Bangladesh J. Zool. **50**(2): 185-200, 2022 ISSN: 0304-9027
eISSN: 2408-8455

COLEOPTERAN DIVERSITY AT THE THREE SELECTED AREAS IN DHAKA CITY, BANGLADESH

Sadia Afroz[1], Md. Aminul Islam[2]*, Md. Abdul Alim[1] and Fatema-Tuz-Zohora[1]

Department of Zoology, Faculty of Life and Earth Sciences, Jagannath University Dhaka 1100, Bangladesh

Abstract: The diversity of coleopteran species was studied at three different selected areas in Dhaka city from December 2016 to November 2017. A total of 11,397 individuals of 56 coleopteran species belonging to 50 genera, including 15 families, were recorded in the study areas during the study period. Of them, 47 species (4916 individuals) of 13 families were found at the Ramna Park, 48 species (2441 individuals) of 15 families at the National Botanical Garden, and 42 species (4040 individuals) of 11 families at the Atomic Energy Research Establishment (AERE) campus. A total of 30 species, 25 genera, and 11 families were common in these three study areas. At the Ramna Park, the highest species richness included the family Chrysomelidae (34.04%), and the lowest was under the six families including Staphylinidae, Bostrichidae, Nitidulidae, Geotrupidae, Erotylidae, and Scarabaeidae (2.13%). At the National Botanical Garden, the maximum number of species was recorded under the family Chrysomelidae (6.24%), and the lowest was under seven families including Staphylinidae, Bostrichidae, Nitidulidae, Geotrupidae, Erotylidae, Elateridae, and Dermestidae (2.08%). The maximum number of coleopteran species was identified under the family Chrysomelidae (35.71%), and the lowest was under six families including Staphylinidae, Cerambycidae, Nitidulidae, Geotrupidae, Elateridae, and Dermestidae (2.38%) at the AERE campus. The Shanon's Diversity Index (H′) and Simpson's Index (λ) indicate high coleopteran diversity at the Ramna Park (H′=3.41, λ=0.05), the AERE Campus (H′=3.07, λ=0.06), and the National Botanical Garden (H′=2.93, λ=0.08). The high species evenness in the Ramna Park (J'= 0.89) and the AERE campus (J'= 0.82) indicates that the species were evenly distributed, whereas at the National Botanical Garden (J'= 0.76) they were comparatively less evenly distributed. The calculated Sorenson's Coefficient (CC) is 0.66, indicating that these three communities were fairly similar or overlapped. The Community Dominances were 21.03%, 32.16% and 18.66% for the Ramna Park, National Botanical Garden, and AERE campus, respectively.

Key Words: Coleopteran Diversity, Diversity Index, Species Evenness, Community Similarity and Dominance.

INTRODUCTION

Coleopterans (Insecta: Coleoptera) are the most diverse, species-rich and major ecosystem service providers than any other order, representing about 25% of all known type of animal life forms (Powell 2009, Foster and Rosenzweig 1995). Coleopterans are herbivores, predatory, scavengers and organic decomposers with highly specialized host range or life cycles (Thakare and Zade 2012). They

*Author for correspondence: <*aminul.ek@du.ac.bd*>, [2]*Department of Zoology, Faculty of Biological Sciences, University of Dhaka, Dhaka 1000, Bangladesh*

 DOI: https://doi.org/10.3329/bjz.v50i2.62052

distribute from forest to the desert, subterranean caverns and in freshwater habitats (Booth and Pope 1989). Study of the whole beetle component of forest diversity has been seriously hindered owing to the lack of identification manuals. Beetles are about 40% of all described insect species and new species are discovered regularly (Hammond 1992). About 500 families and subfamilies are recognized under four suborders (Powell 2009). About 1,50,88 species are known among 3,50,000 coleopteran species from Indian region (Kuschel 1990). Various colorful coleopterans are found in different places in Bangladesh. Environment factors such as vegetation, food availability, temperature and wind exposure always influence the patterns of coleopteran diversity (Khan *et al.* 2004). Begum and Oppenheimer (1981) observed seasonality, habitat, food, and partial distribution of 36 coleopteran species from different parts of Bangladesh. A total of 24 species of Scarabaeidae under three sub families (Rutelinae, Dynastinae and Aphodiinae) have been recorded by Kabir *et al.* (1990) in Bangladesh. In total, 395 Coleopterans were observed in four study areas of Chittagong University campus (Nasiruddin and Shiuli 2017). A total of 14 species have been listed of coleopterans at Chittagong University campus in Bangladesh by DNA barcoding of malaise trap collection (Mazumdar *et al.* 2021). Dhaka is the metropolis of Bangladesh having a tropical savanna climate which is very comfortable for coleopterans. However, no detail study has done on the coleopteran diversity in Dhaka city. The aim of this study was to investigate coleopteran abundance, species diversity, richness, evenness, community similarity, and dominance at the three selected areas in Dhaka city, Bangladesh.

MATERIAL AND METHODS

Study Area and sampling procedure: This research was carried out in the Ramna Park, National Botanical Garden and AERE campus (Fig.1). Several methods were used for sampling beetle. Sweep netting was used to collect insects from above-ground vegetation and foliage. Some species were collected by hand picking. Mostly aerial beetles were collected using sweep net. Ground dwelling beetles were collected with pitfall trap (Nayundo and Yarro 2007). Other types were collected by insect net. Collected insect were stored and killed by keeping them in killing jar filled with 70% alcohol. In every month in any type of weather beetles were counted diurnally at a constant time usually from 8 am to 1 pm and 2 pm to 4 pm. The survey was done in 15 days interval in a month. Collecting areas constitute 100 m area surrounding the spot facilities.

Preservation: After the collection of beetle from field, envelope or collecting jar had been used for temporary storage of the insects. Then they were carried to the Entomology Laboratory of the Department of Zoology, Jagannath University.

Then they placed in 70% alcohol or water for killing and keep outside as soon as possible for colour preservation. Each envelope was labeled with paper and permanent ink or marker pen. Then the specimen was stretched by a stretching board and preserved in wooden box by pinning for further taxonomic analysis. Other large beetles were dried by pinning in laboratory.

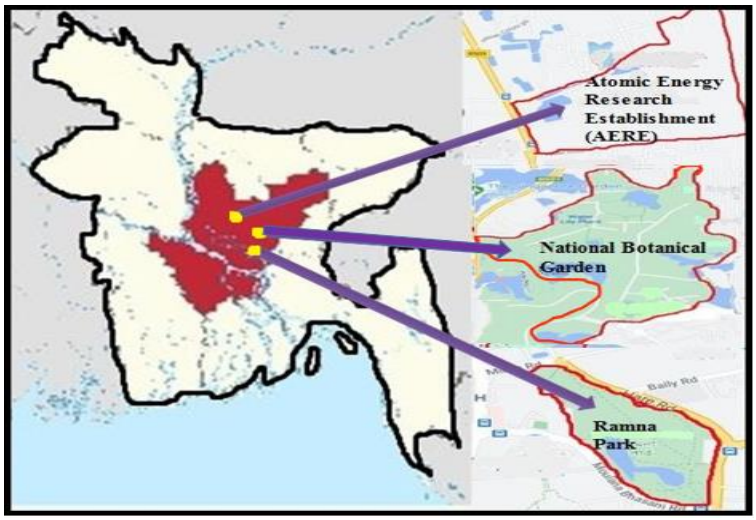

Fig.1. Map of the Dhaka district of the three study areas.

Identification: Photographs of the beetles were taken with the aid of a digital camera (Sony, DSC-W610). The identification was done with the standard keys (Bousquet 1991, Choate 2003), available literature (Caspers 1976) and the coleopteran related websites. The abundance of coleopteran status included in five categories. Species which observed a total of abundance exceeding 50 individuals were described as very common (VC, more than 50 sightings), common (CC: 11-50 sightings), rare (RR: 4–10 sightings), very rare (VR: 2 or 3 sightings), Single Specimen (SS) (Kuschel 1990).

Data analysis: Data were analyzed by making diversity and dominancy index. Species diversity (Shannon-Weiner index), Component of dominance (Simpson dominance index), Species Evenness (pielou index), Community Similarity and Dominance were analyzed. Comparative species diversity for three different locations to measure their dominancy was also analyzed. The recorded species in this research was ranked on the basis of relative abundance of the individuals. Sampling completeness was calculated as ratio of observed species richness to the average species richness estimate value and expressed as percentage.

Diversity Analysis: As models as a measure of diversity the experiment used Shannon's Diversity Index (H') (Shannon and Weiner 1949) and Simpson's Index (λ) (Simpson 1949). The formulae for the two indices:

Shannon's Diversity Index (H′) = $-\sum_{i=1}^{S} pi\ ln\ pi$, Simpson's Index (λ) = $\sum_{i=1}^{S} pi^2$

Where, *p* = the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), ln = the natural log, Σ = the sum of the calculations and *S* = the number of species. The range of optimum values of H′ are generally between 1.5 and 3.5 in the most ecological researches, and the value is rarely greater than 4.

Simpson's Index of Diversity (1- λ): It shows measurement of diversity by which the probability of two randomly selected individuals in a community belongs to different categories e.g. species can be recognized. Its value ranges between 0 and 1, where, high scores (close to 1) and low scores (close to 0) show high and low diversity, respectively (Simpson 1949).

Simpson's Reciprocal Index (1/λ): It measures the relative biodiversity of a community which is used to compare communities to identify intrinsic qualities. A high index value indicates a stable site with many different richness and low competition. A low value of *1/λ* represents a site with a few potential niches where only a few species dominate. This value may alter in response to the ecological interference (MacDonald *et al.* 2017).

Species Richness (SR): The following equation which was used for Species Richness, SR = $\frac{S-1}{\log N}$, Where, S= Total number of species in a sample, N= Total number of individuals of all species (Gleason 1922).

Species Evenness (J'): Species evenness (*J'*) (equitability) was calculated using the formula of: J′= H′/ $\ln S$, Where, J′ = Species Evenness, H′= Species Diversity, S = Number of the species (Pielou 1966).

Community Similarity (CC): It is expressed by Sorenson's Coefficient (CC). The formula is: Sorenson's Coefficient (CC) = $\frac{3C}{S_1+S_2+S_3}$ (Sorenson 1948), Where, C= The number of common species in the three communities, S_1=Total number of species found in community 1, S_2= Total number of species found in community 2, S_3= Total number of species found in community 3.

Community Dominance (CD): Percentage of abundance contributed by two most abundant species is the simple community dominance index. The equation is: *CD (%)* = $\frac{y1+y2}{y} \times 100$, Where, y_1= number of individuals of most dominant species or the rank-1 species, y_2 = number of individuals of the 2nd dominant species or the rank -2 species.

y = Total number of individuals of all species (McNaughton 1968).

Results and Discussion

A total of 11,397 individuals of 56 species of 50 genera belonging to 15 families recorded from the Ramna Park, National Botanical Garden, and AERE campus (Table 1, 2 and 3). Of them 47 species (4916 individuals) under 13 families were found in the Ramna Park (Table 1), 48 species (2441 individuals) under 15 families were found in National Botanical Garden (Table 2), and 42 species (4040 individuals) under 11 families were found in Atomic Energy Research Establishment (AERE) (Table 3). In three study areas, a total of 30 species, 25 genera and 11 families were in common. Each of the study areas the highest species richness found under the family Chrysomelidae in which 16 species at the Ramna Park, 13 species at the National Botanical Garden, and 15 species at the AERE campus. An analogous study was conducted by Kalaichelvan *et al.* (2005) at Central India that revealed a total of 95 species under the family Chrysomelidae.

At the Ramna Park, family-wise coleopteran species richness and population are shown in the Fig. 4 and 5. The highest coleopteran species was under the family Chrysomelidae (16 spp., 34.04%) followed by Coccinellidae (14 spp., 29.79%), Curculionidae (3 spp., 6.38%), Carabidae, Cantharidae, Cerambycidae, Tenebrionidae (2 spp., 4.26%), and the lowest was in the 6 families included Staphylinidae, Bostrichidae, Nitidulidae, Geotrupidae, Erotylidae, Scarabaeidae (1 sp., 2.13%) (Fig. 4 and Table 1). The peak population was in the family Chrysomelidae (2199) and the minimum in the family Tenebrionidae (6) (Fig. 5). The maximum population was recorded in the month of March (14.04%) followed by April (12.71%), February (12.63%), May and January (10.80%), June (8.28%), July (7.20%), September (5.13%) December (7.16%), August (5.07%), October (3.42%), and the minimum was in the November (2.77%) (Fig.6). Among them, *Aulacophara foveicollis* (532) was the most dominant species followed by *Altica chalybea* (319) and *Monolepta signata* (313) (Table 1). On the other hand, *Ambrosiodmus rubricollis* and *Amara ampicollis* (1) were in the lowest population followed by *Teragonothorax gyllenhali* (2), *Propylea dissecta, Crypticus quisquilius, Gonocephalum coriaceum* (3), *Amalusha emorrhous* and *Dicladispa testacea* (6), *Ocys harpaloides* (10). Among observed species 24 were very common (VC), 13 were common (CC), 4 were rare (RR), 4 were very rare (VR), and 2 were single (SS) (Table 1). A preliminary study was conducted by Sharma *et al.* (2004) on beetles in kalatop-Khanjjiar Wildlife Sanctuary, Himachal Pradesh that recorded 18 species under 16 genera belonging to 9 families.

Family-wise coleopteran species richness and population at the National Botanical Garden are shown in Fig. 4 and 5. The highest coleopteran species

was in the family Chrysomelidae (13 spp., 6.24%) followed by Coccinellidae (10 spp., 20.83%), Curculionidae (5 spp., 10.42%), Carabidae (4 spp., 8.33%), Cantharidae, Cerambycidae, Tenebrionidae, Scarabaeidae (2 spp., 4.17%,), and the lowest was in the 7 families included Staphylinidae, Bostrichidae, Nitidulidae, Geotrupidae, Erotylidae, Elasteridae, dermestidae(1 sp., 2.08%,)(Fig 4 and Table 2). The peak population was in the family Coccinellidae (892) and the minimum in the family Dermestidae (4) (Fig 5). The maximum population was recorded in the month of April (12.86%) followed by February (11.43%), January (11.14%), March (10.86%), May (10.77%), December (8.32%), June (8.11%) July (6.39%), September (5.78%), October (5.49%), August (5.00%), and the minimum was in the November (3.85%) (Fig.6). *Cheilomenes sexmaculata* (502) was the most dominant species followed by *Atrecus affinis* (283) and *Coccinella transversalis* (191) (Table 2). While *A. emorrhous* and *T. gyllenhali* (1) were in the lowest population followed by *O. harpaloides and Exochomus flavipes* (3), *Acalles aubei, Henosepilachna pusillanima, Oenopia quadripunctata* and *Dermestes lardarius* (4). Among observed species, 11 were very common (VC), 24 were common (CC), 9 were rare (RR), 2 were very rare (VR) and 2 were single specimen (SS) (Table 2). McCormack *et al.* (2021) represented 21 diverse families including Curculionidae, Scarabaeidae, Carabidae, Tenebrionidae, and Cerambycidae, whereas the family Staphylinidae comparatively less diverse in Lizard Island of Great Barrier Reef Australia.

At the AERE campus, family-wise coleopteran species richness and population are shown in Fig. 4 and 5. The highest coleopteran species was in the family Chrysomelidae (15 spp., 35.71%) followed by Coccinellidae (12 spp., 28.57%), Curculionidae (4 spp., 9.52%), Tenebrionidae (3 spp., 7.14%), Cantharidae (2 spp., 4.76%), and the lowest was in the 6 families included Staphylinidae, Cerambycidae, Nitidulidae, Geotrupidae, Elateridae, Dermestidae (1 sp., 2.38%) (Fig 4 and Table 3). The peak population was in the family Chrysomelidae (1878), and the minimum in the family Dermestidae (2) (Fig. 5). The maximum population was recorded in the month of March (14.85%) followed by April (13.64%), February (12.65%), January (11.26%), May (10.50%), Dec (9.06%) June (8.04%), July (5.89%), August (4.95%) September (3.71%), October (3.00%), and the minimum was in the November (2.45%) (Fig.6). In this study area, *Aulacophara foveicollis* (381) was the most dominant species followed by *Cheilomenes sexmaculata* (373) and *Atrecus affinis* (335) (Table 3). Whereas, *Dicladispa testacea* (1) was in the lowest population followed by *Dermestes lardarius* (2), *Platydema sp.* (3), *Aspidomorpha sanctaecrucis* and *Amalus haemorrhous* (4). Among recorded species, 18 were very common (VC), 12 were common (CC), nine were rare (RR), two were very rare (VR) and one was single (SS) (Table 1). Similar work carried out by Khan *et al.* (2007).

The current findings were concurred with those of Kazmi and Ramamurthy (2004), who found 99 species of Coleoptera from Rajasthan's Thar desert, belonging to 60 genera in 13 families. In the present investigation, the three research locations illustrate the various diversity and abundance of Coleoptera. While Chandra (2012) described 24 species of scarabaeid beetles from Madhya Pradesh, only two scarabaeids were included in the current study. Begum and Oppenheimer (1981) also identified 35 species under eight genera, of which 20 species belong to the genus *Onthophagous*, three species of each of the genus *Caccobious* and *Oniticellus*, and one species each of the genus *Copris, Heliocopris, Onitis*, and *Gymnopleurous* from various regions of Bangladesh. Moreover, 24 species of Scarabaeidae were discovered in Bangladesh by Kabir *et al.* (1990). Bouchard *et al.* (2005) counted 73 species of weevils from southern Quebec, Canada, while the current study only included five species of weevils. Whereas the current study had a total of 16 leaf eaters, Kalaichelvan and Verma (2005) surveyed and collected 95 species of leaf beetles from Bhilai-Drug, Central India. Several families of beetles, including the Carabidae and Tenebrionidae, were noted by Irshad and Haq (2010). Similar to that, the current survey contained three species of Tenebrionidae and four species of Carabidae. During a thorough investigation of predatory Coccinellid beetles conducted by Khan *et al.* (2007) over a period of seven months in the Chitral District of Pakistan, a total of 12 species belonging to nine genera were recorded from 12 different sites. According to Hava (2005), the UAE is home to nine Dermestidae species. Three new species were also discovered at that time. In total, 14 different species of ladybird beetle were identified in the current investigation. Environmental factors like vegetation, food availability, temperature, and wind exposure, as per Khan *et al.* (2004), consistently affect the patterns of coleopteran diversity. In a New Zealand case study carried out by Kuschel (1990), he referred to 982 beetle species from 65 families, of which 753 were found endemic in that region. In contrast, in Bangladesh, proper scientific work on coleopteran species needed to be explored.

The values of various indices of species diversity at the Ramna Park, National Botanical Garden, and AERE campus are shown in Tables 1, 2, and 3, respectively. In this study, Shanon’s Diversity Index appears to have a high value and Simpson’s Index provides the low value in this study, indicating plenteous diversity richness for coleopteran species in these three selected areas. Ganeshaih *et al.* (1997) stated that the diversity index H' appears useful because it incorporates species richness. As per Ludwing and Reynolds (1988), the value of λ decreased as diversity increased. Simpson’s Index of Diversity and Simson’s Reciprocal Index of these three areas represent high coleopteran diversity. The evenness index provides insight into the relative abundance of the

Table 1: Illustration how the various indices change as relative number of each coleopteran species change in the Ramna Park

Family	Scientific name	Common name	N	Status	$P_i = n/N$	P_i^2	ln P_i	P_i ln P_i
Chrysomelidae	*Altica chalybea* (Illiger, 1807)	Grape flea beetle	319	VC	0.0648901546	0.00421073216	-2.73490766	-0.177495507
	Aphthona euphorbiae (Schrank, 1781)	Root feeding flea beetle	206	VC	0.041903987	0.00175594413	-3.1723743	-0.132935131
	Aspidimorpha miliaris (Fabricius, 1775)	Spotted tortoise beetle	59	VC	0.0120016273	0.000144039058	-4.42271303	-0.0530797534
	Aspidimorpha sanctaecrucis (Fabricius, 1792)	Golden tortoise beetle	16	CC	0.0032546786	1.05929328e-5	-5.72766175	-0.0186416981
	Aulacophara foveicollis (Lucas, 1849)	Red pumpkin beetle	532	VC	0.108218063	0.0117111492	-2.22360699	-0.240634441
	Cassida circumdata (Herbst, 1799)	Green tortoise beetle	153	VC	0.0311228641	0.00096863267	-3.46981255	-0.107990504
	Charidotella sexpunctata (Fabricius, 1781)	Golden tortoise beetle	54	VC	0.0109845403	0.000120660126	-4.51126642	-0.0495541878
	Dicladispa testacea (Linnaeus, 1767)	Rockrose prickly leaf beetle	6	RR	0.00122050448	1.48963119e-6	-6.708491	-0.00818774332
	Disonycha sp. (Chevrolat in Dejean, 1836)	Black & White striped flea beetle	19	CC	0.00386493084	1.49376904e-5	-5.55581149	-0.0214728272
	Galerucella sagittariae. (Gyllenhal, 1813)	Golden loosestrife beetle	30	CC	0.00610252238	3.72407794e-5	-5.09905309	-0.0311170856
	Lema externevittata (Linnaeus, 1758)	Leaf beetle	209	VC	0.0425142392	0.00180746053	-3.15791622	-0.134256406
	Lema incognita (Linnaeus, 1758)	Leaf beetle	62	VC	0.0126118796	0.000159059507	-4.37311608	-0.0551532135
	Monolepta signata (Olivier, 1808)	White spotted leaf beetle	313	VC	0.0636696501	0.00405382434	-2.75404728	-0.175349227
	Oulema melanopus (Linnaeus,1758)	Cereal leaf beetle	80	VC	0.016273393	0.00026482332	-4.11822384	-0.067017475
	Phyllotreta nemorum. (Linnaeus, 1758)	Yellow spotted flea beetle	85	VC	0.0172904801	0.000298960702	-4.05759921	-0.0701578384
	Podontia quatuordec impunctata (Linnaeus 1758)	14 spotted lady beetle	56	VC	0.0113913751	0.000129763427	-4.47489878	-0.0509752505
Curculionidae	*Amalusha emorrhous* (Herbst, 1795)	No English name found	6	RR	0.00122050448	1.48963119e-6	-6.708491	-0.00818774332
	Ambrosiodmus rubricollis (Eichhoff, 1875)	Ambrosia beetle	1	SS	0.000203417413	4.13786439e-8	-8.50025047	-0.00172909896
	Tetragonothorax gyllenhali (Faust, 1894)	Cleonine weevil	2	VR	0.000406834825	1.65514575e-7	-7.80710329	-0.0031762015
Carabidae	*Amara ampicollis* (Gyllenhal, 1810)	No English name found	1	SS	0.000203417413	4.13786439e-8	-8.50025047	-0.00172909896
	Ocys harpaloides (Audinet-Serville, 1821)	Dark brown Ground beetle	10	RR	0.00203417413	4.13786439e-6	-6.19766538	-0.0126071306
Cantharidae	*Cantharis nigricans* (Muller, O.F 1776)	Soldier beetle	88	VC	0.0179007323	0.000320436217	-4.02291366	-0.0720131005
	Rhagonycha fulva (Scopoli, 1763)	Common red soldier beetle	197	VC	0.0400732303	0.00160586379	-3.21704674	-0.128917455
Staphylinidae	*Atrecus affinis* (Paykull, 1789)	Rove beetle	138	VC	0.0280716029	0.000788014889	-3.57299679	-0.100299747
Coccinellidae	*Cheilomenes sexmaculata* (Fabricius, 1781)	6 spotted zigzag lady bird	502	VC	0.102115541	0.0104275837	-2.28165035	-0.23299196
	Chilocorus nigrita. (Febricius, 1798)	Black ladybird	20	CC	0.00406834825	1.65514575e-5	-5.5045182	-0.022394297
	Chilomenes propingua nilitica (Mulsant, 1850)	No English name found	123	VC	0.0250203417	0.000626017499	-3.68806612	-0.0922766745
	Coccinella septempunctata (Linnaeus, 1758)	7 spotted lady beetle	280	VC	0.0569568755	0.00324408567	-2.86546087	-0.163207698
	Coccinella transversalis (Febricius, 1781)	Tranverse lady beetle	242	VC	0.0695687551	0.00483981169	-2.66543973	-0.185431324
	Cycloneda sanguinea (Linnaeus, 1763)	Orange spotless lady beetle	60	VC	0.0122050448	0.000148963119	-4.4059059	-0.0537742789
	Exochomus flavipes (Thunberg, 1781)	No English name found	40	CC	0.00813666965	6.62058299e-5	-4.81137102	-0.0391486657
	Henosepilachna pusillanima (Mulsant, 1850)	Epilachnine beetle	171	VC	0.0347843775	0.00120995292	-3.35858692	-0.116826355
	Henosepilachna vigintioctopunctata (Fabricius, 1775)	28 spotted potato lady bird	87	VC	0.0176973149	0.000313194955	-4.03434235	-0.071397027
	Illeis koebelei (Timberlake, 1943)	Yellow spotless lady beetle	16	CC	0.0032546786	1.05929328e-5	-5.72766175	-0.0186416981
	Micraspis discolor (Febricius, 1798)	Spotless lady beetle	214	VC	0.0435313263	0.00189497637	-3.13427446	-0.136439124
	Micraspis hirashimai (Samuelson, 1965)	No English name found	175	VC	0.0355980472	0.00126722096	-3.3354645	-0.118736023
	Oenopia quadripunctata (Kapur, 1963)	Yellow spotted lady beetle	31	CC	0.00630593979	3.97648766e-5	-5.06626327	-0.0319475511
	Propylea dissecta (Mulsant, 1850)	Aphidophagus lady beetle	3	VR	0.000610252238	3.72407794e-7	-7.40163818	-0.00451686626
Cerambycidae	*Graphisurus sp.* (Kirby, 1837)	Gray longhorn beetle	18	CC	0.00366151343	1.34066806e-5	-5.60987871	-0.205406462
	Trachysida mutabilis (Newman, 1841)	Black longhorn beetle	36	CC	0.00732302685	5.36267222e-5	-4.91673153	-0.036005357
Tenebrionidae	*Crypticus quisquilius* (Linnaeus, 1760)	No English name found	3	VR	0.000610252238	3.72407794e-7	-7.40163818	-0.00451686626
	Gonocephalum coriaceum (Motschulsky, 1857)	Darkling beetle	3	VR	0.000610252238	3.72407794e-7	-7.40163818	-0.00451686626
Bostrichidae	*Sinoxylon anale* (Lesne, 1897)	Auger beetle	23	CC	0.00467860049	2.18893025e-5	-5.36475625	-0.0250995512
Nitidulidae	*Stelidota geminate* (Say 1825)	Sap beetle	45	CC	0.00915378356	8.37917535e-5	-4.69358798	-0.0429640885
Geotrupidae	*Anoplotrupes stercorosus* (Scriba, 1791)	Earth boring Dung beetle	42	CC	0.00854353133	7.29919276e-5	-4.76258085	-0.0406892587
Erotylidae	*Megalodacne fasciata* (Fabricius, 1777)	Fungus beetle	10	RR	0.00203417413	4.13786439e-6	-6.19766538	-0.0126071306
Scarabaeidae	*Phyllophaga crinite* (Burmeister, 1855)	White grub scarab	30	CC	0.00610252238	3.72407794e-5	-5.09905309	-0.0311170856
Total	47		**N=4916**		**1**	**0.052802625**	**-224.8163913**	**-3.413330073**

Number of species (S) = 47, Total number of individual (N) = 4916, Shannon Diversity Index (H) = 3.413330073, Simpson's Index (λ) = 0.052802625, Simpson's Index of Diversity ($1 - \lambda$) = 0.947197375, Simpson's Reciprocal Index ($\frac{1}{\lambda}$) = 18.9384524, Species Richness = 12.46, Species Evenness (J') = 0.89, and Community Dominance (CD) = 21.06%. The number of species with percentage under the above families: Chrysomelidae (16 spp., 34.04%), Coccinellidae (14 spp., 29.79%), Curculionidae (3 spp., 6.38%), Carabidae, Cantharidae, Cerambycidae, Tenebrionidae (2 spp., 4.26% included in each of the 6 families), and Staphylinidae, Bostrichidae, Nitidulidae, Geotrupidae, Erotylidae, Scarabaeidae (1 sp, 2.13% included in each of the 6 families).

Table 2: Illustration how the various indices change as relative number of each Coleopteran species change at the National Botanical Garden

Family	*Scientific name*	Common name	N	Status	$P_i = n/N$	P_i^2	ln P_i	P_i ln P_i
	Alticacha lybea (Illiger, 1807)	Grape flea beetle	23	CC	0.00942236788	8.87810165e-5	-4.66466885	-0.0439522259
	Aspidimorpha miliaris (Fabricius, 1775)	Spotted tortoise beetle	5	RR	0.00204834084	4.1957002e-6	-6.19072516	-0.0126807152
	Aspidomorpha sanctaecrucis (Fabricius, 1792)	Golden tortoise beetle	36	CC	0.0147480541	0.0002175051	-4.21664413	-0.0621872957
	Auolacophara foveicollis (Lucas, 1849)	Red pumpkin beetle	166	VC	0.068004916	0.0046246686	-2.68817528	-0.182809134
	Cassida circumdata (Herbst, 1799)	Green tortoise beetle	28	CC	0.0114707087	0.000131577158	-4.46795856	-0.0512506512
	Disonycha sp. (Chevrolat in Dejean, 1836)	Black & White striped flea beetle	176	VC	0.0721015977	0.00519864039	-2.62967908	-0.189604063
	Galerucella sagittariae (Gyllenhal, 1813)	Golden loosestrife beetle	10	RR	0.00409668169	1.67828009e-5	-5.49757798	-0.0225218271
	Lema externevittata(Linnaeus, 1758)	Leaf beetle	21	CC	0.00860303154	7.40121517e-5	-4.75564063	-0.0409129264
	Lema incognita (Linnaeus, 1758)	Leaf beetle	5	RR	0.00204834084	4.1957002e-6	-6.19072516	-0.0126807152
	Monolepta signata (Olivier, 1808)	White spotted leaf beetle	131	VC	0.0536665301	0.00288009645	-2.92496575	-0.156972762
	Oulema melanopus (Linnaeus,1758)	Cereal leaf beetle	27	CC	0.0110610406	0.000122346619	-4.5043262	-0.049822535
	Phyllotreta nemorum. (Linnaeus,1758)	Yellow spotted flea beetle	102	VC	0.0417861532	0.0017460826	-3.17519026	-0.132678987
Chrysomelidae	*Podontia quatuordec impunctata* (Linnaeus 1758)	14 spotted lady beetle	34	CC	0.0139287177	0.000194009177	-4.27380255	-0.0595285892
	Acalles sp. (Boheman, 1837)	No English name found	4	RR	0.00163867268	2.68524815e-6	-6.41386871	-0.0105102314
	Amalusha emorrhous (Herbst, 1795)	No English name found	1	SS	0.000409668169	1.67828009e-7	-7.80016307	-0.00319547852
	Ambrosiodmus rubricollis (Eichhoff, 1875)	Ambrosia beetle	33	CC	0.0135190496	0.000182764702	-4.30365551	-0.0581813323
	Macrancylus linearis (LeConte, J.L., 1876)	No English name found	18	CC	0.00737402704	5.43762748e-5	-4.90979131	-0.0362049339
Curculionidae	*Tetragonothorax gyllenhali* (Faust, 1894)	Cleonine weevil	1	SS	0.000409668169	1.67828009e-7	-7.80016307	-0.00319547852
	Amara ampicollis (Gyllenhal, 1810)	No English name found	47	CC	0.0192544039	0.00037073207	-3.95001547	-0.0760551933
	Bembidion tetracolum (Say, 1825)	Ground beetle	28	CC	0.0114707087	0.000131577158	-4.46795856	-0.0512506512
	Clivina fossor (Linnaeus, 1758)	Ground beetle	16	CC	0.0065546907	4.29639702e-5	-5.02757435	-0.0329541948
Carabidae	*Ocys harpaloides* (Audinet-Serville, 1821)	Dark brown Ground beetle	3	VR	0.00122900451	1.51045209e-6	-6.70155078	-0.00823623613
	Cantharis nigricans (Muller, O.F 1776)	Soldier beetle	10	RR	0.00409668169	1.67828009e-5	-5.49757798	-0.0225218271
Cantharidae	*Rhagonycha fulva* (Scopoli, 1763)	Common red soldier beetle	14	CC	0.00573535436	3.28942896e-5	-5.16110574	-0.0296007703
Staphylinidae	*Atrecus affinis* (Paykull, 1789)	Rove beetle	283	VC	0.115936092	0.0134411774	-2.15471617	-0.249809372
	Cheilomenes sexmaculata (Fabricius, 1781)	6 spotted zigzag lady bird	502	VC	0.205653421	0.0422933296	-1.58156295	-0.325253831
	Chilomenes propingua nilitica (Mulsant, 1850)	No English name found	11	CC	0.00450634986	2.03071891e-5	-5.4022678	-0.0243445087
	Coccinella septempunctata (Linnaeus, 1758)	7 spotted lady beetle	92	VC	0.0376894715	0.00142049626	-3.27837449	-0.123560202
	Coccinella transversalis (Febricius, 1781)	Tranverse lady beetle	191	VC	0.0782466202	0.00612253357	-2.547889664	-0.199363753
	Exochomus flavipes (Thunberg, 1781)	No English name found	3	VR	0.00122900451	1.51045209e-6	-6.70155078	-0.00823623613
	Henosepilachna pusillanima (Mulsant, 1850)	Epilachnine beetle	4	RR	0.00163867268	2.68524815e-6	-6.41386871	-0.0105102314
	Henosepilachna vigintioctopunctata(Fabricius, 1775)	28 spotted potato lady bird	18	CC	0.00737402704	5.43762748e-5	-4.90979131	-0.0362049339
	Micraspis discolor (Febricius, 1798)	Spotless lady beetle	55	VC	0.0225317493	0.000507679727	-3.79282988	-0.085459092
	Micraspis hirashimai (Samuelson, 1965)	No English name found	12	CC	0.00491601803	2.41672333e-5	-5.31525642	-0.0261298964
Coccinellidae	*Oenopia quadripunctata* (Kapur, 1963)	Yellow spotted lady beetle	4	RR	0.00163867268	2.68524815e-6	-6.41386871	-0.0105102314
	Graphisurus sp. (Kirby, 1837)	Gray longhorn beetle	12	CC	0.00491601803	2.41672333e-5	-5.31525642	-0.0261298964
Cerambycidae	*Trachysida mutabilis* (Newman, 1841)	Black longhorn beetle	26	CC	0.0106513724	0.000113451734	-4.54206653	-0.0483792421
	Crypticus quisquilius (Linnaeus, 1760)	No English name found	11	CC	0.00450634986	2.03071891e-5	-5.4022678	-0.0243445087
	Gonocephalum coriaceum (Motschulsky, 1857)	Darkling beetle	12	CC	0.00491601803	2.41672333e-5	-5.31525642	-0.0261298964
Tenebrionidae	*Platydema sp.* (Laporte & Brulle 1831)	No English name found	62	VC	0.0253994265	0.000645130867	-3.67302868	-0.093292822
Elateridae	*Aeolus mellillus* (Say 1836)	Sweet click beetle	8	RR	0.00327734535	1.07409925e-5	-5.72072153	-0.0187487801
Bostrichidae	*Sinoxylon anale* (Lesne, 1897)	Auger beetle	28	CC	0.0114707087	0.000131577158	-4.46795856	-0.0512506512
Nitidulidae	*Stelidota geminate* (Say 1825)	Sap beetle	29	CC	0.0118803769	0.000141143355	-4.43286724	0.0526641336
Geotrupidae	*Anoplotrupes stercorosus* (Scriba, 1791)	Earth boring Dung beetle	36	CC	0.0147480541	0.0002175051	-4.21664413	-0.0621872957
Erotylidae	*Megalodacne fasciata* (Fabricius, 1777)	Fungus beetle	55	VC	0.0225317493	0.000507679727	-3.79282988	-0.085459092
	Dyscinetus morator (Fabricius 1798)	Rice beetle	23	CC	0.00942236788	8.87810165e-5	-4.66466885	-0.0439522259
Scarabacidae	*Phyllophaga crinite* (Burmeister, 1855)	White grub scarab	21	CC	0.00860303154	7.40121517e-5	-4.75564063	-0.0409129264
Dermestidae	*Dermestes lardarius* (Linnaeus, 1758)	Larder beetle	4	RR	0.00163867268	2.68524815e-6	-6.41386871	-0.0105102314
Total	**48**		**N = 2441**		**1**	**0.082031813**	**-229.4385564**	**-2.9275245**

Number of species (S) = 48, Total number of individual (N) = 2441, Shannon Diversity Index (H') = 2.9275245, Simpson's Index (λ) = 0.082031813, Simpson's Index of Diversity ($1 - \lambda$) = 0.917968187, Simpson's Reciprocal Index ($\frac{1}{\lambda}$) = 12.1903925, Species Richness = 13.90, Species Evenness (J') = 0.76, and Community Dominance (CD) = 32.16%. The number of species with percentage under the above families: Chrysomelidae (13 spp., 6.24%), Coccinellidae (10 spp., 20.83%), Curculionidae (5spp., 10.42%), Carabidae (4 spp, 8.33%), Cantharidae, Cerambycidae, Tenebrionidae, Scarabaeidae (2 spp., 4.17% included in each of the 4 families), and Staphylinidae, Bostrichidae, Nitidulidae, Geotrupidae, Erotylidae, Elasteridae, dermestidae(1 sp., 2.08% included in each of the 7 families).

Table 3: Illustration how the various indices change as the relative number of each coleopteran species change at AERE Campus

Family	*Scientific name*	Common name	n	Status	$P_i = n/N$	P_i^2	ln P_i	P_i ln P_i
Chrysomelidae	*Alticacha lybea* (Illiger, 1807)	Grape flea beetle	261	VC	0.0646039604	0.0041736717	-2.73947956	-0.176981229
	Aphthona euphorbiae (Schrank, 1781)	Root feeding flea beetle	285	VC	0.0705445545	0.00497653417	-2.65151079	-0.187049647
	Aspidimorph miliaris (Fabricius, 1775)	Spotted tortoise beetle	7	RR	0.00173267327	3.00215666e-6	-6.35808982	-0.0110164923
	Aspidimorph sanctaecrucis(Fabricius, 1792)	Golden tortoise beetle	4	RR	0.00099009901	9.8029605e-7	-6.91770561	-0.00684921348
	Aulacophara foveicollis (Lucas, 1849)	Red pumpkin beetle	381	VC	0.0943069307	0.00889379718	-2.3612006	-0.222677581
	Cassida circumdata (Herbst, 1799)	Green tortoise beetle	139	VC	0.0344059406	0.00118376875	-3.36952604	-0.115931713
	Charidotella sexpunctata (Fabricius, 1781)	Golden tortoise beetle	19	CC	0.0047029703	2.21179296e-5	-5.35956099	-0.0252058562
	Dicladispa testacea (Linnaeus, 1767)	Rockrose prickly leaf beetle	1	SS	0.000247524752	6.12685029e-8	-8.30399997	-0.00205544553
	Disonycha sp. (Chevrolat in Dejean, 1836)	Black & White striped flea beetle	13	CC	0.00321782178	1.0354377e-5	-5.73905061	-0.018467242
	Lema externevittata (Linnaeus, 1758)	Leaf beetle	48	CC	0.0118811881	0.000141162631	-4.43279896	-0.0526669183
	Lema incognita (Linnaeus, 1758)	Leaf beetle	39	CC	0.00965346535	9.31893933e-5	-4.64043832	-0.0447963105
	Monolepta signata (Olivier, 1808)	White spotted leaf beetle	206	VC	0.050990099	0.0025999902	-2.9761238	-0.151752847
	Oulema melanopus (Linnaeus,1758)	Cereal leaf beetle	106	VC	0.0262376238	0.000688412903	-3.64056088	-0.0955196668
	Phyllotreta nemorum. (Linnaeus, 1758)	Yellow spotted flea beetle	256	VC	0.0633663366	0.00401529261	-2.75882253	-0.174816477
	Podontia quatuordec impunctata (Linnaeus 1758)	14 spotted lady beetle	113	VC	0.027970297	0.000782337514	-3.57661215	-0.100038904
Curculionidae	*Amalushaemorrhous*(Herbst, 1795)	No English name found	4	RR	0.00099009901	9.8029605e-7	-6.91770561	-0.00684921348
	Ambrosiodmus rubricollis (Eichhoff, 1875)	Ambrosia beetle	19	CC	0.0047029703	2.21179296e-5	-5.35956099	-0.0252058562
	Macrancylus linearis (LeConte, J.L., 1876)	No English name found	14	CC	0.00346534653	1.20086266e-5	-5.66494264	-0.0196309893
	Tetragonothorax gyllenhali (Faust, 1894)	Cleonine weevil	7	RR	0.00173267327	3.00215666e-6	-6.35808982	-0.0110164923
Cantharidae	*Cantharis nigricans* (Muller, O.F 1776)	Soldier beetle	142	VC	0.0351485149	0.0012354181	-3.34817291	-0.117683305
	Rhagonycha fulva (Scopoli, 1763)	Common red soldier beetle	96	VC	0.0237623762	0.000564650523	-3.73965178	-0.0888630125
Staphylinidae	*Atrecus affinis* (Paykull, 1789)	Rove beetle	335	VC	0.0829207921	0.00687585776	-2.48986944	-0.206461946
Coccinellidae	*Cheilomenes sexmaculata* (Fabricius, 1781)	6 spotted zigzag lady bird	373	VC	0.0923267327	0.00852422557	-2.38242155	-0.219961198
	Chilomenes propingua nititica (Mulsant, 1850)	No English name found	133	VC	0.0329207921	0.00108377855	-3.41365084	-0.11238009
	Coccinella septempunctata(Linnaeus, 1758)	7 spotted lady beetle	196	VC	0.0485148515	0.00235369082	-3.02588531	-0.146800376
	Coccinella transversalis (Febricius, 1781)	Tranverse lady beetle	234	VC	0.0579207921	0.00335481816	-2.84867886	-0.164997736
	Exochomus flavipes (Thunberg, 1781)	No English name found	19	CC	0.0047029703	2.21179296e-5	-5.35956099	-0.0252058562
	Henosepilachna pusillanima (Mulsant, 1850)	Epilachnine beetle	73	VC	0.0180693069	0.000326499852	-4.01354053	-0.0725218956
	Henosepilachna vigintioctopunctata (Fabricius, 1775)	28 spotted potato lady bird	7	RR	0.00173267327	3.00215666e-6	-6.35808982	-0.0110164923
	Illeis koebelei (Timberlake, 1943)	Yellow spotless lady beetle	8	RR	0.00198019802	3.9211842e-6	-6.22455843	-0.0123258583
	Micraspis discolor (Febricius, 1798)	Spotless lady beetle	206	VC	0.050990099	0.0025999902	-2.9761238	-0.151752847
	Micraspis hirashimai (Samuelson, 1965)	No English name found	4	RR	0.00099009901	9.8029605e-7	-6.91770561	-0.00684921348
	Oenopia quadripunctata (Kapur, 1963)	Yellow spotted lady beetle	16	CC	0.00396039604	1.56847368e-5	-5.53141125	-0.0219065792
	Propylea dissecta (Mulsant, 1850)	Aphidophagus lady beetle	27	CC	0.00668316832	4.46647388e-5	-5.0081631	-0.033470397
Cerambycidae	*Graphisurus sp.* (Kirby, 1837)	Gray longhorn beetle	7	RR	0.00173267327	3.00215666e-6	-6.35808982	-0.0110164923
Tenebrionidae	*Crypticus quisquilius* (Linnaeus, 1760)	No English name found	14	CC	0.00346534653	1.20086266e-5	-5.66494264	-0.0196309893s
	Gonocephalum coriaceum (Motschulsky, 1857)	Darkling beetle	157	VC	0.0388613861	0.00151020733	-3.24775417	-0.126212229
	Platydema sp. (Laporte & Brulle 1831)	No English name found	3	VR	0.000742574257	5.51416527e-5	-7.20538768	-0.0053505354
Elateridae	*Conoderus sp.* (Eschscholtz, 1829)	Click beetle	8	RR	0.00198019802	3.9211842e-6	-6.22455843	-0.0123258583
Nitidulidae	*Stelidota geminate* (Say 1825)	Sap beetle	32	CC	0.00792079208	6.27389472e-5	-4.83826407	-0.0383228837
Geotrupidae	*Anoplotrupes stercorosus* (Scriba, 1791)	Earth boring Dung beetle	26	CC	0.00643564356	4.1417508e-5	-5.04590343	-0.0324736359
Dermestidae	*Dermestes lardarius (*Linnaeus, 1758)	Larder beetle	2	VR	0.000495049505	2.45074012e-7	-7.61085279	-0.00376774891
Total	**42**	**N =4040**			**1**	**0.056320765**	**-199.959017**	**-3.0701943**

Number of species (S) = 42, Total number of individual (N) = 4040, Shannon Diversity Index (H) = 3.0701943, Simpson's Index (λ) = 0.056320765, Simpson's Index of Diversity ($1 - \lambda$) = 0.943679235, Simpson's Reciprocal Index ($\frac{1}{\lambda}$) =17.7554406, Species Richness = 11.37, Species Evenness (J') =0.82, and Community Dominance (CD) = 18.66%. The number of species, their percentage under the above families: Chrysomelidae (15 spp., 35.71%), Coccinellidae (12 spp.,28.57%), Curculionidae (4spp., 9.52%) Tenebrionidae (3 spp., 7.14%), Cantharidae (2 spp., 4.76%), and Staphylinidae, Cerambycidae, Nitidulidae, Geotrupidae, Elasteridae, Dermestidae (1 sp., 2.38% included in each of the 6 families).

species in the community. Sanjayan *et al.* (1995) showed that the value of E tends to be zero, which indicates that the species has become more dominant in a community. In this study, the value of E for the Ramna Park (0.89) and AERE campus (0.82) is high, which shows the species are evenly distributed, while at the National Botanical Garden (E = 0.76) is comparatively low, which means the National Botanical Garden is less evenly distributed than the two other areas. Community similarity among the Ramna Park, National Botanical Garden, and AERE campus is shown in Table 4. The value of Sorenson's Coefficient (CC) of these communities is 0.66. Sorensen (1948) stated that its range is from 0 to 1. The closer the value is to 1, the more the communities have in common. These three communities are fairly similar in terms of Sorenson's Coefficient. The simple Community Dominance index represents the percentage of abundance contributed by the two most abundant species, which is the maximum at the National Botanical Garden compared to the other two study areas.

Table 4. Community Similarity among the Ramna Park, the National Botanical Garden, and the Atomic Energy Research Establishment (AERE)

Community Similarity is measured by Sorenson's Coefficient (CC).

The equation is: Sorenson's Coefficient (CC) $= \frac{3C}{S_1+S_2+S_3}$

Where, the number of species at the three communities (Ramna Park, National Botanical Garden and Atomic Energy Research Establishment) have in common (C) = 30, the total number of species found at the Ramna Park (S_1) = 47, the total number of species found at National Botanical Garden (S_2) = 48, and the total number of species found in the Atomic Energy Research Establishment (AERE) (S_3) = 42.

Sorenson's Coefficient (CC) = $\frac{3C}{S_1+S_2+S_3} = \frac{3x30}{47+48+42} = \frac{90}{137} = 0.66$

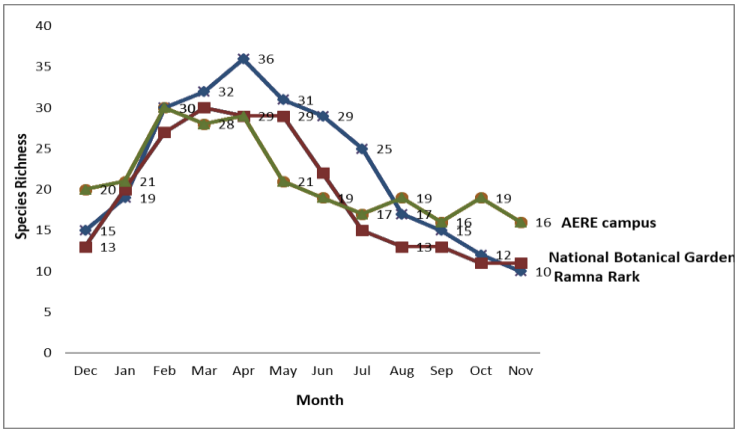

Fig. 2. Species richness of coleoptera for pooled data over 12 months.

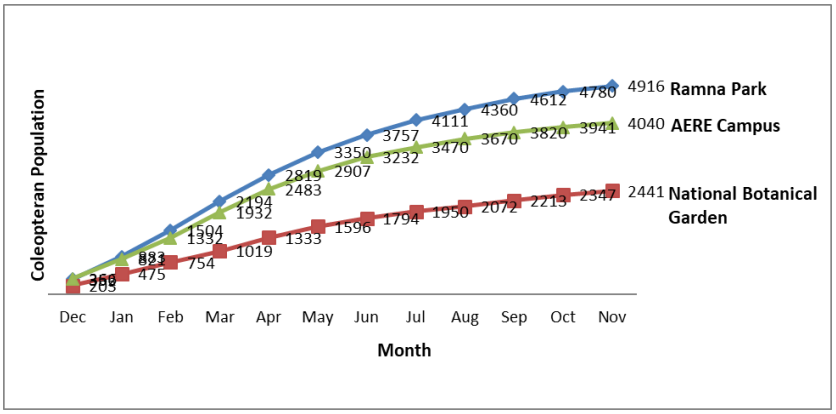

Fig. 3. Month-wise population cumulative curve of faunal assemblage of coleoptera at the three selected areas of Dhaka city.

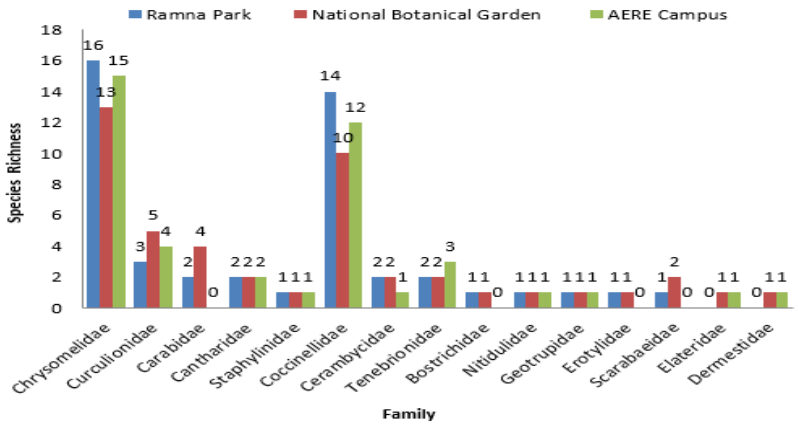

Fig. 4. Family-wise coleopteran species at three selected areas of Dhaka city.

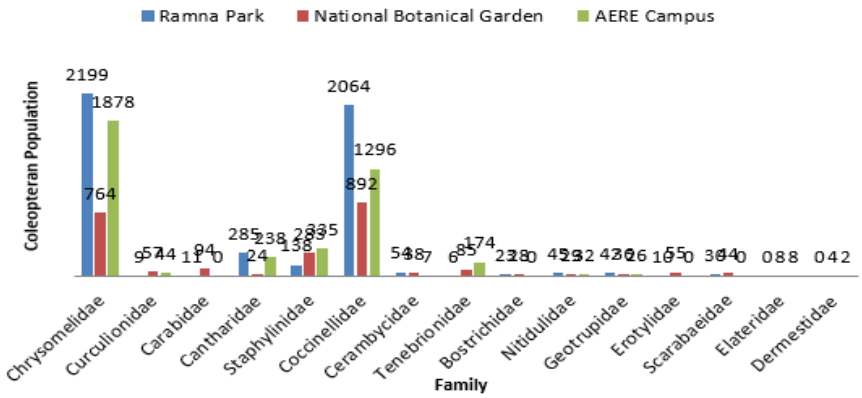

Fig. 5. Family-wise populations of coleoptera at the three selected areas of Dhaka city.

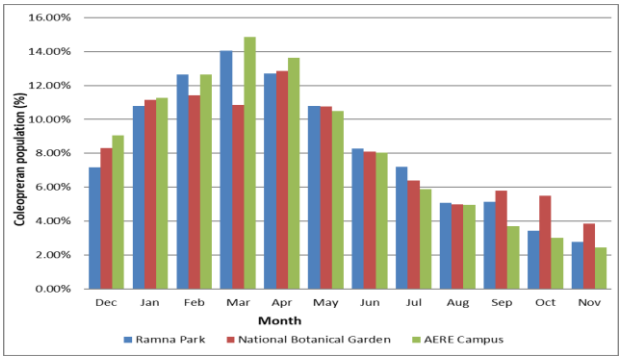

Fig.6. Month-wise coleopteran population (%) at the three selected areas of Dhaka city.

Fig.7. Coleopteran species at the three study areas of the Dhaka city.

CONCLUSION

The present study provides the checklist of Coleopterans in the three areas of Dhaka city. In the current study the species accumulation curve could not attain asymptote after twelve sampling in twelve month indicated that most of the probable species have not been encountered during the inventorying process. In this study better knowledge of the abundance, species richness, seasonal composition and comparative diversity of Coleopteran communities has been achieved, which should be very useful for improving predictive models and developing management guidelines for their control measures. It also provides baseline data for upcoming researchers and gives wide scope for further study. A long term study is needed to observe the species occurrence in all seasons and their interaction with the environmental changes, in order to get better and comprehensive information.

Acknowledgement: Authors are grateful to the authority of Institute of Food and Radiation Biology (IFRB) in the Atomic Energy Research Establishment (AERE), Savar for giving permission to carry out the field study in their campus. Authors are also grateful to the authorities of the Ramna park as well as National Botanical Garden for giving permission to continue this research.

LITERATURE CITED

BOOTH, R. G. and POPE, R. D. 1989. A review of the type material of Coccinellidae (Coleoptera) described by F. W. Hope, and by E. Mulsant in the Hope Entomological Collections, Oxford. *Entomol. Scand.* **20**: 344–370.

BEGUM, J. and OPPENHEIMER, J. R. 1981. Bangladesh Dung bettle (Scarabaeidae and Trogidae): seasonality, habitat, food and partial distribution. *Bangladesh J. Zool.* **9** (1): 9-15.

BOUCHARD, P., LESAGE, L., GOULET, H., BOSTANIAN, N. J., VINCENT, C., ZMUDZINSKA, A., and LASNIER, J. 2005. Weevil (Coleoptera: Curculionoidea) diversity and abundance in two Quebec vineyards. *Ann. Entomol. Soc. Am.* **98**(4): 565-574.

BOUSQUET, Y. 1991. *Checklist of beetles of Canada and Alaska.* Research Branch, Agriculutre Canada Publication 1861/E. Ottawa. 430 pp**.**

CHOATE, P. M. 2003. Introduction to the Identification of Beetles (Coleoptera). *Zookeys* **360**: 1-44.

CHANDRA, K, and DEVANSHU, G. 2012. Diversity and composition of dung bettles (scarabaeidae: scarabaeinae and aphodiinae) assemblages in singhori wildlife sanctuary, raisen, madhya pradesh (India). *Entomol. Zool.* **7**: 1-16.

FOSTER, A. D. and ROSENZWEIG, M. R. 1995. Learning by doing and learning from others: Human capital and technical change in agriculture. *J. Polit. Econ.* **103**(6):1176-1209.

GANESHAIH, K. N., CHANDRASEKARA, K. and KUMAR, A. R. V., 1997. A new measure of biodiversity based on biological heterogeneity of communities. *Curr. Sci.* **73**(2): 128-133.

GLEASON, H. A. 1922. On the relation between species and area. *Ecol.* **3**: 156-162.

HAVA, J. 2009. Order Coleoptera, family Dermestidae. *Arthropod fauna of the UAE* **2**:164-173.

HAMMOND, P. 1992. *Species inventory. In Global biodiversity.* Springer, Dordrecht. pp.17-39).

ISLAM, A. T. M. F., ISLAM, M. H., SAIFULLAH, A. S. M. and YAMANAKA, A. 2013. A preliminary report of moth's fauna in the campus of Atomic Energy Research Establishment (AERE), Savar, Dhaka, Bangladesh. *Int. J Fauna Biol. Stud.* **1**(1): 56-62.

IRSHAD, M. and HAQ, E. 2010. Research Work on Biological Control of Pests in Pakistan. National Agricultural Research Centre, Islamabad. Islamabad, Pakistan: GulAwan Printers. 83pp.

KABIR, S. M., KABIR, A. and MAJUMDER, M. Z. 1990. Relative abundance and species composition of some dung beetles (Coleoptera: Scarabaeinae) in Bangladesh. *Med. Vet. Entomol.* **4** (4): 439-43.

KALAICHELVAN, T. and VERMA, K. K. 2005. Checklist of leaf beetles (Coleoptera: Chrysomelidae) of Bhilai-Drug. *Zoo's Print J.* **20**(4): 1838-1842.

KAZMI, S. I. and RAMAMURTHY, V. V. 2004. Coleoptera (Insecta) Fauna from the Indian Thar Desert, Rajasthan. *Zoos' Print J.* **19**(4): 1447-1448.

KHAN, M., R., KHURSHID, A., IKRAM, B. AND MALIK, A., I. 2004. Biodiversity of Coleopteran from District Poonch Sudhonti, Azad Kashmir. *Asian J. Plan. Sci.* **3**: 556-560.

KHAN, I., DIN, S., KHALIL, S. K. AND RAFI, M. A. 2007. Survey of predatory coccinellids (Coleoptera: Coccinellidae) in the Chitral district, Pakistan. *J. Insect Sci.* **7**(1): 7.

KUSCHEL, G. 1990. *Beetles in a suburban environment: A New Zealand case study. The identity and status of Coleoptera in the natural and modified habitats of Lynfield, Auckland (1974-1989).* Mount Albert Research Centre, New Zealand. 119 pp.

LUDWING, J. A. and REYNOLDS, J. F. 1988. *Statistical ecology:* a primer on methods and computing. John willy and Sons, New York. Vol.**1**, 220 pp.

MAZUMDAR, S., HEBERT, P. D. N. and BHUIYA, B. A. 2021. Survey of Coleopterans in Bangladesh by DNA barcoding of malaise trap collection. *Mun. Ent. Zool.* **16**(1): 275-282.

CASPERS, H. 1976. MS Mani: Ecology and Biogeography in India. In: *Monographiae Biologicae* (Ed., ILLIES., J). The Hague: Dr. W. Junk bv Publishers 1974, India. Vol. 23, 775 pp.

MacDONALD, Z. G., NIELSEN, S. E. and ACORN, J. H. 2017. Negative relationships between species richness and evenness render common diversity indices inadequate for assessing long-term trends in butterfly diversity. *Biodiv. & Conserv.* **26**(3): 617-629.

McNAUGHTON, S. J. 1968. Structure and Function in California grasslands. *Ecology* **49**: 962-972.

MCCORMACK, J. J. and COTORAS, D. D. 2021. Beetle Diversity Across Micro-habitats on Lizard Island Group (Great Barrier Reef, Australia). *Zool. Stud.* **60**.

NASIRUDDIN, M. and SHIULI, F. A. 2017. Entomofauna of four spots of Chittagong University campus and their relative abundance and diversity. *J. Biodivers. Conserv. & Bioresour. Manag.* **3**(1): 55-64.

NYUNDO, B. L. and YARRO, J. G. 2007. An assessment of methods for sampling carabid bettles (Coleoptera: Carabidae) in a montane rain fdorest. *Tanzania J. Sci.* **33**1): 41-49.

PIELOU, E. C. 1966. The measurement of diversity in different types of Biol. Collections. *J. Theort. Biol.* **13**: 131-144.

POWELL, J. A. 2009. "Coleoptera," in *Encyclopedia of Insects (*2nd edition). H. Vincent Resh and T. Ring Cardé, Eds. Academic Press, New York, NY, USA.199 pp.

SANJAYAN, K. P., M. C. MURALIRANGAN, P. D. SURESH, C. SURESH and S. ALBERT. 1995. The plant community structure of the Namangalam Reserve Forest, Tamil Nadu: a paradigm of the spatial distribution pattern in a natural scrub-jungle ecosystem. *Int. J. Ecol. Env. Sci.* **21**:297-307.

SHANNON, C. E. and WIENER, W. 1949.*The mathematical theory*. University of Illinois press, Urbana.117 pp.

SHARMA, R. M., MULGANINA, M. and CHAKRABORTY, P. 2004. Beetles of Kalotop Khanjjiar Wildlife Sanctuary, Himachal Pradesh. *Zoos' Print J.* **19**(9): 1626.

SORENSEN, T. 1948. A method of stabilizing groups of equal amplitude in plant sociology based on similarity of species content and its application to analysis of vegetation on Danish commons. *Biol. Skrifter* **5**: 1-34.

SIMPSON, E. H. 1949. Measurement of diversity. *Nature* **163**: 688.

THAKARE, V. G. and ZADE, V. S. 2012. Diversity of beetles (Insecta: Coleoptera) from the vicinity of Semadoh-Makhala road, Sipna range, Melghat Tiger Reserve, (MS) India. *Bio. Disc.* **3**(1): 112-115.

(Manuscript received on 30 June, 2022; revised on 26 August, 2022)