were done using Microsoft Excel 2016 version and Agres software version 3.01.

3. Results and Discussion

The Indian Chalcididae consists of 220 species under 30 genera under 5 subfamilies [28]. In the present study, a total of 179 Chalcididae individuals were collected from rice ecosystem that represents 4 subfamilies 9 genera and 12 species. The four subfamilies are, Chalcidinae, Dirhininae, Epitraninae and Haltichellinae. Among the species collected under the subfamily Chalcidinae two species were identified *viz*., *Brachymeria burksi* Chhotani, 1966 and *B. euploeae* (Westwood, 1837), *Dirhinus anthracia* Walker, 1846 is the only species collected under the subfamily Dirhininae. Three species *viz*., *Epitranus albipennis* Walker, 1874, *E. elongatulus* Motschulsky, 1863 and *E. erythrogaster* Cameron, 1888, were collected under the subfamily Epitraninae. Altogether, 6 genera each representing one species were collected under the subfamily Haltichellinae. They were, *Antrocephalus nasutus* (Holmgren, 1868), *Haltichella* Spinola, 1811, *Hockeria atra* Masi, 1929, *Kriechbaumerella ayyari*. (Gahan, 1919), *Lasiochalcidia pilosella* Cameron, 1904 and *Psilochalcis carinigena* (Cameron, 1907). However, the species under the genera *Haltichella* is unidentified. Details regarding the hosts of collected chalcidids, their distribution pattern and figures are presented in Table 1 and Plate 1.

Table 1: Chalcidids collected in the study with their host and distribution.

Parasitoid	Host	Distribution	References
Brachymeria burksi	*Aspidomorpha miliaris*	India	[33]
Brachymeria euploeae	*Latoia bicolor*	Oriental region, Australia, USA	[26]
Dirhinus anthracia	*Spilosoma* sp.	India, Pakistan	[7]
Epitranus albipennis	Pyralidae	India, Indonesia, Japan, Malaysia, China, Vietnam	[26]
Epitranus elongatulus	Unknown	India, Indonesia, Japan, Malaysia, China, Vietnam	[17, 26]
Epitranus erythrogaster	*Corcyra cephalonica*	Oriental region	[6]
Antrocephalus nasutus	Un known	India, Indonesia, Malaysia, Philippines, Singapore, Papua New Guinea, Vietnam	[26]
Haltichella sp	Pyralidae	Cosmopolitan	[26]
Hockeria atra	*Apanteles plutellae*	India, Philippines, Java	[37, 38]
Kriechbaumerella ayyari	*Latoia lepida*	India, Vietnam	[26]
Lasiochalcidia pilosella	Myrmeliontids	India, China	[28]
Psilochalcis carinigena	*Opisina arenosella*	India China, Vietnam	[26]

Chalcidid faunal surveys of rice ecosystems on Western zone, Cauvery delta zone and High rainfall zones of Tamil Nadu revealed that the species richness was maximum (08) in both Western and Cauvery delta zones. *Epitranus albipennis, K. ayyari* and *L. pilosella* were collected from Western zone alone, whereas, *B. euploeae, H. atra* and *P. carinigena* were recorded only from Cauvery delta zone.

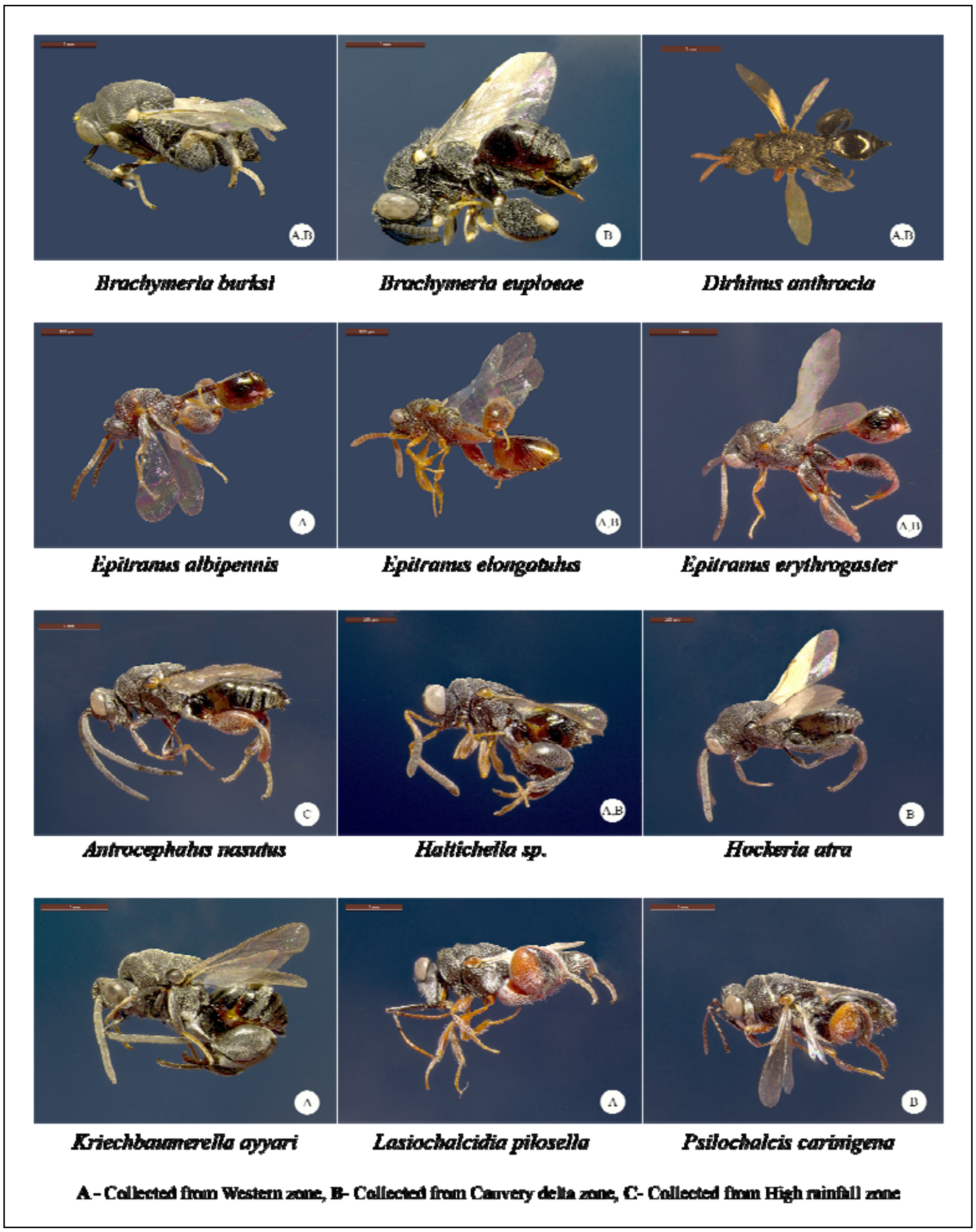

Plate 1: Twelve species of Chalcididae collected from three rice growing zones of Tamil Nadu

Species such as, *B. burksi, D. anthracia*, *E. elongatulus, E. erythrogaster* and *Haltichella* sp. were found in both the Western and Cauvery delta zones. High rainfall zone represented least number of species (01), which is not obtained from other two zones. However, abundance wise High rainfall zone stood first with the total collection of 142 individuals. *Antrocephalus nasutus* was the only species obtained from high rainfall zone and it was not collected from the other two places during the course of study. Western zone ranks second with the total collection of 21 individuals and Cauvery delta region represented least abundance with the total collection of 16 individuals. From the present study it is evident that *A. nasutus* is the dominant chalcidid in the rice ecosystem with a relative abundance of 79.8% (Table.2). The ANOVA test results clearly indicate that, the P-value for *B. burksi* and *A. nasutus* was lesser than 0.05 and so it is evident that there is significant difference between the zones for these two species. For all other species the P-value is greater than 0.05.

Table 2: Comparison of chalcidids collected from three rice growing zones of Tamil Nadu

Species	Zones						Total			
	Western		Cauvery Delta		High Rainfall					
	No.	%	No.	%	No.	%	No	%	F	P
Brachymeria burksi	12	57.1	2	12.5	0	0.0	14	7.9	3.40	0.04
Brachymeria euploeae	0	0.0	2	12.5	0	0.0	2	1.1	1.00	0.37
Dirhinus anthracia	2	9.5	1	6.3	0	0.0	2	1.1	1.00	0.37
Epitranus albipennis	1	4.8	0	0.0	0	0.0	1	0.6	1.00	0.37
Epitranus elongatulus	1	4.8	1	6.3	0	0.0	2	1.1	0.50	0.60
Epitranus erythrogaster	2	9.5	5	31.3	0	0.0	7	3.9	1.16	0.32
Antrocephalus nasutus	0	0.0	0	0.0	142	100	142	79.8	18.6	0.00
Haltichella sp.	1	4.8	2	12.5	0	0.0	3	1.7	0.60	0.55
Hockeria atra	0	0.0	2	12.5	0	0.0	2	1.1	2.11	0.13
Kriechbaumerella ayyari	1	4.8	0	0.0	0	0.0	1	0.6	1.00	0.37
Lasiochalcidia pilosella	1	4.8	0	0.0	0	0.0	1	0.6	1.00	0.37
Psilochalcis carinigena	0	0.0	1	6.3	0	0.0	1	0.6	0.60	0.55
Total	21	-	16	-	142	-	179	-	-	
Species Number	08	-	08	-	01	-	12	-		

% - Relative Density, No.- Total number of individuals collected, F-Value, P-Value

Table 3: Diversity indices of chalcidids from three rice growing zones of Tamil Nadu

Zones	Mean No. of Chalcidiae collected/day	Std. Error	Std. Dev.	SID	*H'*	α	*E1*
Western	1.05 (1.12)^{b}	±0.36	1.61	0.68	1.49	2.29	0.55
Cauvery Delta	0.80 (1.00)^{b}	±0.39	1.77	0.89	1.92	2.52	0.92
High Rainfall	7.10 (2.42) ^{a}	±1.64	7.35	1.00	0.00	0.00	0.00
S.ED	0.29	-	-	-	-	-	-
CD (p=0.05)	0.57	-	-	-	-	-	-

SID- Simpson's Index of Diversity, *H'*- Shannon-Wiener Index, α- Margalef index, *E1*- Pielou's index

From the Table 3, the Simpson's index of diversity is highest for Cauvery Delta Zone (0.89), followed by Western zone (0.68). This means the diversity is more in Cauvery Delta Zone than in Western Zone. Interestingly the SID value of High Rainfall Zone is 1.00 that means there is no diversity. A similar trend was observed for the Shannon-Wiener Index (*H'*) and Margalef index (α). From the values of Shannon-Wiener Index (*H'*) for the three zones, it was observed that the Cauvery Delta Zone was very rich in species with a richness value of 1.92 followed by Western Zone (1.49), while for High rainfall zone the value is 0.00. It is because of the fact that only one species was recorded from High rainfall zone. The values of Margalef index (α) for the three zones revealed that maximum diversity (2.52) accounted for the Cauvery Delta Zone followed by Western Zone (2.29) and for high rainfall zone it is (0.00). Even though the highest number of parasitoids were obtained from high rainfall zone, diversity wise it is least diverse. The diversity richness in Cauvery delta region can be correlated with the area under rice cultivation. In fact, Cauvery delta region is known to be the rice belt of Tamil Nadu. Area under cultivation turns out to be a very important factor with respect to abundance and species density in rice fields [41]. The number of species in a habitat increases with increase in area [14]. The diversity of species among zones with different elevations can indicate how community structure changes with biotic and abiotic environmental pressures [34, 8]. Studies on the effect of elevation on species diversity of groups such as spiders [31], moths [2], paper wasps [23] and ants [36] reported that species diversity decreased with increase in altitude. But importantly, according to [19], diversity of parasitic Hymenoptera is not as proportionately reduced by elevation as in other insect groups, a fact that is in support of our results. A similar study conducted to assess the diversity of members belonging to the subfamily Scelioninae also declared that the elevation did not have any major effect on the overall all diversity patterns [39] The elevation dealt with in this work ranged from 17- 427 m, especially the elevation of High rainfall zone, which is found to be least diverse is about 17m and that of Cauvery delta zone, which is highly diverse is about 27m. So taking into account the scale and extent of elevation gradients, it can be inferred that species diversity and richness is not proportional with that of elevation. The least diversity in high rainfall zone might be due to other factors such as host availability, pest incidence, varietal preferences, weather parameters, or even due to competitive replacement. The elimination of one parasitoid by another under laboratory conditions has already been demonstrated [19].

The species evenness is a measure of the even distribution of the species. The Pielou's evenness value (*E1*) for the sites clearly indicate that the Cauvery delta zone showed maximum evenness pattern with evenness index value (0.92) followed by Western Zone which showed a value of 0.55 and the evenness index value for High rainfall zone is 0.00 (Table.3).

On comparing the species similarities using the Jaccard's in between the three sites, taken in pairs it was found that 45% similarity was between Western Zone and Cauvery delta zone and 0% similarity between High rainfall zone and the other two zones. A possible explanation for the 45% similarity between Western Zone and Cauvery delta zone could be due to the cultivation of same rice varieties like CR 1009, CO-51, SWARNA SUB-1 in these zones for several. On the other hand, high rainfall zone having no similarities with the other zones and has its own peculiar rice varieties such as TPS- 3, TPS-5, ASD- 16. There is much scope for research to be taken on these aspects.

4. Conclusion

This study reveals the diversity of chalcidid parasitoids of three different rice ecosystems of TamilNadu, where the Cauvery delta zone is the most diverse and the High rainfall zone being the least. Large numbers of *Antrocephalus nasutus* were found only in high rainfall zone. The reasons for the significant changes in diversity of chalcidid parasitoids and their host insects are to be further studied.

5. Acknowledgments

Authors are thankful to Professor Dr. S. Manikavasagam and Gowri Prakash Ph.D. Scholar, Department of Entomology, Faculty of Agriculture, Annamalai University, Chidambaram for assisting in identification of the specimens. Thanks are due to Ministry of Minority Affairs, Government of India for the financial grants through Maulana Azad National Fellowship.

6. References

1. Acosta LG, Jahnke SM, Redaelli LR, Pires PR. Insect diversity in organic rice fields under two management systems of levees vegetation. Brazilian Journal of Biology. 2017(AHEAD); 0-0.
2. Axmacher JC, Fiedler K. Habitat type modifies geometry of elevational diversity gradients in geometrid moths (Lepidoptera Geometridae) on Mt Kilimanjaro, Tanzania. Tropical Zoology. 2009; 21(2):243-251.
3. Barbosa PA, editor. Conservation biological control. Academic Press, California, 1998.
4. Bennett FD. Do introduced parasitoids displace native ones?. Florida Entomologist. 1993; 54-63.
5. Bianchi FJ, Booij CJ, Tscharntke T. Sustainable pest regulation in agricultural landscapes: a review on landscape composition, biodiversity and natural pest control. Proceedings of the Royal Society of London B: Biological Sciences. 2006; 273(1595):1715-1727.
6. Bouček Z. Oriental chalcid wasps of the genus *Epitranus*. Journal of Natural History. 1982; 16:577-622.
7. Boucêk Z, Narendran TC. Indian calcid wasps (Hymenoptera) of the genus Dirhinus Parasitic on synanthropic and other Diptera. Systematic entomology. 1981; 6(3):229-251.
8. Condit R, Pitman N, Leigh EG, Chave J, Terborgh J, Foster RB *et al*. Beta-diversity in tropical forest trees. Science. 2002; 295(5555):666-669.
9. Cowan DP. The function of enlarged hind legs in oviposition and aggression by *Chalcis canadenses* (Hymenoptera: Chalcididae). Great Lakes Entomologist. 1979; 12(3):133-136.
10. Crowder DW, Northfield TD, Strand MR, Snyder WE. Organic agriculture promotes evenness and natural pest control. Nature. 2010; 466(7302):109-112.
11. Dey D, Raghuraman M, Gupta SL, Ramamurthy VV. A checklist of the biodiversity of hymenopterous parasitoids associated with rice agro ecosystem. Aisha Shams: SHASHPA publishers, New Delhi, 1999.
12. Dhaliwal GS, Arora R, Dhawan AK. Crop losses due to insect pests in Indian agriculture: an update. Indian Journal of Ecology. 2004; 31(1):1-7.
13. Dudley N, Baldock D, Nasi R, Stolton S. Measuring biodiversity and sustainable management in forests and agricultural landscapes. Philosophical Transactions of the Royal Society of London B: Biological Sciences. 2005; 360(1454):457-470.
14. Gotelli NJ, Graves GR. Null Models in ecology. Smithsonian Institution Press. Washington and London, 1996, 359.
15. Graham MD. A reclassification of the European Tetrastichinae (Hymenoptera: Eulophidae), with a revision of certain genera. A reclassification of the European Tetrastichinae (Hymenoptera: Eulophidae), with a revision of certain genera. 1987; 55(1).
16. Hajek AE. Natural enemies: an introduction to biological control. Cambridge University Press, Cambridge, 2004.
17. Iqbal T, Inayatullah M. Two Species of Genus *Antrocephalus* Kirby (Chalcididae: Chalcidoidea: Hymenoptera): New Records for Province Khyber Pakhtunkhwa, Pakistan. Journal of Entomology and Zoology studies. 2015; 3(1):295-30.
18. Jaccard P. The distribution of the flora in the alpine zone. New Phytologist. 1912; 11:37-50.
19. Janzen DH. Changes in the arthropod community along an elevational transect in the Venezuelan Andes. Biotropica. 1976; 8:193-203.
20. Jarvis DI, Padoch C, Cooper HD. editors. Managing biodiversity in agricultural ecosystems. Columbia University Press, 2007.
21. Jervis MA. editor. Insects as natural enemies: a practical perspective. Springer Science & Business Media, 2005.
22. Kruess A, Tscharntke T. Habitat fragmentation, species loss, and biological control. Science (Washington). 1994; 264(5165):1581-1584.
23. Kumar A, Longino JT, Colwell RK, O'Donnell S. Elevational patterns of diversity and abundance of eusocial paper wasps (Vespidae) in Costa Rica. Biotropica. 2009; 41(3):338-346.
24. Magurran EA. Ecological Diversity and its Measurement. Croom Helm, Australia, 1988, 215.
25. Margalef R. Temporal succession and spatial heterogeneity in phytoplankton *In*: Perspectives in Marine Biology. University of California Press, Berkeley, 1958, 323-347.
26. Narendran TC, van Achterberg C. Revision of the family Chalcididae (Hymenoptera, Chalcidoidea) from Vietnam, with the description of 13 new species. ZooKeys. 2016; (576):1.
27. Noyes JS. Collecting and preserving chalcid wasps (Hymenoptera: Chalcidoidea). Journal of Natural History. 1982; 16:315-334.
28. Noyes JS. Universal Chalcidoidea Database. World Wide Web electronic publication. http://www.nhm.ac.uk/chalcidoids. 2016.
29. Pathak MD, Dhaliwal GS. Trends and strategies for rice

insect problems in tropical Asia. International Rice Research Institute Research Paper, 1981.
30. Pielou EC. The measurement of diversity in different types of biological collections. Journal of Theoretical Biology. 1966; 13:131-144.
31. Sebastian PA, Mathew MJ, Beevi SP, Joseph J, Biju CR. The spider fauna of the irrigated rice ecosystem in central Kerala, India across different elevational ranges. Journal of Arachnology. 2005; 33(2):247-55.
32. Shannon CE, Wiener W. The Mathematical Theory of Communication, University of Illinois Press, Urbana. 1949, 177.
33. Sheela S, Narendran TC, Tiwari RN. Contribution to the knowledge of Chalcididae of India. Records of the Zoological Survey of India. 2003; 101(4):247-266.
34. Shmida A, Wilson MA. Biological determinants of species diversity. Journal of biogeography. 1985; 12:1-20.
35. Simpson EH. Measurement of species diversity. Nature. 1949; 163:688.
36. Smith MA, Hallwachs W, Janzen DH. Diversity and phylogenetic community structure of ants along a Costa Rican elevational gradient. Ecography. 2014; 37(8):720-731.
37. Sujay YH, Sattagi HN, Patil RK. Invasive alien insects and their impact on agroecosystem. Karnataka Journal of Agricultural Sciences. 2010; 23(1):26-34.
38. Sureshan PM. On a collection of Chalcidoidea (Hymenoptera) from Kasaragod District (Kerala State). Records of the Zoological Survey of India. 1999; 97(4):75-82.
39. Shweta M, Rajmohana K. Egg parasitoids from the subfamily Scelioninae (Hymenoptera: Platygastridae) in irrigated rice ecosystems across varied elevational ranges in southern India. Journal of Threatened Taxa. 2016; 8(6):8898-8904.
40. Ubaidillah RR. A new Species of *Brachymeria* parasitic on cocoa husk borer, *Cryptopheles encarpa* (Lepidoptera: Tortricidae) in Malaysia. Bulletin of Entomological Research. 1996; (86)4:481-484.
41. Wilby A, Heong KL, Huyen NP, Quang NH, Minh NV, Thomas MB. Arthropod diversity and community structure in relation to land use in the Mekong Delta, Vietnam. Ecosystems. 2006; 9(4):538-549.