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Comparative study on species composition and diversity of insects in the South Park Street Cemetery and Banabitan Park, West Bengal, India

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ABSTRACT

Insects, which represent the most species-rich taxa, are extremely important ecosystem components and help to perform various activities which are necessary for an ecological balance. They play a major role in maintaining the structure and function of the ecosystems. Parks and Cemeteries take over various functions in urban areas like providing important habitats for a variety of species. Cemeteries are important components of the urban green infrastructure, simply because of their number and the area they cover. The conservation of insects is necessary to sustain varied kinds of ecosystem services for human well-being. Insects constitute a major source of food for birds, mammals, reptiles and other taxonomic groups of animals. They serve as scavengers to clean up the systems of dead materials as well as contribute immensely to decomposition. This study was performed from August 2017 to January 2018, through regular surveys at fifteen days interval to obtain the list of insects from the South Park Street Cemetery (Kolkata) and Banabitan Park (Saltlake). During the entire periods five insect orders (Lepidoptera, Hemiptera, Orthoptera, Coleoptera and Odonata) were recorded. Lepidopteran diversity was highest in the study area in both the habitats. Occurrence of species diversity and abundance were maximum in the months of October and minimum in the months of January. Diversity and species number were highest in Park Street Cemetery and lowest in Banabitan Park due to more human interference in Banabitan Park. Cemeteries offer a variety of structures enabling a wide range of species. Hence, cemeteries are particularly valuable for urban biodiversity conservation. Insects are therefore treated as an important model group in ecology and conservation.

Key words: *Park, Cemetery, Insect diversity, Species richness*

Introduction

Insects are known to be the most successful and diverse form of organisms on earth. They play an important role in running an ecosystem and help to perform various activities which are necessary for an ecological balance (Khadijah *et al.*, 2013). They play a major role in maintaining the health of the ecosystems and essential role in energy flow (Tiple and Khurad, 2009). They act as herbivores, scavengers and detritivores, predators and parasites (Sala *et al.*, 2009). They are key virtually components in any food web of a terrestrial or fresh water ecosystem (Shurin *et al.*, 2005). They are the major herbivores and consume large proportion of plant biomass in terrestrial ecosystems (Varshney, 1998). They are also an important pollinators as well as one of the important components of food chain of the birds, reptiles, spiders and predatory insect (Sudarshan and Sunil, 2016). According to Samways (1993) insect conservation has to be in a broad scale which should cover all possible types of landscapes

and biotypes like high mountains, caves, deserts, forests, grasslands, islands and river systems which are liable to be affected by anthropogenic disturbances and natural calamities.

Parks and Cemeteries are primarily places of land used for rest and recreation. Urban parks are green spaces set aside for recreation inside towns and cities. Cemeteries are urban green areas that are central and close elements of an urban green space network especially in densely populated urban areas. Friends and relatives are given an opportunity to visit the resting place of the deceased, to commemorate the lost and to process their grief. Cemeteries and other types of burial grounds are regarded as sacred places all over the world, closely linked to community history (Rugg, 2000) and often functioning as repositories of natural and cultural diversity (Barrett and Barrett, 2001). Cemeteries with a high structural diversity are an important habitat especially for insects (Richter, 1994; Schmidt, 1994; Hottinger, 2004). The relationship between biodiversity (here mainly refers to species diversity) and ecosystem functioning has received increasing scientific interest in recent decades (Balvanera *et al.,* 2006). Horvath *et al.* (2007) studied on diversity in insects of cemetery in the Hungarian town of Kiskunhalas and Biodiversity functions of urban cemeteries in Europe studied by Kowarik (2016) and Loki *et al.* (2019). Studies on 'green spaces' (e.g. cemeteries, parks, gardens) have important research area within cities to determine urban ecology by Pickett and Cadenasso (2008). The conservation of insects is necessary to sustain various kinds of ecosystem services for human well-being. Despite their vital role little information is known about the insect communities in Park and Cemetery in Kolkata. Therefore, keeping in mind the above fact, present work was conducted to study the diversity and distribution of insects in the South Park Street Cemetery (Kolkata) and Banabitan Park (Saltlake), West Bengal, India. Hopefully, there will be a further research study on the insect biodiversity and taxonomy in this area, in order to get better and comprehensive information on those aspects to be documented for future reference.

Materials and Methods

Study area and sampling

This study was carried out in South Park Street Cemetery, Kolkata (22.5466° N, 88.3602° E) and Banabitan Park (Central Park), Saltlake (22.5846° N, 88.4162° E) during good weather periods (no heavy rain and strong wind). During this study period five insect orders (Lepidoptera, Hemiptera, Orthoptera, Coleoptera and Odonata) were recorded. The survey work was conducted twice in a month at fifteen days interval from 8 am to 10 am during the period August 2017 to January 2018. The butterflies were observed and recorded in the field following "Pollard Walk" method (Pollard and Yates, 1993) with necessary modifications, beside the observer and visual count method was also adopted (Kunte, 1997). Butterflies were observed within 2.5 meters to the left and right side and five meters in front of the observer. In critical conditions, they were captured by hand net following Tiple (2012), identified using suitable keys (Haribal, 1992; Kehimkar, 2008) and released in the same habitat from where they were captured with least disturbance. The dead specimens were kept in butterfly collection box. From the study site the adult grasshoppers were collected by sweep net sampling which is the most commonly used method to estimate grasshopper species composition (Joshi *et al.,* 1999). Twenty sweeps of a 30 cm diameter sweep net were taken. Hemipteran species were collected with aerial nets (in flight) and sweeping nets (vegetation) and the collected materials were kept in 70% alcohol. Coleopteran species was collected by beating and sweeping in random way. The adult Odonata was collected by using sweep net from the study sites. All the specimens were counted and brought to the laboratory for identification. All identifications were confirmed from Zoological Survey of India, Kolkata.

Data Analysis

The relative abundance (RA) of different species was recorded in these two habitats. The study area in each month was determined using the Shannon-Weaner Index, Margalef Index, Equitability index and Menhinick's Index for species diversity analysis.

Shannon-Wiener index (H')

$$H' = - \Sigma (n_i/N) \ln (n_i/N)$$

Or

$$H' = - \Sigma P_i \ln P_i$$

Where,

n_i = importance value for each species

N = total importance value

P_i = importance probability for each species = n_i/N

ln = is the log with base 'e' (Natural log)

Variety index or Margalef's index (D_{Mg})

$D_{Mg} = S-1/lnN$

Where

S = number of species

N = number of individuals

ln = is the log with base 'e' (Natural log)

Equitability index (J)

$J = H'/lnS$

Where,

H' = Shannon-Wiener index

S = number of species

ln = is the log with base 'e' (Natural log)

Menhinick's Index (D_{Mn})

$D_{Mn} = S/\sqrt{N}$

Where,

S = number of species

N = number of individuals

Results

Species composition and diversity of insects in Park Street Cemetery

During study period the monthly variation in insect orders with their Relative Abundance (%) in two habitats are shown in Fig. 1. The number of Lepidoptera was the highest in both the habitats whereas coleopteran was lowest in both the habitats. During the course of present study, insect individuals belonging to 38 species from 16 family's belongings to 5 orders, i.e. Lepidoptera consisting of 22 species, followed by Odonata 6 species, Hemiptera and Orthoptera which comprises of 4 species each and while Coleoptera comprise of 2 species were recorded from Park Street Cemetery. A total of 456 insect individuals including Lepidopteran 5 families (Nymphalidae: N=16.67%, S=10; Papilionidae: N=6.80%, S=5; Pieridae: N=20.18, S=5; Arctiidae: N=2.63%, S=1; Hesperiidae: N=31.58%, S=1), Hemipteran 4 families (Scutelleridae: N=5.04%, S=1; Alydidae: N=3.95%, S=1; Pentatomidae: N=0.22%, S=1; Coreidae: N=0.44%, S=1), Orthopteran 3 families (Acrididae: N=2.85%, S=1; Tettigoniidae: N=0.44%, S=1; Gryllidae: N=0.66%, S=1), Coleopteran 2 families (Carabidae: N=2.19%, S=1; Coccinellidae: N=0.22%, S=1) and Odonata 2 families (Libellulidae: N=2.85%, S=3; Coenagrionidae: N=3.29%, S=3) were observed from the study area during the entire period. Lepidoptera was the highest number of insects and observed in the month of November (Hesperiidae; N=63.69%), 2017 whereas maximum number of insects were not found in the orders of Hemiptera, Orthoptera, and Coleoptera in the month of January, 2018. Nymphalidae, Pieridae and Hesperiidae were observed in every month (Table 1). The maximum numbers of insects were observed in Lepidoptera (77.85%) and lowest in Coleoptera (2.41%).

During the study period the species richness and different indices as a measure of diversity of insects in both Park Street and Banabitan habitats are shown in Table 3. The Shannon diversity index (H') was highest in Lepidoptera (H'=1.007) followed by Hemptera (H'=0.93); Orthoptera (H'=0.78); Odonata (H'=0.69) and Coleoptera (H'=0.3). The Margalef index was maximum in Lepidoptera (3.58) and minimum in Coleoptera (0.42). The Menhinick index (Dmn) was maximum in Lepidoptera (1.167) and minimum in both Coleoptera (0.603) and Hemiptera (0.603). The values of evenness index showed little contrast; it was maximum in Hemiptera (0.67)

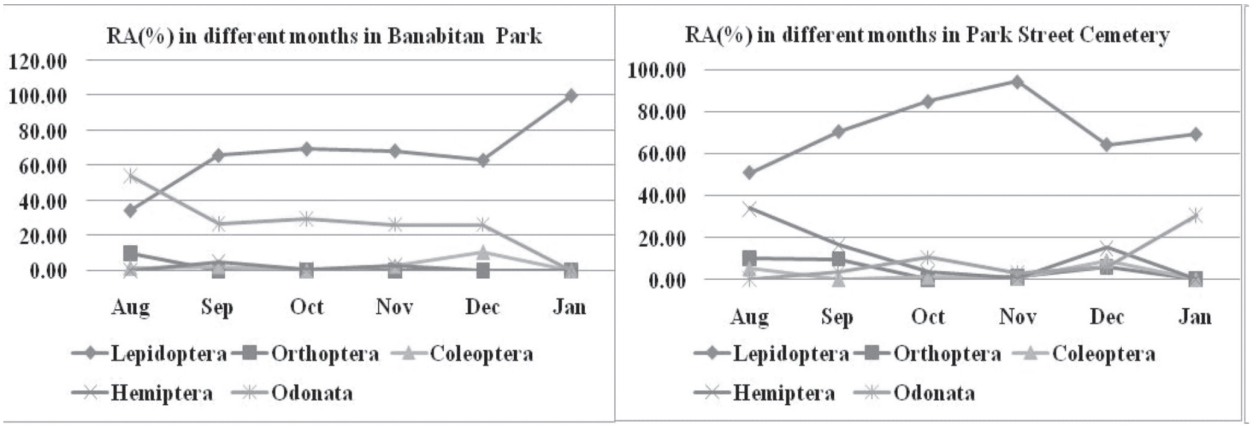

Fig. 1. Monthly variation in insect orders with their Relative Abundance (%) during study period in two habitats.

and minimum in Lepidoptera (0.325).

Species composition and diversity of insects in Banabitan Park (Central Park)

This study revealed that the Lepidoptera was the most dominant species and it was found in all the every month in Banabitan Park (Table 2). In this study area, insect individuals belonging to 30 species from 16 family's belongings to 5 orders i.e. Lepidoptera consisting of 18 species, followed by Odonata 5 species, Orthoptera comprise of 3 species while Hemiptera and Coleoptera comprises of 2species each were recorded from Banabitan Park. A total of 266 insect individuals including Lepidopteran 5 families (Nymphalidae: N=21.43%, S=10; Papilionidae: N=4.89%, S=2; Pieridae: N=12.03%, S=3; Arctiidae: N=0.38%, S=1; Hesperiidae: N=22.18%, S=2), Orthopteran 2 families (Acrididae: N=1.5%, S=2; Tettigoniidae: N=0.75%, S=1), Coleopteran 2 families (Carabidae: N=0.75%, S=1; Coccinellidae: N=1.13%, S=1), Hemipteran 2 families (Scutelleridae: N=1.13%, S=1; Pentatomidae: N=0.38%, S=1) and Odonata 2 families (Libellulidae: N=27.07%, S=3; Coenagrionidae: N=6.39%, S=2) were observed from the study area during the entire period. The maximum numbers of insects were ob-

Table 1. Showing the monthly fluctuation of insect orders and families with their Relative Abundance (%) collected during study period in South Park Street Cemetery.

Order	Family	Month wise Relative Abundance (%)					
		Aug	Sep	Oct	Nov	Dec	Jan
Lepidoptera	Nymphalidae	10.17	8.20	24.42	17.20	20.90	11.54
	Papilionidae	0	1.64	22.09	3.82	5.97	3.85
	Pieridae	28.82	19.67	26.74	9.55	22.39	38.46
	Arctiidae	3.39	16.39	0	0	0	0
	Hesperiidae	8.47	24.59	11.63	63.69	14.93	15.38
Hemiptera	Scutelleridae	25.43	8.20	3.49	0	0	0
	Alydidae	8.47	3.28	0	0.64	14.93	0
	Pentatomidae	0	1.64	0	0.00	0.00	0
	Coreidae	0	3.28	0	0.00	0.00	0
Orthoptera	Acrididae	8.47	9.84	0	0.00	2.99	0
	Tettigoniidae	1.69	0.00	0	0.00	1.49	0
	Gryllidae	0	0.00	0	1.27	1.49	0
Coleoptera	Carabidae	5.09	0.00	0	0.64	8.96	0
	Coccinellidae	0	0.00	1.16	0.00	0.00	0
Odonata	Libellulidae	0	3.28	1.16	0.00	5.97	23.08
	Coenagrionidae	0	0	9.30	3.18	0	7.69

Table 2. Showing the monthly fluctuation of insect orders and families with their Relative Abundance (%) collected during study period in Banabitan Park

Order	Family	Month wise Relative Abundance (%)					
		Aug	Sep	Oct	Nov	Dec	Jan
Lepidoptera	Nymphalidae	3.28	12.20	25.49	36.84	47.37	20.00
	Papilionidae	0.00	2.44	6.86	10.53	5.26	0.00
	Pieridae	6.56	24.39	15.69	2.63	0.00	20.00
	Arctiidae	0.00	0.00	0.00	2.63	0.00	0.00
	Hesperiidae	24.59	26.83	21.57	15.79	10.53	60.00
Orthoptera	Acrididae	6.56	0.00	0.00	0.00	0.00	0.00
	Tetegonidae	3.28	0.00	0.00	0.00	0.00	0.00
Coleoptera	Carabidae	0.00	0.00	0.00	2.63	5.26	0.00
	Coccinedellidae	1.64	2.44	0.00	0.00	5.26	0.00
Hemiptera	Scutelleridae	0.00	4.88	0.98	0.00	0.00	0.00
	Pentatomidae	0.00	0.00	0.00	2.63	0.00	0.00
Odonata	Libellulidae	49.18	26.83	19.61	15.79	26.32	0.00
	Coemgrionidae	4.92	0.00	9.80	10.53	0.00	0.00

served in Lepidoptera (60.90%) and lowest in Hemiptera (1.50%). The Shannon diversity index (H′) was highest in Lepidoptera (H′=1.29) followed by Hemptera (H′=0.732); Coleoptera (H′=0.693); Orthoptera (H′=0.637) and Odonata (H′=0.48). The Margalef index was maximum in Lepidoptera (3.34) and minimum in Coleoptera (0.62). The Menhinick index was maximum in Lepidoptera (1.141) and minimum in Odonata (0.529). The values of evenness index showed little contrast; it was maximum in Hemiptera (1.056) and minimum in Odonata (0.299).

Discussion

The study revealed that maximum numbers of insects were found during the months of October and November, 2017 whereas lowest in the month of January, 2018 since favorable weather and climatic conditions was present increasing the chances of their survival. Our observation suggests that total abundance, species richness and diversity of insects were highest in the Order Lepidoptera in both habitats. Although the diversity trends of the insects in different months are not similar. Representation of Nymphalidae, Pieridae and Hesperiidae were highest while representatives of Papillionidae and Arctiidae were lowest of the study area. Nymphalidae is the dominant family in all time with highest number of Lepidopteran species (Kunte, 1997). The seasonal fluctuations of insect population also probably reflect seasonal variability in availability and quality of food resources and climatic setting in the area. In the month January lower temperature might have adversely affected the biological activity of insects leading to their little abundance and low insect species. Mukherjee *et al.* (2015) also reported that Lepidopteran diversity and abundance were low in the month December - February. This is similar to my observation that may be due to climatic condition and local vegetation. Diversity and species number were highest in Park Street Cemetery and lowest in Banabitan Park due to more human interference in Banabitan Park. Cemeteries offer a variety of structures enabling a wide range of species. Sacred places have long and diverse histories in human cultures and demonstrate ancient links between peoples and their environment (Anderson *et al.*, 2005). As result it is expected this cemetery is blessed with great biodiversity. Not only in biodiversity conservation, has cemetery also played an important role in soil conservation.

Biological diversity is the base for upholding the ecosystems and the functional aspects of the species that provide goods and services for human well-being. It is recognized that sacred burial places are key in conserving natural vegetation in their area (Barrett and Barrett, 2001). Alternatively, Schuldt *et al.* (2011) also suggested that high plant diversity can potentially support a higher density of herbivorous arthropods in natural habitats. The Orthoptera fauna appears to be highly diverse in cemeteries (Tan, 2012 and Tan *et al.*, 2013). Insects are treated as an important model group in ecology and conservation (Watt and Boggs, 2003; Ehrlich and Hanski, 2004; Saha and Haldar, 2009). Biodiversity of insects, therefore, is one of the most important components of a life supporting system and become an urgent task for entomologists and all citizens (You *et al.*, 2005). Therefore it is obvious that loss of insect species and their genetic diversity will cause the degradation and collapse of ecosystems that will threaten our existence on earth.

Urban cemeteries are very much important to special places for nature and species protection (so-called "islands") that require be duly considering and promoting because of their value (Schroder, 2007). Parks and cemeteries both belong to the sites that combine the particularities of urban ecosystems with special proximity to nature. Rare and endangered species can find new habitats in urban cem-

Table 3. Results of different ecological indices in different Orders in two habitats during study period

South Park Street Cemetery							Order	Banabitan Park						
D_{mg}	J	D_{mn}	H′	S	RA (%)	N		N	RA (%)	S	H′	D_{mn}	J	D_{mg}
3.58	0.33	1.17	1.01	22	77.85	355	Lepidoptera	162	60.90	18	1.29	1.41	0.45	3.34
0.79	0.67	0.60	0.93	4	9.65	44	Orthoptera	6	2.26	3	0.64	1.22	0.58	1.12
1.04	0.56	0.94	0.78	4	3.95	18	Coleoptera	5	1.88	2	0.69	0.89	0.99	0.62
0.42	0.43	0.60	0.3	2	2.41	11	Hemiptera	4	1.50	2	0.73	1	1.06	0.72
1.5	0.39	1.13	0.69	6	6.14	28	Odonata	89	33.46	5	0.48	0.52	0.30	0.89

eteries (Hottinger, 2004; Kowarik, 1992). Cemeteries and parks hence function as refuges for endangered species. This is due to characteristic features of cemeteries such as: (i) Semi-open habitats, (ii) Old age of soils and locations; and (iii) High level of habitat diversity. Although old cemeteries are often rich in species, the age is not the primary factor determining the diversity. A high structural diversity allows a large number of species to settle and thus promotes biodiversity. Cemeteries offer a variety of structures enabling a wide range of species. Hence, cemeteries are particularly valuable for urban biodiversity conservation. The degree of interaction is dependent on the location of the cemetery within the urban structure, the population density of the surrounding urban area, the number of visitors and the frequency of human interference, the permeability to other ecosystems, and the cultural and cost-related practices in the management of a cemetery. Being as indicators of environment insects are sensitive towards their surroundings and changes in their ambience may lead to the changes in their status. The conservation of insects is necessary to sustain varied kinds of ecosystem services for human well-being. There is an urgent need to protect and conserve this enormous diversity of life which is so vital to many ecosystem functions.

Conclusion

Diversity and species number were highest in Park Street Cemetery and lowest in Banabitan Park due to more human interference in Banabitan Park. Cemeteries offer a variety of structures enabling a wide range of species. Hence, cemeteries are particularly valuable for urban biodiversity conservation. Cemeteries ensure the crucial function of balancing the city's climate and the microclimate and they are important habitats for plants and animals. The fauna diversity in cemeteries is high and particularly worth protecting. The significant biodiversity at sacred burial grounds documented worldwide highlights the importance of customs in maintaining elements of the landscape for centuries, while currently their existence is largely threatened by changing demands of the modern world. Urban cemeteries are very much important to special places for nature and species protection (so-called "islands") that require be duly considering and promoting because of their value. Therefore, public awareness is an ultimate necessity to conserve the suitable habitats of these ecologically important insect organisms. The role of cemeteries in biodiversity conservation in the close proximity of urban areas is unquestionable in the new era.

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References

Anderson, D.M., Salick, J., Moseley, R.K. and Xiaokun, O. 2005. Conserving the sacred medicine mountain: A vegetation analysis of Tibetan sacred sites in Northwest Yunnan. *Biodiversity and Conservation.* 14: 3065-3091.

Balvanera, P., Pfisterer, A.B., Buchmann, N., He, J.S., Nakashizuka, T., Raffaelli, D. and Schmid, B. 2006. Quantifying the evidence for biodiversity effects on ecosystem functioning and services. *Ecology Letters*. 9: 1146-1156.

Barrett, G.W. and Barrett, T. L. 2001. Cemeteries as repositories of natural and cultural diversity. *Conserv. Biol.* 15 (6): 1820-1824.

Ehrlich, P.R. and Hanski, I. 2004. *On the Wings of Checkerspots: a Model System for Population Biology.* Oxford: Oxford University Press. p. 408.

Haribal, M. 1992. The butterflies of Sikkim Himalayas and their natural history. Gangtok: Sikkim Nature Conservation Foundation (SNCF). p. 217.

Horvath, G., Malik, P., Kriska, G. and Wildermuth, H. 2007. Ecological traps for dragonflies in a cemetery: the attraction of *Sympetrum* species (Odonata: libellulidae) by horizontally polarizing black gravestones. *Freshw. Biol.* 52 (9) : 1700-1709.

Hottinger, H. 2004. Grundlagen zum Schutz von Tagschmetterlingen in Städten (Lepidoptera: Papilionoidea & Hesperioidea). *Oedippus.* 22: 1-48. zit nach Rabitsch (2009).

Joshi, P.C., Lockwood, J.A., Vashishth, N. and Singh, A. 1999. Grasshopper (Orthoptera: Acrididae) community Dynamics in a Moist Deciduous Forest in India. *Journal of Orthoptera Research.* 8 : 17-23.

Kehimkar, I. 2008. *The Book of Indian Butterflies.* Mumbai: Bombay Natural History Society and Oxford University Press. p. 497.

Khadijah, A.R; Azidah, A.A. and Meor, S.R. 2013. Diversity and abundance of insect species at Kota Damansara Community Forest Reserve, Selangor. *Scientific Research and Essays.* 8 : 359-374.

Kowarik, I. 1992. Das Besondere der städtischen Flora und Vegetation. Natur in der Stadt – der Beitrag der

Landespflege zur Stadtentwicklung. Schriftenreihe des Deutschen Rates für Landespflege. Bonn, Heft 61: 33–47.

Kowarik, I., Buchholz, S., von der Lippe, M. and Seitz, B. 2016. Biodiversity functions of urban cemeteries: Evidence from one of the largest Jewish cemeteries in Europe. *Urban Forestry & Urban Greening.* 19(1): 68-78.

Kunte, K. 1997. Seasonal pattern in butterfly abundance and species diversity in four tropical habitats in northern Western Ghats. *Journal of Bioscience.* 22(5): 593-603.

Loki, V., Deak, B., Andras Balazs Lukacs, A.K. and Molnar, V.A. 2019. Biodiversity potential of burial places ea review on the ora and fauna of cemeteries and churchyards. *Global Ecology and Conservation.* 18: 1-15

Mukherjee, S., Banerjee, S., Saha, G.K. and Basu, P. 2015. Butterfly diversity in Kolkata, India: An appraisal for conservation management. *Journal of Asia-Pacific Biodiversity.* 8 : 210-221.

Pickett, S.T.A. and Cadenasso, M.L. 2008. Linking ecological and built components of urban mosaics: an open cycle of ecological design. *Journal of Ecology*. 96: 8–12.

Pollard, E. and Yates, T.J. 1993. *Monitoring Butterflies for Ecology and Conservation.* Chapman and Hall, London.

Richter, G. 1994. Gestaltung und Pflegegrundsätze für Dorffriedhöfe und Kirchhöfe. – Laufener Seminarbeiträge 1/94: 65-75,zit. nach Rabitsch 2009.

Rugg, J. 2000. Defining the place of burial: what makes a cemetery a cemetery? *Mortality.* 5 (3): 259-275.

Saha, H.K. and Haldar, P. 2009. Acridids as indicators of disturbance in dry deciduous forest of West Bengal in India. Biodiversity and Conservation. *Biodiversity and Conservation.* 18 : 2343-2350.

Sala, O.E., Meyerson, L.A. and Camille, P. 2009. *Biodiversity Change and Human Health: from Ecosystem Services to Spread of Disease.* Island Press, USA pp: 3-5.

Samways, M.J. 1993. Insects in biodiversity conservation: some perspectives and directives. *Biodiversity and Conservation*. 2 : 258-282.

Schmidt, A. 1994. Friedhöfe und Naturschutz – Bedeutung der Friedhöfe für die Tier- und Pflanzenwelt. – Laufener Seminarbeiträge 1/94: 53-59, zit nach Rabitsch (2009).

Schröder, R. 2007. Friedhöfe als planerische Herausforderung für die Stadtplanung. Jahrbuch Stadterneuerung 2006/2007: 113.

Schuldt, A., Both, S., Bruelheide, H., Härdtle, W., Schmid, B., Zhou, H. and Assmann, T. 2011. Predator diversity and abundance provide little support for the enemies hypothesis in forests of high tree diversity. *PloS One*. 6 (7) e22905: 1-8.

Shurin, J.B. and Seabloom, E.W. 2005 The strength of trophic cascades across ecosystems: predictions from allometry and energetics. *Journal of Animal Ecology.* 74: 1029–1038.

Sudarshan, P.S. and Sunil, D.A. 2016. Changing biodiversity scenario in Lonar meteoritic crater. Maharastra, India, as revealed by the studies on insects (Order- Lepidoptera, Orthoptera and Odonata). *International Journal of Life Science*. 4: 133-136.

Tan, M.K. 2012. Orthoptera of the exhumed Bidari cemetery, Singapore. *Nat. Singapore*. 5 : 343-350.

Tan, M.K., Yeo, H., Hasnan, S., Woon, S.Z.S. and Wu, B. 2013. A rapid comparsion of the orthoptera communities of Bukit Brown cemetery and lornie trail of the central catchment nature reserve, Singapore. *Nat. Singapore*. 6 : 97-103.

Tiple, A.D. and Khurad, A.M. 2009. Butterfly species diversity, Habitats and seasonal distribution in and around Nagpur City, Central India. *World. J. Zool* pp: 153-162.

Tiple, A.D. 2012. Butterfly species diversity, relative abundance and status in Tropical Forest Research Institute, Jabalpur, Madhya Pradesh, central India. *Journal of Threatened Taxa.* 4 (7) : 2713-2717.

You, M., Xu, D., Cai, H. and Vasseur, L. 2005. Practical importance for conservation of insect diversity in China. *Biodiversity and Conservation.* 14 : 723-737.

Varshney, R.K. 1998. Faunal Diversity in India Insecta. *Zoological Survey of India* pp: 146-157.

Watt, W.B. and Boggs, C.L. 2003. Synthesis: butterflies as model systems in ecology and evolution present and future. In: Boggs CL, Watt WB, Ehrlich PR, editors. *Butterflies: Ecology and Evolution Taking Flight.* Chicago: The University of Chicago Press. pp. 603-613.