DIVERSITY AND ABUNDANCE OF PARASITIC WASPS (INSECTA: HYMENOPTERA) OF BANGLADESH

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Abstract

A survey was conducted to study the diversity and population of parasitic Hymenoptera by using Malaise traps, from March 2014 to February 2015 in Chittagong University and Rajshahi University Campus. A total number of 173 genera was identified under 53 subfamilies, 23 families and 7 super families. Among the super families, the highest percentage of species individuals (59%) in Chalcidoidea, and of genera (55%) in Ichneumonoidea were recorded. The Species Richness (SR), H or H', H_{max}, Evenness, Community dominance and Question of similarity indices were applied to determine the diversity and abundance of parasitic hymenoptera.

***Key words**:* Parasitic Hymenoptera; Diversity; Abundance; Bangladesh.

INTRODUCTION

Diversity of organisms is essential for proper functioning of ecosystem (Sivaperuman and Venkataraman 2018). Indices describe general properties of communities that allow comparing different regions, taxa and trophic levels. Therefore, they are of fundamental importance for environmental monitoring and conservation (Mollenhauer *et al.* 2018). Insect is the earth's most diverse organisms, accounting 1,013,825 species out of total 1,635,250 species representing around 80% of world's recorded fauna and acting as central players in most of major biomes of the world notably the tropics where they display an enormous species richness and range of specializations (Roskov *et al.* 2015 and Loxdale 2016). Parasitic Hymenoptera constitutes about 20% of all insect species and some 80-85% of hymenopterous species, and a total number of 68,918 species of parasitic hymenoptera has been described (Godfray 1994, Wisegeek 2015). Their importance is due to the fact that they are consumers in the food web and play a vital role, in a multitrophic interaction context, in natural communities (LaSalle and Gauld 1992). The present research program was undertaken to study the diversity and abundance of parasitic wasps in Chittagong University and Rajshahi University Campuses.

MATERIAL AND METHODS

Samplings were made weekly from March 2014 to February 2015 by using Malaise trap in Chittagong University Campus (CUC) (Lat. 22.46359°N, Long. 91.7808°E) and Rajshahi University Campus (RUC) (Lat. 24.3742°N, Long. 88.6295°E) based on their unique, different, and distinctly placed regions in Bangladesh. In briefly, CUC consists of about 1753.88 acres of land, of which about 72% land consists of hills and hillocks and remaining are either plains or valleys. The altitude of these hills and hillocks ranges from 10 to 90 m and rest are less than 30 m in height. Chittagong University Campus is situated on the south-eastern edge of Sitakunda hill range. Climate of Campus is typically tropical monsoon, characterized by hot humid summer and dry chilled winter. The region has a mean annual rainfall of about 275 cm, temperature varies from 46^0F in January to 95^0F in May. Ecologically, CUC falls under the region of tropical evergreen forest. As a result of which it has changed to present form of unclassed state forest where herbs and shrubs are dominant (CU 2016, FUC 2014, Hossain 2017, Shuvo 2015 and WOCU 2018). Rajshahi University Campus is 753 acres (3 km^2); climate is generally marked with monsoons, high temperature, considerable humidity and moderate rainfall; high temperature observed varies from 32 to 36 °C in the month of April to July, and minimum temperature recorded

from 7 to 16 °C in January. Highest rainfall is observed during months of monsoon. Annual rainfall is about 1,448 mm (URG 2006, WOUR 2018 and RUA 2018). Many of the collected specimens were identified up to species level and the rest specimens were identified up to genus level using morphological and molecular technique. For morphological identification, mounted specimens were imaged with an Entovision Imaging System. Some doubtful specimens were sent for taxonomic identification and confirmation in the Department of Zoology, Malabar Christian College, Calicut 673001, Kerala, India. The specimens were preserved at Insect Museum of Department of Zoology at Chittagong University. Microsoft Office Excel 2007 was used for statistical analysis.

Biodiversity of the community from two different areas was calculated using the Shannon-Weiner diversity index – H or $H' = - \sum_{i=1}^{i=N} pi \log_2 pi$, where, pi is the proportion of each super families within the community, N expresses the total number of super families within the community. The evenness as well as community dominance was also evaluated from the Shannon-Weiner diversity index. However, the formulae for calculating evenness and community dominance are - $\frac{H'}{Hmax}$ and $\frac{Y1+Y2}{Y} \times 100$, respectively. In these equations, H_{max} expresses the maximum diversity of a community, Y expresses the total number of genus within a community, Y_1 expresses the superfamily having the highest genus, and Y_2 expresses the superfamily having the second highest genus. The major vegetation associations of the localities are also recorded (Table 1).

Table 1. List of major plants available in two collection sites of Chittagong University Campus (CUC) and Rajshahi University Campus (RUC). (■ = Chittagong University Campus, □ = Rajshahi University Campus).

Family Name	Scientific and common name of plants	Plant status
Amaranthaceae	*Amaranthus spinosus* L. (Prickly Amaranth) ■ □	Vegetable
Apiaceaee	*Coriand rum sativum* L. (Coriander) □	Crop
Asteraceae	*Mikania micrantha* Kunth (Heartleaf hempvine) □	Medicinal plant
Brassicaceae	*Brassica campestris* L. (Field mustard) ■ □	Crop
	Brassica juncea (L.) Czern. (Indian mustard) ■	Crop
	Brassica napus var. *dichotoma* Prain (Rapeseed) □	Crop
Caricaceae	*Carica papaya* L. (Papaya) □	Fruit
Cucurbitacae	*Cucumis sativus* L. (Cucumber) ■ □	Vegetable
	Cucurbita maxima Duchesne (Sweet gourd) ■	Vegetable
	Lagenaria siceraria (Monila) Stand l. (Bottle gourd) □	Vegetable
	Momordica charantia L. var. *charantia* (Bitter gourd) ■ □	Vegetable
	Trichosans cucumerina L. (Snake gourd) ■ □	Vegetable
Fabaceae	*Lablab purpureus* (L.) Sweet subsp. *purpureus* (Bean) ■ □	Vegetable
	Phaseolus vulgaris L. (French bean) □	Vegetable
	Vigna unguiculata (L.) Walp. (Yard-long bean) ■	Vegetable
Malvaceae	*Abelmoschus esculentus* (L.) Moench (Lady's finger) ■ □	Vegetable
Musaceae	*Musa paradisiaca* L. (Banana) □	Fruit
Myetaceae	*Psidium guajava* L. (Guava) □	Fruit
Solanaceae	*Solanum lycopersicum* L. (Tomato) ■ □	Vegetable
	Solanum melongena L. (Brinjal) ■ □	Vegetable
Tiliaceae	*Corchorus capsularis* L. (Jute) □	Vegetable
Verbenaceae	*Clerodendrum viscosum* Vent. □	Medicinal plant

RESULTS AND DISCUSSION

A total number of 173 genera was identified under 53 subfamilies, 23 families and 7 superfamilies. Among the identified genera, 145 species were confirmed under 93 genera. Of them, 83 genera of 22 families were DNA barcoded where 31 species under 19 genera were confirmed. All of the 173 species of parasitic hymenoptera are found in both of the study sites. The diversity of genus and species in

Chalcidoidea are 62 and 86, respectively; in Ichneumonoidea 95 and 44, respectively; in Platygastroidea 8 and 6, respectively; in Diaprioidea 3 and 4, respectively; in Cynipoidea 3 and 3, respectively; in Ceraphronoidea 1 and 1 respectively; and in Evanoidea 1 and1, respectively (Table 2).

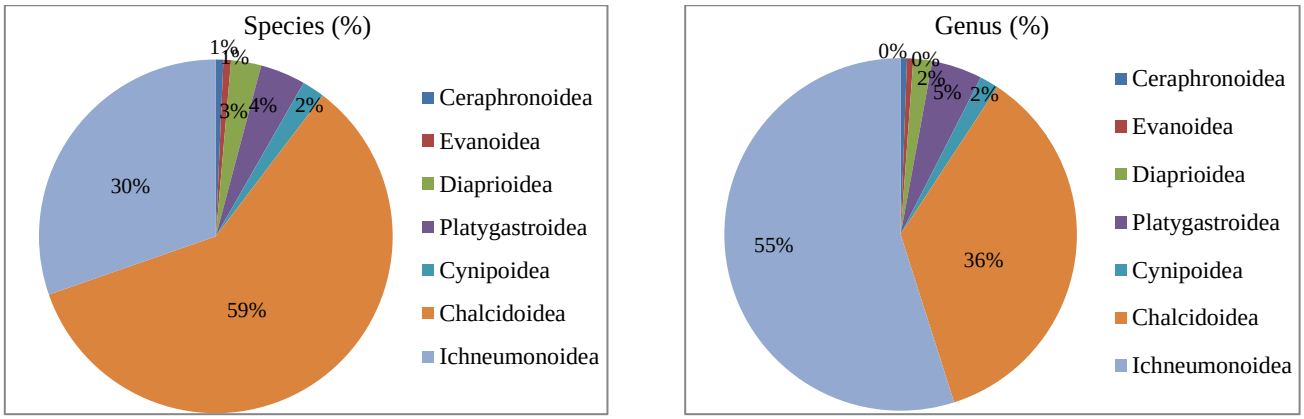
Table 2. Total number of identified genera and species in the present study.

Superfamily	Genus	Genus of CUC	Genus of RUC	Species	Species of CUC	Species of RUC
Ceraphronoidea	1	1	0	1	1	0
Evanoidea	1	1	1	1	1	1
Diaprioidea	3	3	1	4	4	2
Platygastroidea	8	8	3	6	6	2
Cynipoidea	3	3	2	3	3	2
Chalcidoidea	62	58	31	86	84	23
Ichneumonoidea	95	91	22	44	42	17
Total	**173**	**165**	**60**	**145**	**141**	**47**

CUC= Chittagong University Campus, RUC=Rajshahi University Campus

The most dominant Superfamily of species individuals (59%) was observed in Chalcidoidea and of these genera (55%) in Ichneumonoidea; followed by Ichneumonoidea (30%) were in species whilist Chalcidoidea (36%) in genera; the least was Ceraphronoidea and Evanoidea (1%) in species even as no percentage in genera (Fig.1a).

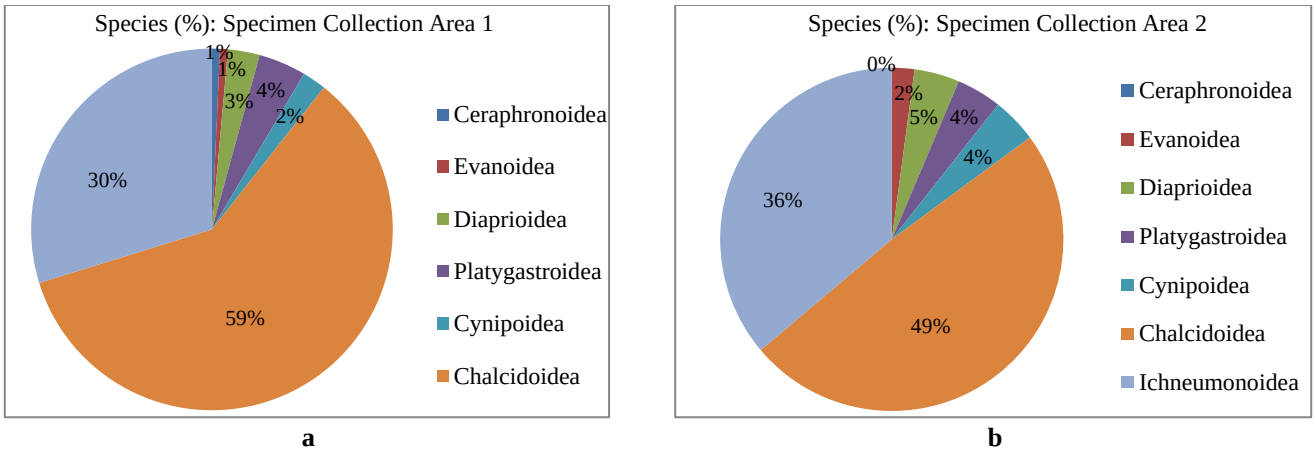
Super families Platygastroidea (4%), Diaprioidea (3%), Cynipoidea (2%), Ceraphronoidea (1%) and Evanioidea (1%) provided a little species diversity; meanwhile 5%, 2%, and 2% were observed for Platygastroidea, Cynipoidea and Diaprioidea in genera, respectively (Fig. 1b).



a **b**

Fig. 1. Diversity of observed super families: **a**. species; and **b**. genus.

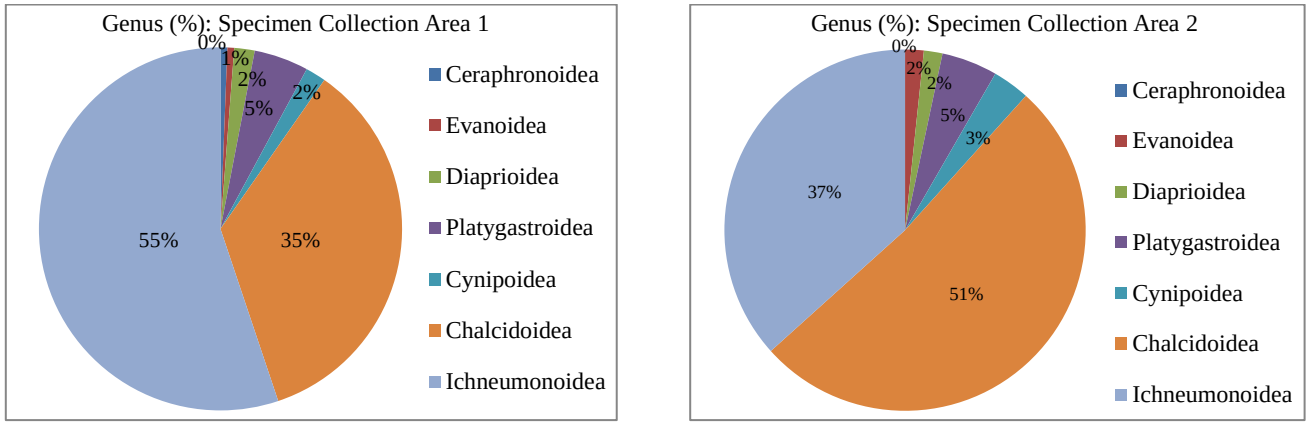
In CUC, a peak species diversity percentage (59%) of Chalcidoidea was observed. Ceraphronoidea and Evanioidea were considerably lowest in number (only 1%). For the time being, 2%, 3% and 4% species were identified for Cynipoidea, Diaprioidea and Platygastroidea, respectively. Number of Ichneumonoidea (30%) was nearly twice as identified species as Chalcidoidea (59%) (Fig. 2a). In addition, the maximum genera in Ichneumonoidea (55%) where Chalcidoidea (35%) was in second position and Platygastroidea (5%) in the third position; whereas 2% for Diaprioidea and Cynipoidea, and 1% for Evanioidea were observed and no population was found in Ceraphronoidea (Fig. 3a).



a **b**

Fig. 2. Species diversity in percentage in different specimen collection area: **a**. area 1 (CUC); and **b**. area 2 (RUC).

In RUC, Chalcidoidea (49%) and Ichneumonoidea (36%) were dominant super families in percentage of species. Cynipoidea and Platygastroidea demonstrate similar percentage (4%) and 2 in number separately. Though Diaprioidea ranged 5% and 2% for Evanioidea, no species was found in Ceraphronoidea (Fig. 2b). The majority of genera was occupied by Chalcidoidea (51%) and Ichneumonoidea (37%). The great diversified genera were identified in the rest superfamilies, such as 2%, 2%, 3% and 5% in Evanioidea, Diaprioide, Cynipoidea and Platygastroidea, respectively. No genus was recorded in Ceraphronoidea (Fig. 3b).



a **b**

Fig. 3. Generic diversity in percentage in different specimen collection area: **a**. area 1 (CUC); and **b**. area 2 (RUC).

Species diversity is a parameter of community structure involving species and their abundance for the taxa (Wang *et al.* 2000). The present study revealed that over all diversity of parasitic hymenoptera in CUC is better than RUC. It was suspected that geographical and ecological conditions in sample collection areas may influence the diversity of parasitic hymenoptera. It is also reported that insect diversity could be affected by parameters related to vegetation structure, such as plant height, plant canopy, plant size or leaf shape (Haysom and Coulson 1998, Axmacher *et al.* 2004). Similarly, insect species richness often increases with an increase in vegetation height, with the highest diversity recorded in full-grown forests (Yi *et al.* 2011). Huber and Islam (2017) also stated that the greatest numbers of genera were found in natural habitat, presumably with many more plant species and potential insect hosts than experimental field plots planted with a single crop.

Table 3. Biodiversity index assessment (Genus).

Super families	**Area 1 (CUC)**				**Area 2 (RUC)**			
	Genus	**pi**	**$\log_2$ pi**	**pi$\log_2$pi**	**Genus**	**pi**	**$\log_2$ pi**	**pi$\log_2$pi**
Ceraphronoidea	1	0.01	-0.15	-0.002	0	0	0	0
Evanoidea	1	0.01	-0.15	-0.002	1	0.02	-0.18	-0.004
Diaprioidea	3	0.02	-0.18	-0.004	1	0.02	-0.18	-0.004
Platygastroidea	8	0.05	-0.231	-0.01	3	0.05	-0.231	-0.01
Cynipoidea	3	0.02	-0.18	-0.004	2	0.03	-0.197	-0.006
Chalcidoidea	58	0.35	-0.66	-0.231	31	0.52	-1.06	-0.55
Ichneumonoidea	91	0.55	-1.16	-0.64	22	0.37	-0.697	-0.258
Total	165		2.711	-0.893	60		2.545	-0.832
Speices Richness (SR)				07				07
H or H'				0.893				0.832
H_{max}				2.81				2.81
Evenness				0.32				0.30
Community dominance				90.3%				88.3%
Question of similarity				1				1

High diversity of parasitic Hymenoptera found in both CUC and RUC were 0.893 and 0.832, respectively (Table 3). They were fairer in CUC (0.32) than in RUC (0.30). On the other hand, H_{max} was equal in both CUC and RUC accounting 2.81 (Table 4).

Table 4. Biodiversity index assessment (Species).

Super families	**Area 1 (CUC)**				**Area 2 (RUC)**			
	Species	pi	$\log_2$ pi	pi$\log_2$pi	Species	pi	$\log_2$ pi	pi$\log_2$pi
Ceraphronoidea	1	0.01	-0.15	-0.002	0	0	0	0
Evanoidea	1	0.01	-0.15	-0.002	1	0.02	-0.18	-0.004
Diaprioidea	4	0.03	-0.20	-0.006	2	0.04	-0.22	-0.009
Platygastroidea	6	0.04	-0.22	-0.009	2	0.04	-0.22	-0.009
Cynipoidea	3	0.02	-0.18	0.004	2	0.04	-0.22	-0.009
Chalcidoidea	84	0.60	1.36	-0.816	23	0.49	-0.972	-0.48
Ichneumonoidea	42	0.30	-0.58	-0.174	17	0.36	-0.68	-0.24
Total	141		-2.84	-0.	47		-2.49	
Species Richness (SR)		07				07		
H or H'				1.01				0.751
H_{max}				2.81				2.81
Evenness				0.36				0.27
Community dominance				89.36%				85.1%
Quesion of similarity				1				1

Diversity as a community ecological concept refers to the heterogeneity in a community or assemblage of different organisms (Bakar and Khan 2016). Thus diversity is dependent upon the number of species present (Species richness, SR) and the distribution of all individuals among the species (Evenness) (Rahman *et al*. 2017). Therefore diversity index value of the present study may supports Lotfalizadeh *et al.* (2016) where the high species richness and Shannon indices, such as an area Interpretation of light trap catches of insects is affected by daily variation in weather that alters flight.

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