Iranian Journal of Animal Biosystematics (IJAB)
Vol.19, No.1, 23-32, 2023
DOI: 10.22067/ijab.2022.78445.1037

IJAB
ISSN: 1735-434X (print); 2423-4222 (online)

RESEARCH ARTICLE Open access

A comparative insight on Bombyliid's biodiversity indexes in grasslands in north of Iran

Shirin Aghavirdinezhad[1], Alireza Jalali zand[1]* and Hadi Ostovan[2]
[1] *Department of Plant Protection, Faculty of Agriculture, Isfahan (Khorasgan) branch, Islamic Azad University, Isfahan, Iran*
[2] *Department of Plant Protection, Faculty of Agriculture, Shiraz branch, Islamic Azad University, Shiraz, Iran*

(Received: *1 September 2022*; Accepted: *25 December 2022*)

Abstract
The Bombyliidae family with around 5382 described species is one of the most important families in order Diptera considering their remarkable roles in biological pest control. Species of the family Bombyliidae were monitored in Guilan province in 2019 and 2020. We aimed to evaluate their biodiversity in the grasslands along with the determining Simpson and Margalef indexes. Totally 20 species from 11 genera in 2019 and 17 species from 10 genera in 2020 were identified in eight selected stations. The highest numbers of Bombyliids individuals were observed in Heiran pass station in 2019. Surprisingly the lowest number of individuals also was present in Heiran pass station in 2020. The results of ecological indices also showed the highest Margalef index in Darestan station (2.18) in 2019 and the lowest observed in Bivazen station (0) and Rudbar- Loockhee (0) in 2019 and 2020 respectively. Also, the highest values for the Simpson index were recorded in Bivazen (1) in 2019 and Rudbar- Loockhee (1) in 2020. The lowest values of the Simpson index have been recorded for Amlash (0.13) stations as well. It seems that climate and ecological condition changes in different years clearly affect the insect biodiversity indexes via making changes in their population dynamics.

Key words: *Diversity, Bombyliidae, Simpson index, Margalef index, Guilan province.*

INTRODUCTION

Bombyliidae Latreille, 1802 (Asiloidea) with 5382 described species worldwide and more than 101 species in Iran is the eighth most diverse family within Diptera (Pape et al., 2011). They have a thick, hairy body and, as the name implies, are frequently confused with hymenoptera due to their bee-like appearance. Larvae stage with large, tong-like mandibles which are probably designed to help the parasitic life cycle (Merritt et al., 2009). All of the Bombyliid species feed on Coleoptera, Hymenoptera, Lepidoptera, Orthoptera, Neuroptera and Diptera's immature stages as parasitoid or predator (Yeates and Greathead, 1997; Boesi et al., 2009). The immature stages of Bombyliids facilitate the control of other insect populations, while the adult stages function as effective pollinators (Motten et al., 1981; Kearns, 2001).

Corresponding Author: arjalalizand@gmail.com

FIGURE 1. The sampling localities in Guilan province.

Biodiversity mainly studies diversity, population structure and many patterns. It is also used as an indicator to compare the ecological status of ecosystems. The goal is to achieve a single quantity to easily compare and evaluate communities and ecosystems (Jenkins and Parker, 1998). It is also important to note that biodiversity contributes to ecosystem stability and conservation, as more species in an area create a more complex structure, which suggests a greater likelihood of sustainability. As a result, more biodiversity implies greater sustainability of ecosystems. (Thompson et al., 2007).

Currently, there is little knowledge of the Bombyliidae family in northern Iran since only a few studies have been conducted in this area. The Bombyliids species richness and diversity in northern parts of Iran are probably high due to the temperate and humid climate conditions and the rich plants flora in the margin of the Caspian Sea (Gharali et al., 2010; Aghavirdinejad and Jalali Zand, 2021). The margalef Index expresses the presence of various species (Park et al., 2019), since the Simpson species diversity index, emphasizes the dominant species in the sample (Heidari Latibari et al., 2016).

Since Bombyliid species play such an important role in both pollination and pest management and considering the agronomic potential of the northern provinces of Iran, both investigation of Bombyliid fauna and their species diversity indexes may offer valuable insight, as a basis for further investigations related to Bombyliidae in similar ecological contexts (Aghavirdinejad and Jalali Zand, 2021). The present paper will examine the first comparative study between the species richness and diversity of Bombyliidae in two consecutive years in the grasslands of Guilan province, Iran.

MATERIAL AND METHODS

SAMPLING

Our sampling was conducted in the selected locations (Fig. 1), in the rangelands of Guilan province (Table 1). In order to collect larger species, sweeping nets were used.

TABLE 1. Sampling localities.

STATION	LOCATION
BIVAZAN	36°40’57.19”N, 49°34’39.57”E
HEIRAN PASS	36°42’12.85”N, 49°47’17.57”E
RUDBAR- LOOCKHEE	37°5’29.88”N, 50°11’12.98”E
ROSTAM ABAD- JOKIN	36°40’57.19”N, 49°34’39.57”E
DAMASH	38°26’32.45”N, 48°34’53.26”E
JIRANDEH	36°48’34.96”N, 49°24’57.98”E
RUDBAR-DARESTAN	3 6°48’34.96”N, 49°24’57.98”E
AMLASH	37°5’29.88”N, 50°11’12.98”E

SPECIES IDENTIFICATION

Species identification has been done using available keys (Greathead and Evenhuis, 2001; Yao et al., 2011). The identifications have been confirmed by Dr Rahim Abdollahi Mesbah (University of Tehran, IRAN).

STATISTICAL ANALYSIS

The collected Bombyliids were categorized based on their location and species. Their recorded data were analyzed based on Simpson and Margalef Indexes for comparing species diversity and richness between selected localities in Guilan province, Iran. SDR software (Hasanvand et al., 2015), was employed to calculate the amounts of mentioned indexes.

RESULTS

Twenty species of Bombyliids (Diptera, Bombyliidae) from eleven genera as well as seventeen species belong ten genera were collected from selected stations (Table 2).

Our findings in 2019 indicated the highest and lowest number of individuals were observed in Heiran pass and Rudbar- Loochkee station respectively (Figure 4). However, species richness differed among stations. Rudbar- Darestan was the richest station according to the Margalef richness indicator (2.18) while the lowest amount of Margalef richness was seen in the Bivazan (0) (Figure 2). Simpson index which is known as an indicator for species dominancy demonstrated the highest amount for the Bivazan station which included just one species (1) and the lowest amount was recorded for Rudbar-Darestan station (0.19) (Figure 3). According to the results of the investigation in 2020, Bivazan and Heiran pass stations were the most and least populated (Figure 7). According to the Margalef richness indicator, Rudbar- Darestan was the richest station (2.16), while Rudbar- Loockhee had the lowest amount (0) (Figure 5). Rudbar-Lockhee and Amlash stations recorded the highest (1) and the lowest (0.13) amount of Simpson index in 2020 respectively (Figure 6). It is surprising to note that, while Heiran station recorded the highest number of individuals in 2019, the lowest number of individuals in 2020 was recorded for this station, however, the number of species reported in 2019 was higher than in 2020.

TABLE 2. Information of collected species. A) 2019; B) 2020.

A)

Species	Bivazan	Heiran pass	RudbarLoockhee	Rostam abad- Jokin	Damash	Jirandeh	Rudbar- Darestan	Amlash	Sum
Exoprosopa amseli				3		3	7		13
E. kirgizorum				15		6			21
E. efflatounbeyi							4		4
E. pectoralis			3						3
E. grandis							1		1
E. dispar				2		2			4
Thyridanthrax punctum							1		1
T. elegans					4			8	12
T. griseolus							6		6
Lomatia belzebul					5				5
Usia bicolor		40					5	25	70
Parageron lutescens			1						1
Conophorus pseudaduncus		1							1
Heteralonia megerlie		1							1
H. suffuse			3						3
Callostoma soror								5	5
Veribubo misellus							3		3
Hemipenthes subvelutinus				6		10	2		18
Phthiria vagans	100	100	20	10	30	20	10	20	210
P. pulicaria					1				1
Sum	100	142	27	36	40	41	39	58	383

B)

Species	Bivazan	Heiran pass	RudbarLoockhee	Rostam abad- Jokin	Damash	Jirandeh	Rudbar- Darestan	Amlash	Sum
Exoprosopa amseli				14		3	2	22	41
E. kirgizorum				2		6			8
E. efflatounbeyi		1					8		9
E. grandis				9			24		33
E. dispar				2					2
Thyridanthrax punctum						2	7		7
T. griseolus					9		3		3
Lomatia belzebul				21					30
Usia bicolor		3					11		14
Conophorus pseudaduncus		1		13			9	2	25
Heteralonia megerlie		1							1
H. suffuse					48		1		49
Callostoma soror		4						44	48
Veribubo misellus							4		4
Hemipenthes subvelutinus						10	12		22
Phthiria vagans	86		44		30	20	20	13	213
P. pulicaria	18								18
Sum	104	10	44	59	87	41	101	58	527

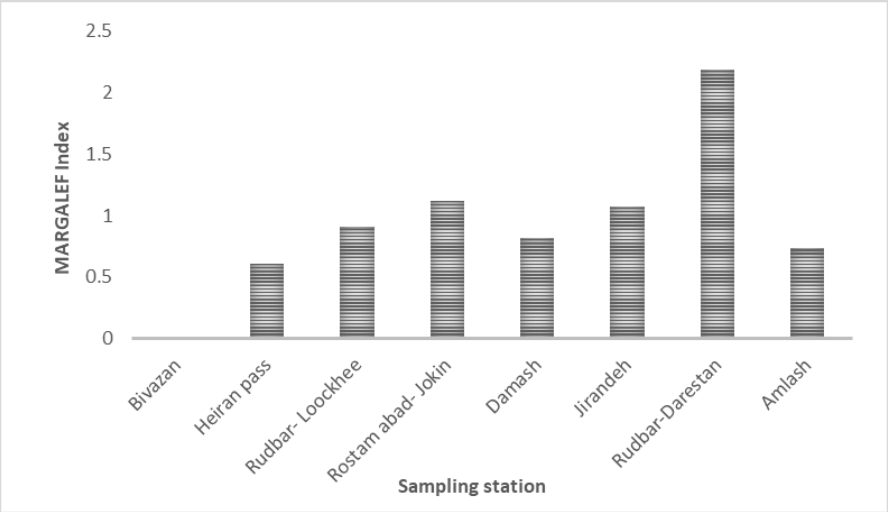

FIGURE 2. Margalef index in sampling stations 2019.

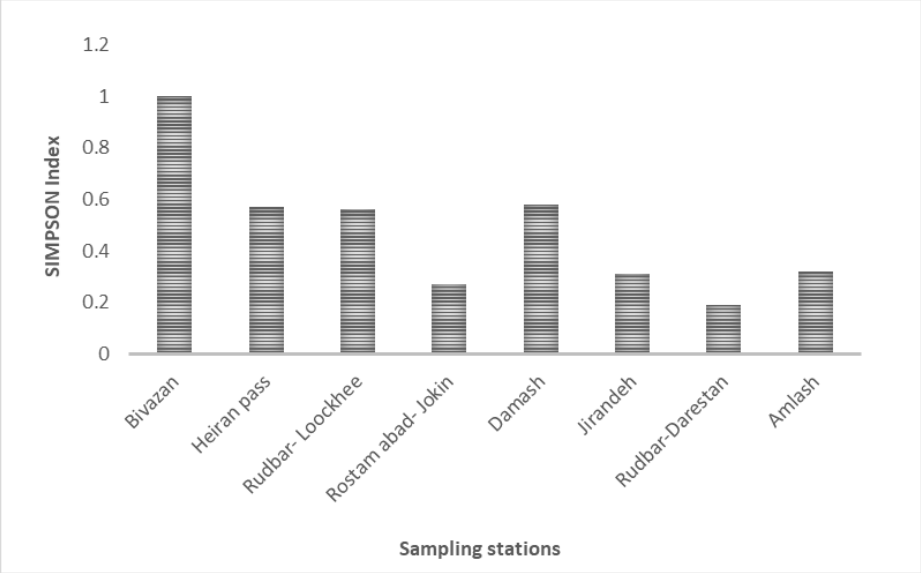

FIGURE 3. Simpson index in sampling stations 2019.

DISCUSSION

Dipterans are among the most common insects that visit flowers, and they also play an important role in pollinating them (Kevan and Baker, 1983). Adult dipterans feed on nectar to meet their energy requirements during flight, mate search, oviposition, finding mates, and mating (Larson et al., 2001). The Bombyliidae family is one of the flower-visiting dipteran families recorded in the present study. All Bombyliids species play a role as natural enemies in their larval stage (parasites of grasshopper eggs, solitary bees and wasps) (Aghavirdinejadand Jalili Zand, 2021).

The calculated biodiversity indexes in the present study, indicate the good diversity and richness of the Bombyliidae family in the grasslands of Guilan province. We concluded that the most numbers and richness of Bombyliids species were present in the mid of sampling seasons (summer and spring

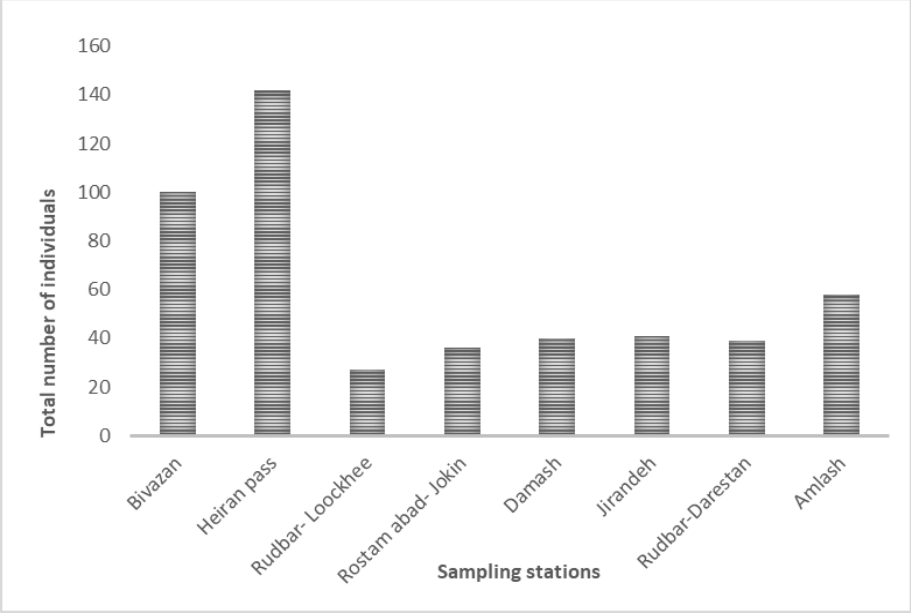

FIGURE 4. Number of individuals in sampling stations 2019.

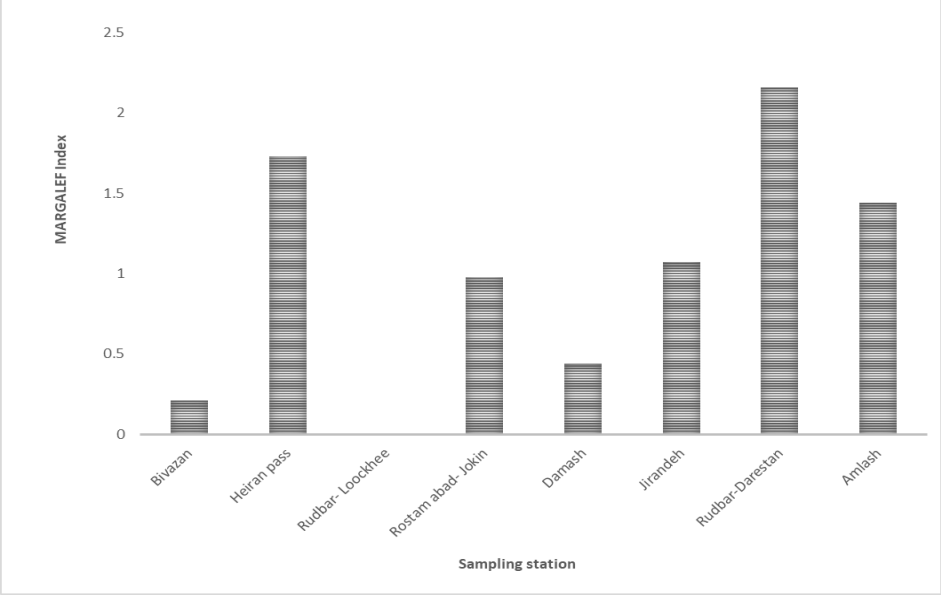

FIGURE 5. Margalef index in sampling stations 2020

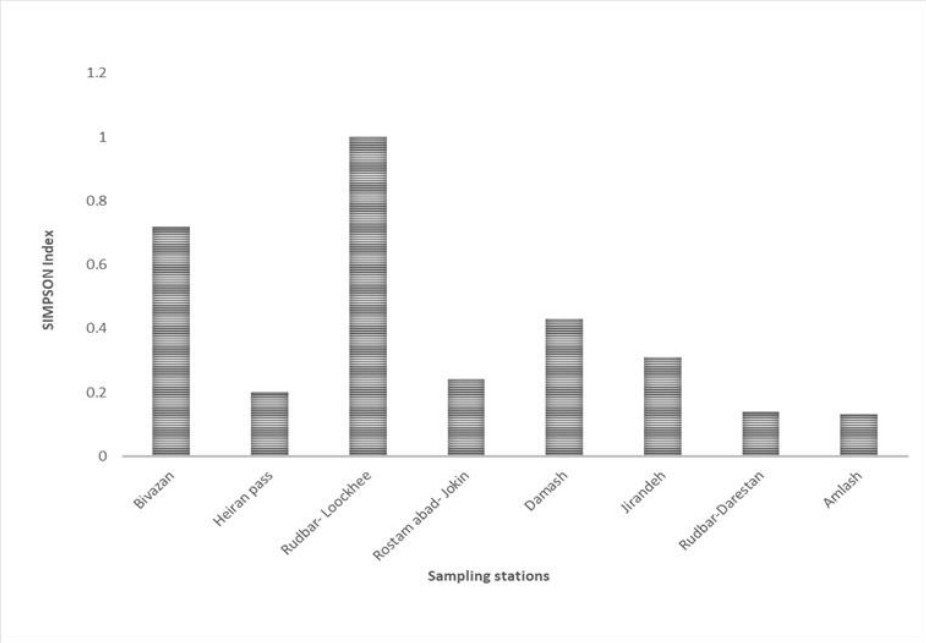

FIGURE 6. Simpson index in sampling stations 2020

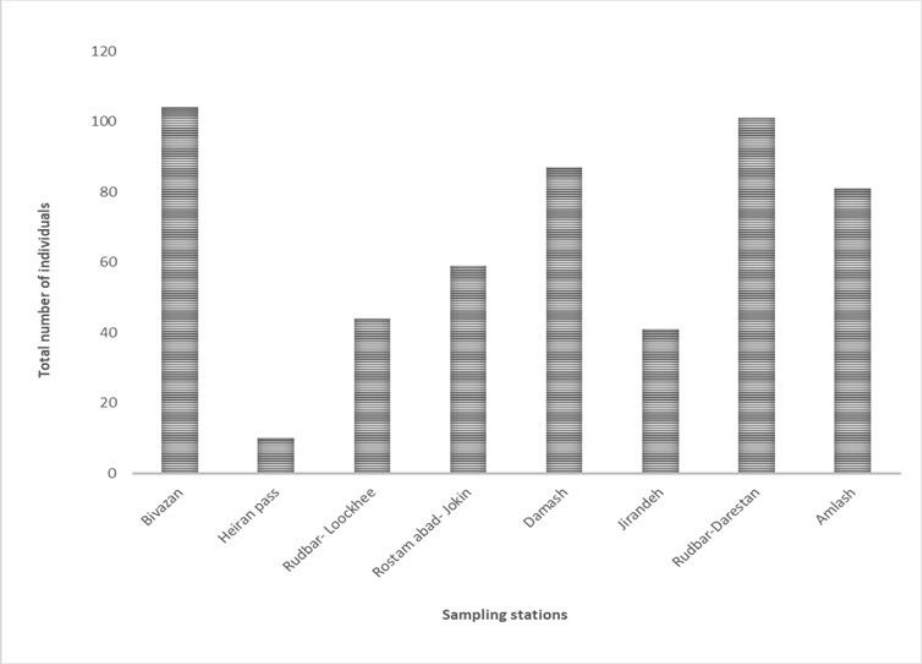

FIGURE 7. Number of individuals in sampling stations 2020.

respectively). The Bombyliidae showed an increase with increase in floristic biodiversity, which is probably due to the fact that they show specialization links with plants that are suitable for being visited by these pollinators (Benvenuti, 2022).

It should be noted that a peak in activity of most pest species, which are hosts of this family, is simultaneous with this event since it is a strong relationship between the population density of predators and their hosts (Stevens, 2010). However, the same sampling stations in different years showed different values of biodiversity indices for this family. We believe that climate changes and ecological conditions have caused these differences (Bellard et al., 2012). Guilan province on the southwest shore of the Caspian Sea is one of the most important agricultural cores of Iran. On the other hand, the environmental risks of using pesticides that are not hidden from anyone have doubled the importance of using biological control agents (Heidari Latibari et al., 2018). Therefore, the results of the present study have provided valuable information for the application of integrated pest control methods. Due to the rich flora and fauna of Guilan province, studies such as this study are strongly recommended for other families of insects that play a role as natural enemies.

ACKNOWLEDGMENTS

This research has been supported by the Islamic Azad University Isfahan (Khorasgan) Branch in the framework of the Ph.D. thesis, which is gratefully acknowledged. We wish to thank the anonymous reviewers for their constructive comments on the primary version of the manuscript. This work was financially supported by Islamic Azad University, Isfahan (Khorasgan) branch. The authors declare that there is no conflict of interest regarding the publication of this paper.

LITERATURE CITED

Aghavirdinejad, S., & Jalali-Zand, A. (2021). Study on humbleflies species biodiversity (Diptera: Bombyliidae) in the western margin of the Caspian Sea coastline. *Journal of the Entomological Research Society*, *23*(1), 61-67.

Benvenuti, S. (2022). Wildflowers-pollinator-crab spider predator food-web as indicator of the agroecosystem biodiversity. *Ecological Indicators*, *143*, 1-9.

Boesi, R., Polidori, C., & Andrietti, F. (2009). Searching for the right target: oviposition and feeding behavior in Bombylius bee flies (Diptera: Bombyliidae). *Zool Stud*, 48: 141-150.

Greathead, D. J., & Evenhuis, N. L. (2001). Annotated keys to the genera of African Bombylioidea (Diptera: Bombyliidae; Mythicomyiidae). *African Invertebrates*, *42*(1), 105-224.

Hasanvand, I., Jafari, S., Kazemi, S., & Shakarami, J. (2015). Fauna and species diversity of edaphic mesostigmatic mites of superfamilies Eviphidoidea and Ascoidea (Acari: Mesostigmata) in Khorramabad County, Lorestan Province (Text in Persian). *Plant Pests Research*, *4*(4), 25-34.

Heidari Latibari, M., Moravvej, G., Namaghi, H. S., & Khormizi, M. Z. (2016). Coccinellid biodiversity on the coniferous trees Thuja orientalis and Pinus mugo in urban landscape of Mashhad, Razavi Khorasan Province, Iran. *Egyptian Journal of Biological Pest Control*, *26*(2), 419.

Heidari Latibari, M., Zare Khormizi, M., Sahamian, E., Dehghan Dehnavi, L., & Moravvej, G. H. (2018). Faunistic survey of Aphidoidea (Hemiptera) and associated predatory ladybirds in orchards, Yazd Province, Iran. *EPPO Bulletin*, *48*(1), 160-163.

Jenkins, M. A., & Parker, G. R. (1998). Composition and diversity of woody vegetation in silvicultural openings of southern Indiana forests. *Forest ecology and management*, *109*(1-3), 57-74.

Kevan, P. G., & Baker, H. G. (1983). Insects as flower visitors and pollinators. *Annual review of entomology*, *28*(1), 407-453.

Kearns, C. A. (2001). North American dipteran pollinators: assessing their value and conservation status. *Conservation Ecology*, 5(1).

Larson, B. M. H., Kevan, P. G., & Inouye, D. W. (2001). Flies and flowers: taxonomic diversity of anthophiles and pollinators. *The Canadian Entomologist*, *133*(4), 439-465.

Merritt, R. W., Courtney, G. W., & Keiper, J. B. (2009). Diptera:(Flies, Mosquitoes, Midges, Gnats). In *Encyclopedia of insects* (pp. 284-297). Academic Press.

Motten, A. F., Campbell, D. R., Alexander, D. E., & Miller, H. L. (1981). Pollination effectiveness of specialist and generalist visitors to a North Carolina population of Claytonia virginica. *Ecology*, *62*(5), 1278-1287.

Pape, T., Blagoderov, V., & Mostovski, M. B. (2011). Order Diptera Linnaeus, 1758. In: Zhang, Z.-Q. (Ed.) Animal biodiversity: An outline of higher-level classification and survey of taxonomic richness. *Zootaxa*, *3148*(1), 222-229.

Park, J. H., Woo, S. Y., Kwak, M. J., Lee, J. K., Leti, S., & Soni, T. (2019). Assessment of the diverse roles of home gardens and their sustainable management for livelihood improvement in West Java, Indonesia. *Forests*, *10*(11), 970.

Thompson, I. D., Okabe, K., Tylianakis, J. M., Kumar, P., Brockerhoff, E. G., Schellhorn, N. A., Parrotta, J. A. & Nasi, R. (2011). Forest biodiversity and the delivery of ecosystem goods and services: translating science into policy. *BioScience*, *61*(12), 972-981.

Yao, G., Yang, D., & Evenhuis, N. L. (2011). Two new species of Tovlinius Zaitzev, from China, with a key to the genera of Bombyliinae from China and a second key to the world species (Diptera, Bombyliidae, Bombyliinae, Bombyliini). *ZooKeys*, (153), 73.

Yeates, D. K., & Greathead, D. (1997). The evolutionary pattern of host use in the Bombyliidae (Diptera): a diverse family of parasitoid flies. *Biological Journal of the Linnean Society*, *60*(2), 149-185