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Parasitoid wasps diversity (Hymenoptera: Ichneumonidae) in diverse habitats of northeastern Iran

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Abstract. The Ichneumonidae, one of the largest insect families, includes beneficial insects parasitizing several pests. Due to the geographic and climatic varability of Iran, a great Ichneumonidae diversity may be expected, but our knowledge about fauna and biodiversity of this family in Iran is still insufficient, with only a few sporadic biodiversity studies on Iranian ichneumonids. This paper examines the alpha diversity, species evenness, species richness and beta diversity of the Ichneumonid parasitoid wasp assemblages in Golestan Province, northeastern Iran with an emphasis on the two largest Ichneumonid subfamilies: Cryptinae and Ichneumoninae. The spatial diversity of Ichneumonidae in two consecutive years was studied in three habitats: forest, rangeland and orchards. A total of 336 specimens representing 62 genera and 97 species were collected and identified. The forest sites (Shast kalate and Tuskestan) and rangeland sites (Chahar bagh and Souz javal) were found to be more diverse than orchard sites (Kordkuy and Garmabdasht), but the lowest species evenness was observed in the latter. The highest species richness was found in rangeland, the highest similarity between the two forest sites, and the lowest similarity between Kordkuy (orchard) and Chaharbagh (rangeland). Of all individuals collected, 32.7% and 67.3% were female and male, respectively. The species richness and abundance of parasitoid wasp species yielded from the relatively small sample area indicate that there are many species in Iran that still remain to be discovered. In total, the use of parasitoid Hymenoptera, as potential bioindicators, provide a useful and practicable monitoring tool for tracking and evaluating changes in various ecosystems and reflecting environmental conditions.

Key words: biodiversity, Ichneumonid wasps, parasitoid Hymenoptera, Parasitoid abundance, species richness, trophic guilds.

Introduction

Evaluating species diversity is a vital element of any ecological and conservation studies and is the basis for most of the environmental monitoring. Decreasing species richness and diversity can bring about decreasing overall levels of ecosystem functioning. This is especially relevant to ongoing ecological changes in which natural ecosystems comprising of tens to hundreds of species are being replaced by managed systems comprising of only a few dominant species (Naeem et al. 1999). The abundance and omnipresence of insects reflect their crucial contribution to global biodiversity and ecosystem services. Insects as dominant biodiversity components play a crucial role in mediating the relationship between plants and ecosystem processes (Weisser & Sieman 2008). Regarding the important role of insects in the environment, it seems quite reasonable that some taxa have the potential to provide accurate insights into environmental conditions or biodiversity (McGeoch 2007, Anderson et al. 2011, Morrison et al. 2012, Stevens et al. 2013).

Hymenopteran parasitoids play a fundamental role in the ecosystem by controlling the populations of other insects (Quicke 2015). This role is even more crucial in agroecosystems since many of their hosts are pests of crops, so they may be used for biological control (Ode & Heimpel 2016). Furthermore, they may provide useful information about the conservation state of ecosystems, since their abundance and richness could mirror the diversity of other arthropods (Anderson et al. 2011, Stephens 2005), and they are sensitive to habitat fragmentation and environmental changes (Komonen et al. 2000, Maeto et al. 2009, Anderson et al. 2011).

Generally, habitat type affects the number of available niches mainly for herbivores and thus for their parasitoids (Hawkins 1988, Idris & Hasmawati 2002, Sääksjärvi et al. 2004), so that parasitoid species distribution patterns can be derived from environmental heterogeneity (Sääksjärvi et al. 2004).

Among all Hymenopteran parasitoids, Ichneumonidae is the most common and speciose family. Its members play a salient role in the functioning of natural and agricultural ecosystems by either regulating or maintaining their host populations at low levels and their role as bioindicators of land-use and human impact is well known (Mazón & Bordera 2014).

Here we use this taxa to study environmental changes in a part of Iran, Golestan province, which is located southeast of the Caspian Sea, northeastern Iran, consisting of forests (around 18% of the province), rangelands (51%) and agricultural or residential areas (31%). Although being one of the most diverse regions in Iran in terms of habitat types and species diversity, the threats of human destructive activities such as illegal changes of land use, deforestation, fragmentation, over-exploitation, monocultural agriculture and extensive usage of herbicides, pesticides and inorganic nutrients are severe in the area, leading to biodiversity loss (Varamesh et al. 2017). Measuring this impact requires a comprehensive study based on a certain taxa whose response can representatively indicate any environmental changes.

Iranian Ichneumonidae fauna has been largely studied by Kolarov and Ghahari (2005, 2006, 2007, 2008), Barahoei et al. (2013), Ghahari & Jussila (2015) and Mohebban et al. (2016, 2019), however, little is known about their ecology, species assemblages, diversity and the effect of land use on their populations.

As biodiversity conservation in small areas can contribute to global biodiversity conservation via preservation of localized ecosystems (Baldwin & Fouch 2018), studying of biodiversity in such areas should not be taken for granted. Regarding the aforementioned, we studied the biodiversity of ichneumonids in one of the most diverse regions of the country, northeastern Iran. We hypothetized that: 1) parasitoid abundance and diversity are affected by habitat type 2) the presence and diversity of the parasitoids are negatively affected in conventional agroecosystem compared to natural ones, and 3) habitat types have an impact on ichneumonid assemblages and diversity of trophic guilds. In order to test these hypothesis, the ichneumonid communities, different aspects of ichneumonid diversity and their structure within communities were measured by comparing the diversity indices, species richness and species composition across three different ecosystems representing areas without human activities (forests and rangelands), and areas with human activities (orchards).

Materials and Methods

Study sites, sampling and identification

Specimens of the subfamilies Cryptinae and Ichneumoninae were collected using Malaise traps during 2015-2016 from April to October in Golestan province, northeastern Iran. Considering the data of evaporation and rainfall stations of Regional Water Company of Golestan, including Gorgan, Kordkuy, Shahkooh, Shast kalateh, Tuskestan and Ziarat in two consecutive years (2015 and 2016), the average temperature and the mean annual rainfall in the studied areas were 17.5°C and 685.06 mm, respectively. The orchards and forests had mild climatic conditions and the rangelands had cold and mountainous climatic conditions (most of the precipitation as snow).

Sampling took place in three selected habitats within the studied area, with two sites per habitat:

A- Forest:

1) Shast kalateh: An area with some natural trees such as *Carpinus betulus* and *Parrotia persica*, many planted trees like *Acer insign*, *Alnus subcordata* and *Juglans regia* with dense herbages.

2) Tuskestan: A completely natural forest dominated by *Carpinus betulus*, *Parrotia persica* and *Quercus castanifolia*, some herbages like *Euphorbia rigida*, *Hypericum androsaemum*, *Primula vulgaris* and *Ruscus hyrcanus* with sparse shrubs like *Crataegua* sp. and *Rubus* sp.

B-Orchard:

3) Garmabdasht: an orchard consisting of apple, black cherry, cherry, fig, grape, pear and walnut trees and dense herbages.

4) Kord kuy: an orchard composed of *Citrus*, kiwi, peach and pomegranate trees and very sparse herbages.

C-Rangeland:

5) Chahar bagh: A protected area with chamaephyte types like *Achillea tenvifolia, Astragalus* spp., *Bromus tomentellus*, *Corinila varia*, *Dactylis glomerata*, *Stipa barbata*, *Stachys bizantica* and *Ortica dioiciea*; phanerophyte type: *Juniperus commnis*; therophyte types such as *Chenopodium album*, *Euphorbia* sp. and *Poa annua*.

6) Souz javal: A conservation area with dwarf-shrubs such as *Achillea tenvifolia, Astragalus* spp., *Bromus tomentellus*, *Corinila varia*, *Dactylis glomerata*, *Stipa barbata*, *Stachys bizantica* and *Ortica dioiciea*; phanerophyte plant species: *Juniperus commnis*; therophyte types like *Chenopodium album*, *Euphorbia* sp. and *Poa annua*.

Totally, six commercial Malaise traps (Townes 1970) in black and white were run for two consecutive years, one trap in each site (see Table 1). The traps were set in a NW – SE direction with the collecting head towards the southeastern end, with 70% ethanol as a preservative. Co-workers serviced each trap throughout the period of flight activity (April to November) twice in a month on average.

Table 1. Location of Malaise traps placed at the six sites in the three habitats at Golestan Province.

Habitat	Site	Coordinates	Altitude (m.a.s.l.)
Forest	1- Shast kalate	36°47'22.06''N, 54°22'00.01''E	242
	2- Tuskestan	36°46'35.41''N, 54°34'59.11''E	547
Orchard	3 Garmabdasht	36°44'41.81''N, 54°34'1.27''E	550
	4- Kord kuy	36°47'06.78''N, 54°08'26.35''E	50
Rangelands	5- Char bagh	36°32'34''N, 54°30'51''E	2100
	6- Souz javal velley	36°30'56''N, 54°34'32''E	2500

All collected Ichneumonids were separated and identified to subfamily level. The study, however, focused on two subfamilies, Cryptinae and Ichneumoninae; so, the specimens belonging to these subfamilies were determined to species level by using available keys (Perkins 1959, Townes 1970, Rasnitsyn 1981, Selfa & Diller 1994). The external morphology of specimens was studied at the Zoologische Staatssammlung in Munich (Germany) and the Biologiezentrum in Linz (Austria). The voucher specimens are deposited in the Ferdowsi University of Mashhad.

Species were classified into trophic guilds following Mazón & Bordera (2014) based on the trophic habits of their hosts: 1) parasitoids of xylophagous larvae; 2) parasitoids of concealed phytophagous larvae; 3) parasitoids of grazing phytophagous larvae; 4) parasitoids of mycophagous (fungus-feeding) larvae; 5) parasitoids of cocoons and pupae; 6) parasitoids of melitophagous larvae; 7) parasitoids of saprophagous larvae; 8) parasitoids of zoophagous larvae; 9) polyphagous parasitoids and 10) parasitoids with unknown hosts (Table 2). Bibliographic information of Yu et al. (2012) was utilized for identifying the Ichneumonid hosts.

Data Analysis

Sampling effectiveness was evaluated by comparing the observed richness in every habitat to that predicted by non-parametric estimators: ICE and Chao 2. They estimate the potential number of species occurring in one area by the relative abundance of rare species, i.e., those species having one or two individuals during the whole sampling (Longino et al. 2002). Richness estimators were calculated with the software EstimateS Win 8.2.0 (Colwell 2006).

To study the biodiversity components, the analyses were performed by Species Diversity and Richness (SDR) software version 4.1.2. (Seaby & Handerson 2007). In order to know if the two sites in every habitat could be considered as replicates, we performed a principal components analysis, where the relative abundances of all species were combined into a single variable per site (Mazón & Bordera 2008). We plotted the two components that provided more than 70% of variance (components 1 and 2, Fig 1). Since the differences between the two orchard sites were greater than those amongst different habitats, they can not be considered as replicates. In consequence, even when the rangeland and the forest sites had very similar Ichneumonidae composition, all six sites were analysed separately. Alpha diversity (α) (the diversity inherent to a habitat) was calculated for each site by I) the Shannon-Wiener (H′) index, II) the Simpson (D) index, III) the species evenness indices [Pielou J and Simpsons's E], and IV) species richness indices using across-sample rarefaction. The rarefaction analysis estimates the number of species if abundances were the same in all sites, so the method was performed since the number of individuals differed across the samples. Rarefaction analyses were done separately for the cumulated abundance of the six habitats and for their monthly abundance. To compare diver-

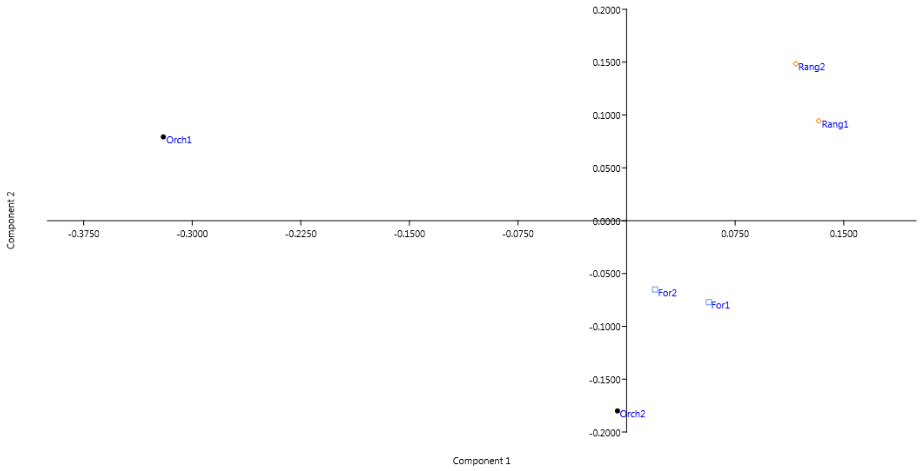

Figure 1. Principal components analysis for the Ichneumonidae samples at the six sites in Golestan province. Dots represent the orchard samples (1: Kordkuy, 2: Garmabdasht), squares the forest samples (1: Tuskestan, 2: Shast kalateh) and the diamonds the rangeland samples (1: Chahar bagh, 2: Souz javal velley).

sity variables amongst different sites, a randomization test with 1000 random partitions was assessed (Solow 1993) with SDR software. Beta diversity (β) (differences in species assemblages between sites) was evaluated by Whittaker dissimilarity index. Also, a one-way Permutational multivariate analysis of variance (PERMANOVA) was performed in order to know if the Ichneumonidae assemblages in every site were significantly different. Data were square-root transformed, and Bray-Curtis distances were used. When Ichneumonidae assemblages were significantly different, a SIMPER analysis was done, showing which species were contributing the most to those differences. PERMANOVA and SIMPER were run with the software PAST version 3.23.

Trophic guilds' proportions in all sites were presented as the relative abundance of all individuals belonging to each trophic guild, as well as their cumulative number as a measure of the functional alpha diversity, calculated by Shannon-Wiener and Simpson's D indexes, which were compared with the SDR software. Those species whose host trophic habit was unknown were not considered for the functional diversity analysis.

Results

Faunistic composition and annual phenology

The faunistic inventory yielded a total of 1090 specimens of Ichneumonids corresponding to 15 subfamilies. Out of all collected specimens, 30.8% (336 specimens) belonged to the subfamilies Ichneumoninae (29 species) and Cryptinae (68 species) (Table 2). Among the collected specimens, 8 genera and 17 species were new records for the fauna of Iran (Table 2). Forty eight species were collected at forest (n= 136 individuals), 42 species at rangeland (n= 79) and 38 species at orchard (n= 121) sites. The most abundant taxa among all identified wasps were *Aritranis director* (n= 32), *Trychosis legator* (n= 23) and *Stibeutes tricinctor* (n= 23), all belonging to the subfamily Cryptinae. The most abundant wasp among all identified species of the subfamily Ichneumoninae was *Melanichneumon leucocheilus* (n= 22). Rangeland, with 12 generic taxa, was the richest habitat. From all collected specimens, 32.7% were females and 67.3% were males (sex ratio 1:3). About 70% of the species belonged to the subfamily Cryptinae.

According to the non-parametric richness estimators (Table 3), all three ecosystems were subsampled, having reached from 45 to 60% of the predicted richness.

Analysis of alpha diversity

According to all diversity indices, the pairs of habitats had similar diversity, although different results have been found when comparing all habitats each other (Fig 2). Of all samples, Souz javal had the highest diversity, but according to both D and E Simpson's indices it was not significantly ($p < 0.05$) different from forests diversity. Both orchards' diversity was significantly the lowest regarding Shannon-Wiener and Pielou's J indices, but in both Simpson's there were no differences when comparing to forests.

The rarefaction analysis showed the rangeland (Chahar bagh and Souz javal) as the richest habitat, followed by forest (Shast kalate and Tuskestan) and orchard (Garmabdasht and Kurd kuy) (Table 4). Regarding to the temporary patterns, in all studied habitats, the highest (15.22) and lowest (9.805) total species richness were found in September and April, respectively. In June, the highest total abundance was recorded (45), however July and October had the lowest (12).

Analysis of beta diversity

Analysis of beta diversity depicted that similarity did not reach 50% between pairs of sites. Dissimilarity was the highest between Kord kuy (orchard) and Chahar bagh (rangeland) which had no common species (Table 5). The two forests had the lowest disimilarity to each other, sharing about 48% of their species, whilst the orchards only had about 24% of common species (Table 2).

PERMANOVA test showed that Ichneumonidae assemblages were significantly different ($F = 1.598$, $p = 0.0007$), especifically Shast kalateh (forest) and Garmabdasht (orchard) when compared to the two rangeland sites, and between the two forests' assemblages (Table 6). After the SIMPER analysis (Tables A1-A6), no species was found to be highly contributing to these differences, except for *Agrothereutes abbreviatus* (Table A2), who contributed with more than 10% to differences between Tuskestan (forest) and Souz javal (rangeland). *Thaumatogelis* sp., *Hoplocryptus murarius* and *Trychosis legator* were usually the species that contributed the most to these differences, with about 6-9% (Tables A1, A3 and A4).

Functional diversity

Not all the trophic guilds were present in all sites (Fig 3). The

Table 2. Abundance of male (M) and female (F) Cryptinae and Ichneumoninae collected at the ecosystems studied, including the trophic guilds assigned. Forest: 1: Shast kalate, 2: Tuskestan; Orchard: 3: Garmabdasht, 4: Kord kuy, Rangeland: 5: Chaharbagh, 6: Souz javal. First records of genera and species for the Iran fauna are depicted by one and two asterisks, respectively. Xyl: parasitoids of xylophagous larvae; cPh: parasitoids of concealed phytophagous larvae; gPh: parasitoids of grazing phytophagous larvae; Myc: parasitoids of mycophagous (fungus-feeding) larvae; Coc: parasitoids of cocoons and pupae; Mel: parasitoids of melitophagous larvae; Sap: parasitoids of saprophagous larvae; Zoo: parasitoids of zoophagous larvae; Poly: polyphagous parasitoids and 10) unkn: parasitoids with unknown hosts. M: males; F: females.

Species	Forest				Orchard				Rangeland				Trophic guilds
	1		2		3		4		5		6		
	F	M	F	M	F	M	F	M	F	M	F	M	
CRYPTINAE. Cryptini													
Acroricnus seductor (Scopoli)	0	0	0	0	0	0	0	0	1	0	0	0	Zoo
Agrothereutes abbreviates (Fabricius)	0	1	1	1	1	1	0	0	0	0	0	0	gPh
Aritranisdirector (Thunberg)	1	5	0	3	4	19	0	0	0	0	0	0	gPh
Aritranis longicauda (Kriechbaumer)	0	0	0	0	0	1	0	0	0	0	0	0	Unkn
*Aritranis nigripes** (Gravenhorst)	0	2	0	0	0	0	0	1	0	0	0	0	Unkn
*Ateleute linearis*** Förster	0	0	1	0	0	0	0	0	0	0	0	0	cPh
Buathralaborator (Thunberg)	0	0	1	1	0	0	0	0	0	0	0	0	gPh
Cryptus armator Fabricius	0	0	6	0	0	0	0	0	0	0	0	0	gPh
Cryptus inculator (Linnaeus)	0	0	0	0	0	0	0	0	1	0	0	0	Unkn
Cryptus macellus Tschek	0	0	0	0	0	0	0	0	0	0	1	0	Unkn
Cryptus spiralis (Geoffroy)	0	0	0	0	0	0	0	0	0	3	0	0	**cPh**
*Cryptus titubator** (Thunberg)	0	0	1	0	0	0	0	0	0	1	0	0	gPh
*Cryptus vitreifrontalis** Schwartz	0	0	0	0	0	0	0	0	0	2	1	1	Unkn
Hoplocryptus bellosus (Curtis)	0	0	1	0	0	0	0	0	0	0	0	0	Mel
Hoplocryptus coxator (Tschek)	0	0	0	0	0	0	0	1	0	0	0	0	Mel
Hoplocryptus confector (Gravenhorst)	1	0	0	0	0	0	0	0	0	0	0	0	Mel
Hoplocryptus heliophilus (Tschek)	0	0	0	0	0	0	0	0	2	1	1	0	Zoo
Hoplocryptus murarius (Borner)	1	3	1	2	0	1	1	0	0	0	0	0	gPh
Idiolispa analis (Gravenhorst)	0	1	1	1	1	11	2	2	0	0	0	0	gPh
Ischnus alternator (Gravenhorst)	0	4	0	0	0	1	0	0	0	0	0	0	gPh
*Ischnus migrator** (Fabricius)	0	0	0	0	0	0	0	0	0	1	0	0	Coc
*Meringopus attentorius** (Panzer)	0	0	1	0	0	0	0	0	0	0	0	0	gPh
Meringopus sp.	0	0	0	0	0	0	0	0	2	0	0	0	Unkn
Mesostenus transfuga Gravenhorst	0	0	0	0	0	1	0	0	0	2	0	0	cPh
*Mesostenus*sp.	0	0	0	0	0	0	0	0	0	1	0	0	Unkn
Myrmeleonostenus italicus (Gravenhorst)	0	0	1	0	0	0	0	0	2	1	0	2	Zoo
Pterocryptus sp.	1	0	0	0	0	0	0	0	0	0	0	0	Unkn
Sphecophaga vesparum (Curtis)	0	0	0	0	1	0	0	0	0	0	0	0	Zoo
Trychosis legator (Thunberg)	4	3	3	0	5	7	0	1	0	0	0	0	gPh
*Xylophrurus*sp.	0	0	0	0	0	0	0	0	0	2	0	0	Unkn
CRYPTINAE. Hemigasterini													
*Aptesis flagitator** (Rossi)	0	0	0	0	0	0	0	0	0	4	0	0	gPh
*Aptesis jejunator** (Gravenhorst)	0	0	2	0	0	0	0	0	1	1	2	0	Coc
Aptesis sp.	1	0	0	0	0	0	0	0	0	0	0	0	Unkn
Cubocephalus sp.**	1	0	0	0	0	0	0	0	0	0	0	0	Unkn
Polytribax perspicillator (Gravenhorst)	0	0	0	0	0	0	0	0	0	0	0	1	Coc
CRYPTINAE. Phygadeuontini													
Aclastus solutus (Thomson)	0	0	0	0	0	0	0	0	0	0	1	0	Zoo
*Arotrephes*sp.	0	0	0	1	1	1	0	0	0	0	0	0	Unkn
Bathythrix pellucidator (Gravenhorst)	0	0	1	0	1	2	0	0	0	0	0	0	Coc
Charitopes sp_1.	0	0	0	0	0	0	0		1	0	1	0	Unkn
Charitopes sp_2.	0	0	0	0	0	1	0	0	0	0	0	1	Unkn
Charitopes sp_3.	0	0	0	0	0	0	0	0	1	0	1	0	Unkn
Dichrogaster sp.	0	0	0	0	0	0	0	0	0	1	0	0	Unkn
*Endasys*sp.	3	0	0	1	1	1	0	0	0	0	0	0	Unkn
Gelis bicolor (Villers)	1	0	1	1	0	1	0	0	0	0	0	0	Poly
Gelis vicinus (Gravenhorst)	0	0	0	0	0	0	0	0	0	1	0	0	Unkn
Gelis sp_1.	0	0	0	0	0	1	0	0	0	0	0	0	Unkn

Continued on the next page

Table 2. (continued)

Species	Forest				Orchard				Rangeland				Trophic guilds
	1		2		3		4		5		6		
	F	M	F	M	F	M	F	M	F	M	F	M	
Gelis sp2.	0	1	0	2	0	2	0	0	0	1	0	0	Unkn
*Hemiteles rubropleuralis** Kiss	0	0	0	0	2	0	0	0	0	0	0	0	Unkn
*Lochetica westoni*** (Bridgman)	0	0	0	0	2	0	0	0	0	0	0	0	Unkn
Lysibia nanus (Gravenhorst)	0	0	0	0	0	1	0	0	0	0	0	0	cPh
*Mastrulus marshalli*** (Bridgman & Fitch)	0	0	0	0	0	0	0	0	0	1	0	0	gPh
*Mastrus deminuens*** (Hartig)	0	0	0	0	1	0	0	0	0	0	0	0	Coc
*Megacara hortulana*** (Gravenhorst)	0	0	1	0	0	0	0	0	0	0	0	0	Poly
Megacara sp.	0	0	1	0	0	0	0	0	0	0	0	0	Unkn
*Mesoleptus laticinctus** (Walker)	0	0	0	0	1	0	0	0	0	0	0	0	Coc
*Orthizema nigriventre*** Horstmann	0	0	0	0	1	0	0	0	0	0	0	0	Unkn
Orthizema sp.*	0	2	0	2	0	0	0	0	0	0	0	0	Unkn
*Phygadeuon vexator** (Thunberg)	0	0	0	0	1	0	0	0	0	0	0	0	gPh
Phygadeuon sp1.	1	0	0	0	0	0	0	0	0	0	0	0	Unkn
Phygadeuon sp2.	2	0	1	1	2	0	0	3	0	0	0	1	Unkn
*Rhembobius perscrutator** (Thunberg)	0	0	1	0	0	0	0	0	0	0	0	0	Sap
*Stibeutes tricinctor*** (Aubert)	0	1	1	10	3	8	0	0	0	0	0	0	Unkn
Stibeutes sp.	0	0	0	0	0	1	0	0	0	0	0	0	Unkn
Thaumatogelis sp.	0	8	0	0	0	0	0	1	0	2	0	1	Unkn
Theroscopus sp1.	0	1	0	0	0	0	0	0	0	0	0	0	Unkn
Theroscopus sp2.	0	1	0	0	0	0	0	0	0	0	0	0	Unkn
Theroscopus sp3.	0	3	0	1	0	0	0	0	0	0	0	0	Unkn
Zoophthorus sp.	0	0	0	0	0	3	0	0	0	0	0	0	Unkn
ICHNEUMONINAE. Heresiarchini													
Coelichneumn comitator (Linnaeus)	0	0	0	0	0	0	0	0	0	0	0	1	gPh
Coelichneumon melanocastaneus Riedel	0	0	0	0	0	0	0	0	0	2	1	0	Coc
Coelichneumon nobilis (Wesmael)	0	2	0	4	0	1	0	0	0	1	0	0	Coc
Coelichneumon nigrifrons Riedel	0	0	1	0	0	0	0	0	0	0	0	0	Coc
ICHNEUMONINAE Ichneumonini													
Barichneumon derogator (Wesmeal)	0	0	0	1	0	0	0	0	2	1	0	0	gPh
Barichneumon sexalbatus (Gravenhorst)	0	0	0	0	0	0	0	0	0	0	1	0	gPh
Cratichneumon culex (Mulier)	0	0	0	0	0	0	0	0	0	0	0	1	gPh
Cratichneumon flavifrons (Schrank)	0	0	0	0	0	0	0	0	0	1	0	0	gPh
Crypteffigieslanius (Gravenhorst)	0	0	1	0	0	1	0	0	0	0	0	0	Myc
Ctenichneumon melanocastaneus (Gravenhorst)	0	0	0	0	0	0	0	0	1	0	0	0	Unkn
Ichneumon molitorius Holmgren	0	0	1	0	0	0	0	0	0	0	0	0	gPh
Ichneumon sarcitorius Linnaeus	0	0	0	0	0	1	0	1	0	0	0	0	gPh
Ichneumon sp.	0	0	0	0	0	0	0	0	0	0	0	1	Unkn
Melanichneumon leucocheilus (Wesmael)	0	0	2	4	0	9	0	0	0	6	0	1	gPh
Obtusodonta equitatoria (Panzer)	0	0	0	0	0	0	0	0	1	0	0	0	gPh
Platylabops mimus (Berthoumieu)	0	0	0	0	0	0	0	0	1	0	0	0	gPh
Spilothyrateles nuptatorius (Fabricius)	0	0	0	0	0	0	0	0	1	0	0	0	gPh
Stenichneumon culpator (Schrank)	0	0	0	0	0	1	1	0	0	0	0	0	gPh
Virgichneumon albosignatus (Gravenhorst)	0	0	0	0	0	0	0	0	0	1	0	0	gPh
Vulgichneumon deceptor (Scopoli)	0	1	0	0	0	0	0	0	0	0	0	0	gPh
Vulgichneumon suavis (Gravenhorst)	1	1	0	0	0	1	0	0	0	0	0	0	gPh
ICHNEUMONINAE. Phaeogenini													
Diadromus collaris (Gravenhorst)	0	0	0	0	0	0	0	0	0	2	0	0	Coc
Misetus oculatus (Westmael)	0	1	1	0	1	0	0	0	0	0	0	0	cPh
Phaeogenes sp.	0	0	0	1	0	0	0	0	0	0	0	0	Unkn
Stenodontus marginellus (Gravenhorst)	0	0	0	1	0	0	0	0	0	0	0	0	Unkn
Stenodontus meridionator Aubert	1	2	0	0	0	0	0	0	0	0	0	0	Unkn
Tycherus sp.	0	1	0	1	0	0	0	0	0	0	0	0	Unkn
ICHNEUMONINAE. Platylabibi													
Apaeleticus bellicosus Wesmael	0	0	0	0	0	0	0	0	0	1	0	0	Unkn
Apaeleticus inimicus (Gravenhorst)	0	0	0	0	1	0	0	0	0	0	0	0	Unkn

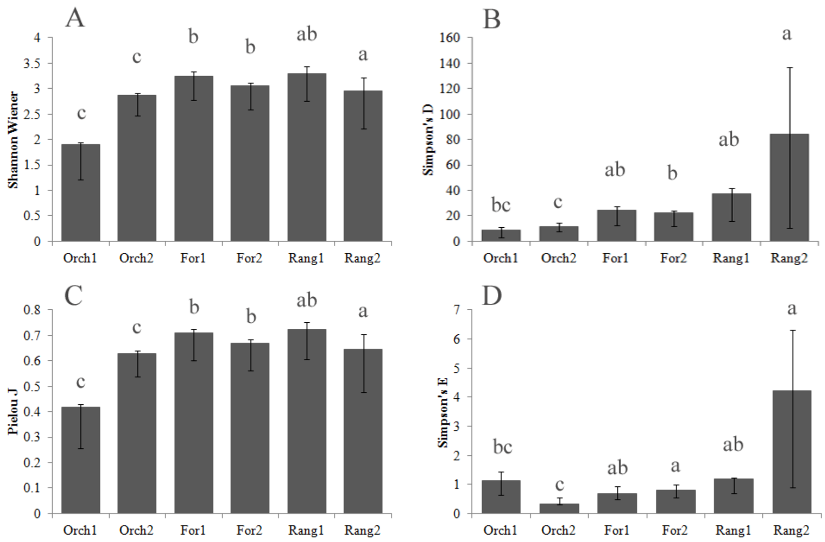

Figure 2. Mean values for diversity indices in all sites: A, Shannon-Wiener index; B, Simpson's D index; C, Pielou's J index; D, Simpson's E index. Orch1: Kord kuy, Orch2: Garmabdasht, For1: Tuskestan, For2: Shast kalateh, Rang1: Chahar bagh, Rang2: Souz javal velley. Vertical bars denote 95% confidence intervals. Different letters indicate statistically significant differences at 5% confidence level, obtained from the randomization test in SDR software.

Table 3. Sampling effectiveness given by the proportion (between brackets) of observed species from that predicted by Jacknife 1 and Chao 2 richness estimators in every habitat evaluated. S obs = observed number of species.

	S obs	ICE	Chao 2
Forest	48	84.31 (56.93%)	80.59 (59.56%)
Orchard	38	84.5 (44.97%)	63.63 (59.72%)
Rangeland	42	92.76 (45.28%)	79.7 (52.70%)

Table 4. Monthly species richness and cumulated richness values obtained by the rarefaction analysis in the six sites. When no more than one sample per month had data, the software was not able to calculate species richness, which is represented by a hyphen.

	Forest		Orchard		Rangeland		Total
	Shast kalate	Tuskestan	Garmabdasht	Kord kuy	Chahar bagh	Souz javal	
April	2.733	1.924	1.792	-	1	-	9.805
May	2.675	1.814	1.916	-	1.953	3.714	12.08
June	2.776	1.956	1.867	1	1.948	4	12.78
July	2.7	-	2	1	2	-	11.43
August	3	-	1	1	2	-	13.24
September	2	2	2	-	1	3	15.22
October	2.838	1	1	-	-	-	10.99
Cumulated	10.8	11.17	9.232	7.637	11.9	12.92	

Table 5. Values of Cryptinae and Ichneumoninae Whittaker indices for dissimilarity amongst the six sites.

	Forest		Orchard		Rangeland	
	Shast kalate	Tuskestan	Garmabdash	Kord kuy	Chahar bagh	Souz javal
Shast kalate	1	0.5238	0.5556	0.7222	0.9	0.875
Tuskestan		1	0.5714	0.814	0.791	0.8182
Garmabdash			1	0.7674	0.8507	0.8182
Kord kuy				1	1	0.9286
Chahar bagh					1	0.6154
Souz javal						1

parasitoids of melitophagous larvae were absent from the rangelands, parasitoids of zoophagous and those emerging from cocoons were absent from Kord kuy (orchard), and those attacking saprophagous larvae were only present in Shast kalateh (forest). In all sites, the parasitoids of grazing phytophagous larvae were the most abundant guild. Parasitoids whose trophic habits' larvae were unknown represented 59% of total species, and in terms of abundance were from 14 to 47% of the total abundance in every site (Fig 3).

Functional diversity barely differed amongst the six sites, but results depended on the diversity index (Fig 4). According to Shannon-Wiener index, all sites had the same functional diversity except Garmabdasht (orchard), with a significantly lower diversity than Chahar bagh (rangeland,

Table 6. p-values obtained from the PERMANOVA test after pair-wise comparison amongst sites. In italics when significant (p < 0.05).

	Forest		Orchard		Rangeland	
	Tuskestan	Shast kalateh	Kord kuy	Garmabdasht	Chahar bagh	Souz javal
Tuskestan		*0.0302*	0.0657	0.3662	0.0574	*0.0134*
Shast kalateh			0.1044	0.114	*0.0003*	*0.0019*
Kord kuy				0.2091	0.2656	0.2367
Garmabdasht					*0.0047*	*0.0219*
Chahar bagh						0.3776
Souz javal						

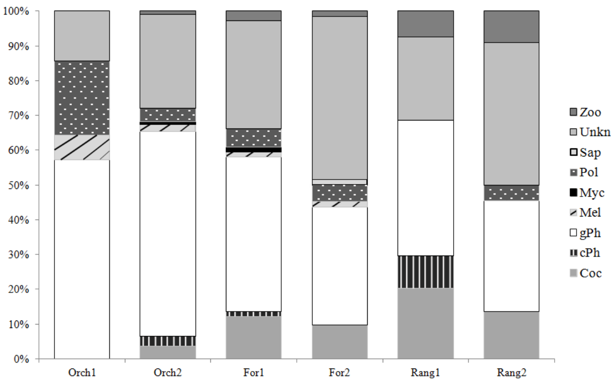

Figure 3. Relative abundances of every trophic guild in all sites: Orch1: Kord kuy, Orch2: Garmabdasht, For1: Tuskestan, For2: Shast kalateh, Rang1: Chahar bagh, Rang2: Souz javal velley.

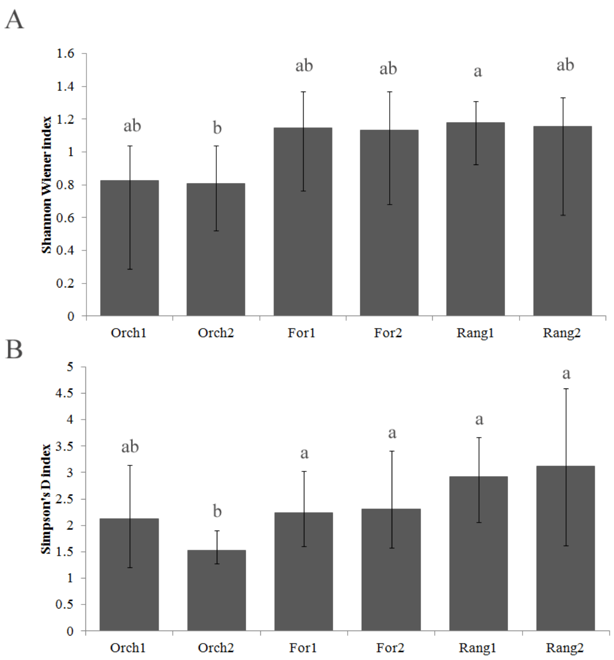

Figure 4. Mean values for functional diversity in all sites: A, Shannon-Wiener index; B, Simpson's D index. Orch1: Kord kuy, Orch2: Garmabdasht, For1: Tuskestan, For2: Shast kalateh, Rang1: Chahar bagh, Rang2: Souz javal velley. Vertical bars denote 95% confidence intervals. Different letters indicate statistically significant differences at 5% confidence level, obtained from the randomization test in SDR software.

Fig 4A). However, Simpson's D index showed a significantly lower functional diversity of Garmabdasht (orchard) when compared to most sites (except to Kord kuy) (Fig 4B).

Discussion

Iran has an astounding biodiversity thanks to its mosaic landscape structure, with heterogeneous ecosystems consisting of some influenced by anthropogenic activities. Despite the importance of parasitoid wasps for ecosystem functioning, little is known about their diversity and how they are related to habitats with different level of anthropogenic influence. The current study provides primary Ichneumonidae diversity data from the northeastern Iran and how this diversity is affected by human activities.

In this area we found 97 ichneumonid species of the subfamilies Cryptinae and Ichneumoninae, which represents about 55.28% (Mahyabadi et al. 2017) and 15.7% (Barahoei et al. 2012) of Cryptinae and Ichneumoninae species recorded throughout Iran, respectively. It is noteworthy to mention that more than half of the Cyptinae species recorded from Iran have been found in our study, which emphasizes the distinctive feature of this region. This high richness might be related to the high diversity of flora and fauna of this region, which in its turn results in higher host resources for ichneumonids.

Sex ratio was significantly towards the males (67.3%), which may be a result of sampling disparities found for tribe Cryptini when collected by Malaise trap (Aguiar & Santos 2010).

The results of this study supported the expected negative relationship between the environmental disturbance and relative ichneumonid diversity. Considering alpha diversity indices, the least diverse habitats in our study were the orchards. Intensive application of pesticides and forest clearance for agriculture, which both are increasing phenomenons in Iran, destroy the habitat and generally cause a decrease in species abundance and diversity (Varamesh et al. 2017). Anthropogenic disturbances usually occurring in orchards in order to manage pests, diseases and weeds may probably change the vegetation structure and host–parasitoid food webs, resulting in much lower habitat heterogeneity. Moreover, the two orchard sites were the pair of habitats with the greatest differences. They differed in the pest control strategies that were used: extensive spraying in Kordkuy with only sparse herbages compared to minimal spraying in Garmabdasht with dense herbages (nearly organic). However, the slight ecological management that was applied in Garmabdasht did not help to improve parasitoid diversity, and actually species evenness and functional diversity were low in this site. There is an urgent need for increasing biodiversity in agroecosystems, but according to our results, neither the nearly organic management nor the proximity to the Turkestan forest were enough to ensure a high species diversity for parasitoids, so more research studies are required to be conducted on this topic.

Plant diversity and habitat complexity might have manifold effects on assemblage and abundance of parasitoids (Gols et al. 2005, Petermann et al. 2010, De Rijk et al. 2013). On one hand, the more non-host plant odour is present, the higher the possibility of disguising target odour or repellent effects (Schröder & Hilker 2008, Wäschke et al. 2014). Furthermore, the more complex the habitat, the more diversity of refuges for potential hosts to avoid parasitism are available (Wilkinson & Feener 2012, Mazón & Bordera 2014, Wäschke et al. 2014). On the other hand, many studies showed that with increasing plant species richness and diversity, the parasitoids become more diverse (Arnan et al. 2011, Fabian et al. 2014, Kendall and Ward 2016). Hence, habitat complexity can have either pros or cons for both hosts and parasitoids, and many other hidden drivers may be affecting parasitoid diversity. For example, bottom-up effects may be determining the parasitoid assemblages, regarding the plant species and their hosts (Mehrparvar et al. 2019). Moreover, even when community structure metrics are similar, differences in habitat conservation may be reflecting on food-web metrics (Maia et al. 2019). Therefore, there is much need on this kind of research studies , to truly understand what is determining the parasitoid assemblages in one site or another.

Subfamily Cryptinae, the most abundant in our study, is one of the most diverse groups of parasitoids, attacking a broad host range, mainly holometabolous, herbivorous insects, consequently they are expected to be directly related to plant diversity and structure (González-Moreno et al. 2015). Ichneumoninae, the second largest subfamily of Ichneumonidae, constitutes an exceedingly large and diverse group of parasitoid wasps usually parasitizing Lepidoptera (Riedel 2013, Norhafiza and Idris 2013). In our study, both rangelands and forests were more complex in terms of plant diversity than orchards, and in these habitats, more diverse assemblages of both Cryptinae and Ichneumoninae were gathered probably due to the higher resources for ichneumonid phytophagous hosts. A mono/oligoculture plantation, as it occurs in the orchards, can favor the presence of a restricted subset of phytophagous insects and thereby leading to the existence of a restricted group of parasitoids (Risch 1981, Cook-Patton et al. 2014). In consequence, low host population density acts as a barrier to ichneumonid species richness by rendering certain species too scarce to serve as a specialist's host (Janzen and Pond 1975, Janzen 1981).

According to our results, both rangeland and forest had the same evenness, which was higher than that of orchards. The low evenness in orchards might show that some ichneumonids found in these areas had a very small population probably because they originated from neighbouring areas and moved into the orchards, but unfavourable condition of the orchars prevent establishment of them (Trotter et al. 2008, Razali et al. 2016). Moreover, the abundance of resources for only a few species in orchards promotes competitive dominance of them leading to reduction in species richness/species evenness. Nevertheless, high population number of some Ichneumonid species occurred in the orchards because of abundance of some host species.

Species evenness has a similarly extensive range of ecological impacts. This index indicates how similar abundances are across species and may respond more swiftly to environmental changes than the species richness (Chapin et al. 1998, Rohr et al. 2016). Hence, low species evenness may probably lead to low resistance to stress induced by environmental changes (Norberg et al. 2001, Wittebolle et al. 2009). Therefore, to adapt cultures to the climate change effects, a high species evenness is needed (Hisano et al. 2018), and needs to be taken into account in future researches.

However, despite differences in diversity values among habitats, the strongest differences were found when comparing the species assemblages, with orchards sharing only a few species with rangelands. Surrounding landscapes seem to have a great impact on insect assemblages in the habitats embedded (Verdú et al. 2011). In our study, the Garmabdasht habitat (orchard) is situated next to Tuskestan habitat (forest), and thus these two sites, despite the fact that they are rather different habitats in terms of plant diversity, shared about 42% of species, a similarity even higher than that between Garmabdasht and the other orchard. Therefore, not only the habitats but the landscaping variables should be taken into account in future studies. Based on PERMANOVA, which includes not only the presence/absence of species (as in Whittaker index) but their relative abundances, Ichneumonid assemblages were significantly different between the two forests and also between Shast kalateh (forest) and Garmabdasht (orchard), and in Garmabdasht when compared to the two rangelands. This would mean that, although the two forests share almost 50% of their species, those species may not be the most representative of these sites and about 20% of these differences were explained by the relative abundances of three species: *Thaumatogelis* sp., *Hoplocryptus murarius* and *Trychosis legator*, all of them idiobiont parasitoids attacking mature either larvae or pupae of grazing Lepidoptera (Traynor & Mayhew 2005). These three species do not have any rangelands, open areas with a dominant herbaceous layer, so they may prefer areas with a higher proportion of tree or shrub layers that provide shelter for their hosts. As they do not need to overtake the host defences, parasitoids with idiobiont strategy often have a broader host range and hence are likely to be less sensitive to habitat disturbances (Hawkins 1994, Stenbacka et al. 2010, Quicke 2015). Therefore, these species could be suitable candidates for biological control in climate change conditions leading to habitat changes. In any case, differences in ichneumonid assemblages between the two forests might be related to differences in the tree species or in the shrubby vegetation (Schulz and Wagner 2002, Schowalter & Zhang 2005, Vance et al. 2007).

Parasitoid functional diversity can elucidate parasitoid diversity and composition patterns across different habitat types (Kendall & Ward 2016). The goal of measuring functional diversity is to augment conventional diversity measures in apprehending the processes underlying community assembly and species co-occurrence (Mason et al. 2005, Mason & de Bello 2013). In our study, nearly all habitat types had relatively similar functional diversity which might be resulted from consistent expression of dominant traits (Wong & Kay 2019), since grazing phytophagous larval parasitoids were, by far, the dominant guild in all habitats.

Nevertheless, some functional groups were only present in certain habitats, like parasitoids of melitophagous larvae, that were associated to forests and orchards, or the guilds made up of those attacking cocoons, and zoophagous, mycetophagous and concealed phytophgous larvae, respectively, that were completely absent in the orchard with the chemical-based management. Hence, not only functional diversity but the relative occurrence of certain trophic guilds could be used to assess the conservation status of a habitat. However, it should be taken into consideration the rather low sampling effectiveness shown by the richness estimators. The precise positioning of Malaise traps substantially affects the sampling efficiency of the trap (Hammond 1992, Ilari et al. 2006). Furthermore, about 40% of species were not included in the analysis of functional diversity as their biology is unknown. Therefore, increasing the number of traps and a better knowledge of species biology would definitely lead to a better understanding of the functional implications of Ichneumonidae occurrence.

Considering the abovementioned and because of Ichneumonidae position at high trophic levels, conducting such diversity studies will provide valuable information for better understanding the effects of landscape context on these efficacious components of ecosystems and also assist in better realization of the importance and the advantages of environmental conservation projects to improve conservation-oriented measures and to protect the species diversity.

Eventually, as changes in biodiversity can impose tremendous effects on ecosystem and landscape processes (Chapin et al. 1998) and considering the present swift rates of environmental changes, it is mandatory to preserve the current diversity levels as insurance against an uncertain future.

Compliance with Ethical Standards. There is not any conflicts of interests. Ethics approval was not required as insects are not classified as animals for the purposes of the Animal Welfare of Iran Legislation. Department of Environment of Golestan and Faculty of Forest Science, Gorgan University of Agricultural Sciences & Natural resources provided us with facilities and permissions to collect material in Tuskestan and Shastkalateh.

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Appendix - Supporting information in 6 tables + pages

Table A1 Results from SIMPER analysis between the two forests' assemblages.
Table A2 Results from SIMPER analysis between Tuskestan (forest) and Souz javal (rangeland) on Ichneumonidae assemblages.
Table A3 Results from SIMPER analysis between Shast kalateh (forest) and Chahar bagh (rangeland) on Ichneumonidae assemblages.
Table A4 Results from SIMPER analysis between Shast kalateh (forest) and Souz javal (rangeland) on Ichneumonidae assemblages.
Table A5 Results from SIMPER analysis between Garmabdasth (orchard) and Chahar bagh (rangeland) on Ichneumonidae assemblages.
Table A6 Results from SIMPER analysis between Garmabdasth (orchard) and Souz javal (rangeland) on Ichneumonidae assemblages.

Table A1 Results from SIMPER analysis between the two forests' assemblages.

Taxa	Av. dissim	Contrib. %	Cumulative %	Mean Tuskestan	Mean Shast kalateh
Thaumatogelis sp	6.55	7.097	7.097	0	0.878
Hoplocryptus murarius	6.267	6.79	13.89	0.345	0.571
Trychosis legator	5.84	6.328	20.21	0.247	0.651
Aritranis director	4.182	4.531	24.75	0.39	0.449
Stibeutes tricinctor	3.84	4.16	28.91	0.714	0.143
Orthizema sp	3.806	4.124	33.03	0.286	0.202
Stenodontus meridionator	3.798	4.115	37.14	0	0.429
Agrothereutes abbreviatus	3.737	4.048	41.19	0.286	0.143
Ischnus alternator	3.182	3.448	44.64	0	0.39
Gelis sp2	3.181	3.447	48.09	0.286	0.143
Theroscopus sp3	2.676	2.9	50.99	0.143	0.345
Cryptus armator	2.475	2.681	53.67	0.571	0
Phygadenon sp2	2.401	2.602	56.27	0.286	0.202
Endasys sp	2.328	2.523	58.79	0.143	0.247
Barichneumon derogator	2.088	2.262	61.05	0.143	0
Hoplocryptus confector	2.062	2.234	63.29	0	0.143
Aritranis nigripes	2.037	2.207	65.50	0	0.286
Tycherus sp	1.974	2.139	67.63	0.143	0.143
Idiolispa analis	1.798	1.948	69.58	0.202	0.143
Gelis bicolor	1.746	1.891	71.47	0.202	0.143
Vulgichneumon suavis	1.736	1.881	73.35	0	0.286
Phygadenon sp1	1.735	1.879	75.23	0	0.143
Vulgichneumon deceptor	1.631	1.767	77	0	0.143
Misetus oculatus	1.607	1.741	78.74	0.143	0.143
Hoplocryptus bellosus	1.4	1.517	80.26	0.143	0
Buathra laborator	1.259	1.364	81.62	0.286	0
Coelichneumon nobilis	1.215	1.317	82.94	0.35	0
Melanichneumon leucocheilus	1.215	1.317	84.26	0.35	0
Theroscopus sp2	1.137	1.232	85.49	0	0.143
Cubocephalus sp	1.041	1.128	86.62	0	0.143
Aptesis sp	1.041	1.128	87.75	0	0.143
Bathythrix pellucidator	1.018	1.103	88.85	0.202	0
Pterocryptus sp	0.8357	0.9054	89.75	0	0.143
Theroscopus sp1	0.8357	0.9054	90.66	0	0.143
Rhembobius perscrutator	0.7628	0.8265	91.49	0.143	0
Phaeogenes sp	0.7628	0.8265	92.31	0.143	0
Arotrephes sp	0.7628	0.8265	93.14	0.143	0
Stenodontus marginellus	0.7197	0.7797	93.92	0.143	0
Coelichneumon nigrifrons	0.7197	0.7797	94.7	0.143	0
Ateleute linearis	0.7197	0.7797	95.48	0.143	0
Aptesis jejunator	0.7016	0.7601	96.24	0.202	0
Megacara sp	0.4961	0.5375	96.78	0.143	0
Megacara hortulana	0.4961	0.5375	97.31	0.143	0
Myrmeleonostenus italicus	0.4961	0.5375	97.85	0.143	0
Cryptus titubator	0.4961	0.5375	98.39	0.143	0
Meringopus attentorius	0.4961	0.5375	98.93	0.143	0
Ichneumon molitorius	0.4961	0.5375	99.46	0.143	0
Crypteffigies lanius	0.4961	0.5375	100	0.143	0
Aptesis flagitator	0	0	100	0	0
Xylophrurus sp	0	0	100	0	0
Hoplocryptus coxator	0	0	100	0	0
Phygadenon vexator	0	0	100	0	0
Sphecophaga vesparum	0	0	100	0	0
Orthizema nigriventre	0	0	100	0	0
Mesoleptus laticinectus	0	0	100	0	0
Cryptus vitrefrontalis	0	0	100	0	0
Mastrulus marshalli	0	0	100	0	0
Lysibia nanus	0	0	100	0	0
Mesostenus sp	0	0	100	0	0
Lochetica westoni	0	0	100	0	0

Taxa	Av. dissim	Contrib. %	Cumulative %	Mean Tuskestan	Mean Shast kalateh
Stibeutes sp.	0	0	100	0	0
Mastrus deminuens	0	0	100	0	0
Apaeleticus inimicus	0	0	100	0	0
Hemiteles rubropleuralis	0	0	100	0	0
Mesostenus transfuga	0	0	100	0	0
Apaeleticus bellicosus	0	0	100	0	0
Gelis sp1	0	0	100	0	0
Meringopus sp	0	0	100	0	0
Gelis vicinus	0	0	100	0	0
Diadromus collaris	0	0	100	0	0
Cryptus spiralis	0	0	100	0	0
Virgichneumon albosignatus	0	0	100	0	0
Dichrogaster sp	0	0	100	0	0

Table A2 Results from SIMPER analysis between Tuskestan (forest) and Souz javal (rangeland) on Ichneumonidae assemblages.

Taxa	Av. dissim	Contrib. %	Cumulative %	Mean Tuskestan	Mean Souz javal
Agrothereutes abbreviatus	10.5	10.65	10.65	0.286	0
Barichneumon derogator	7.983	8.099	18.75	0.143	0
Orthizema sp	6.987	7.089	25.84	0.286	0
Gelis sp2	5.447	5.526	31.37	0.286	0.143
Stibeutes tricinctor	4.282	4.345	35.71	0.714	0
Barichneumon sexalbatus	3.516	3.567	39.28	0	0.143
Cryptus armator	3.041	3.086	42.36	0.571	0
Phygadenon sp2	2.882	2.923	45.29	0.286	0.143
Melanichneumon leucocheilus	2.543	2.58	47.87	0.35	0.143
Tycherus sp	2.517	2.554	50.42	0.143	0
Hoplocryptus bellosus	2.517	2.554	52.98	0.143	0
Aptesis jejunator	2.415	2.45	55.43	0.202	0.202
Myrmeleonostenus italicus	2.4	2.435	57.86	0.143	0.286
Hoplocryptus murarius	2.265	2.298	60.16	0.345	0
Cryptus vitrefrontalis	2.087	2.117	62.28	0	0.286
Aritranis director	1.907	1.934	64.21	0.39	0
Thaumatogelis sp	1.735	1.76	65.97	0	0.143
Charitopes areolaris	1.735	1.76	67.73	0	0.143
Polytribax perspicillator	1.735	1.76	69.49	0	0.143
Trychosis legator	1.698	1.722	71.21	0.247	0
Buathra laborator	1.556	1.579	72.79	0.286	0
Coelichneumon nobilis	1.412	1.432	74.22	0.35	0
Idiolispa analis	1.386	1.406	75.63	0.202	0
Gelis bicolor	1.285	1.304	76.93	0.202	0
Bathythrix pellucidator	1.285	1.304	78.24	0.202	0
Mesostenus sp	1.275	1.293	79.53	0	0.143
Hoplocryptus heliophilus	1.275	1.293	80.82	0	0.143
Rhembobius perscrutator	0.9802	0.9944	81.82	0.143	0
Arotrephes sp	0.9802	0.9944	82.81	0.143	0
Phaeogenes sp	0.9802	0.9944	83.81	0.143	0
Misetus oculatus	0.9802	0.9944	84.8	0.143	0
Coelichneumon nigrifrons	0.9086	0.9218	85.72	0.143	0
Stenodontus marginellus	0.9086	0.9218	86.64	0.143	0
Ateleute linearis	0.9086	0.9218	87.57	0.143	0
Theroscopus sp3	0.9086	0.9218	88.49	0.143	0
Ichneumon sp	0.8126	0.8244	89.31	0	0.143
Cryptus macellus	0.8126	0.8244	90.14	0	0.143
Charitopes sp1	0.8126	0.8244	90.96	0	0.143
Cratichneumon culex	0.8126	0.8244	91.79	0	0.143
Aclastus solutus	0.8126	0.8244	92.61	0	0.143
Charitopes sp2	0.8126	0.8244	93.43	0	0.143

Taxa	Av. dissim	Contrib. %	Cumulative %	Mean Tuskestan	Mean Souz javal
Cryptus inculator	0.8126	0.8244	94.26	0	0.143
Coelichneumon melanocastaneus	0.8126	0.8244	95.08	0	0.143
Coelichneumon comitator	0.8126	0.8244	95.91	0	0.143
Megacara sp	0.5763	0.5847	96.49	0.143	0
Megacara hortulana	0.5763	0.5847	97.08	0.143	0
Cryptus titubator	0.5763	0.5847	97.66	0.143	0
Endasys sp	0.5763	0.5847	98.25	0.143	0
Ichneumon molitorius	0.5763	0.5847	98.83	0.143	0
Crypteffigies lanius	0.5763	0.5847	99.42	0.143	0
Meringopus attentorius	0.5763	0.5847	100	0.143	0
Aptesis flagitator	0	0	100	0	0
Xylophrurus sp	0	0	100	0	0
Hoplocryptus coxator	0	0	100	0	0
Phygadenon sp1	0	0	100	0	0
Phygadenon vexator	0	0	100	0	0
Sphecophaga vesparum	0	0	100	0	0
Orthizema nigriventre	0	0	100	0	0
Mesoleptus laticinectus	0	0	100	0	0
Pterocryptus sp	0	0	100	0	0
Stibeutes sp.	0	0	100	0	0
Mastrulus marshalli	0	0	100	0	0
Lysibia nanus	0	0	100	0	0
Lochetica westoni	0	0	100	0	0
Mastrus deminuens	0	0	100	0	0
Apaeleticus inimicus	0	0	100	0	0
Hemiteles rubropleuralis	0	0	100	0	0
Mesostenus transfuga	0	0	100	0	0
Apaeleticus bellicosus	0	0	100	0	0
Gelis sp1	0	0	100	0	0
Meringopus sp	0	0	100	0	0
Gelis vicinus	0	0	100	0	0
Diadromus collaris	0	0	100	0	0
Vulgichneumon suavis	0	0	100	0	0
Cryptus spiralis	0	0	100	0	0
Virgichneumon albosignatus	0	0	100	0	0
Dichrogaster sp	0	0	100	0	0
Ischnus migrator	0	0	100	0	0
Platylabops mimus	0	0	100	0	0
Obtusodonta equitatoria	0	0	100	0	0
Ischnus alternator	0	0	100	0	0

Table A3 Results from SIMPER analysis between Shast kalateh (forest) and Chahar bagh (rangeland) on Ichneumonidae assemblages.

Taxa	Av. dissim	Contrib. %	Cumulative %	Mean Shast kalateh	Mean Chahar bagh
Hoplocryptus murarius	6.83	7.043	7.043	0.571	0
Thaumatogelis sp	6.427	6.627	13.67	0.878	0.286
Trychosis legator	5.83	6.011	19.68	0.651	0
Stenodontus meridionator	4.081	4.208	23.89	0.429	0
Aritranis director	3.615	3.727	27.62	0.449	0
Ischnus alternator	3.394	3.5	31.12	0.39	0
Meringopus sp	3.188	3.287	34.4	0	0.286
Gelis sp2	2.687	2.77	37.17	0.143	0.143
Theroscopus sp3	2.437	2.512	39.68	0.345	0
Xylophrurus sp	2.426	2.502	42.19	0	0.286
Hoplocryptus confector	2.255	2.325	44.51	0.143	0
Aritranis nigripes	2.155	2.222	46.73	0.286	0
Barichneumon derogator	2.121	2.187	48.92	0	0.345
Melanichneumon leucocheilus	2.111	2.177	51.1	0	0.488

Taxa	Av. dissim	Contrib. %	Cumulative %	Mean Shast kalateh	Mean Chahar bagh
Endasys sp	2.09	2.155	53.25	0.247	0
Mesostenus transfuga	2.004	2.067	55.32	0	0.286
Phygadenon sp1	1.873	1.931	57.25	0.143	0
Vulgichneumon suavis	1.826	1.883	59.13	0.286	0
Virgichneumon albosignatus	1.787	1.843	60.97	0	0.143
Coelichneumon nobilis	1.787	1.843	62.82	0	0.143
Vulgichneumon deceptor	1.755	1.809	64.63	0.143	0
Aptesis flagitator	1.71	1.763	66.39	0	0.39
Phygadenon sp2	1.558	1.607	68	0.202	0
Myrmeleonostenus italicus	1.507	1.554	69.55	0	0.345
Acroricnus seductor	1.4	1.444	70.99	0	0.143
Dichrogaster sp	1.267	1.306	72.3	0	0.143
Apaeleticus bellicosus	1.267	1.306	73.61	0	0.143
Gelis vicinus	1.267	1.306	74.91	0	0.143
Coelichneumon melanocastaneus	1.243	1.281	76.19	0	0.286
Orthizema sp	1.242	1.281	77.48	0.202	0
Theroscopus sp2	1.207	1.244	78.72	0.143	0
Cryptus spiralis	1.106	1.141	79.86	0	0.247
Misetus oculatus	1.102	1.136	81	0.143	0
Cubocephalus sp	1.102	1.136	82.13	0.143	0
Aptesis sp	1.102	1.136	83.27	0.143	0
Hoplocryptus heliophilus	1.046	1.078	84.35	0	0.247
Stibeutes tricinctor	0.9479	0.9774	85.32	0.143	0
Gelis bicolor	0.9479	0.9774	86.3	0.143	0
Idiolispa analis	0.9479	0.9774	87.28	0.143	0
Aptesis jejunator	0.9033	0.9313	88.21	0	0.202
Pterocryptus sp	0.8783	0.9056	89.12	0.143	0
Tycherus sp	0.8783	0.9056	90.02	0.143	0
Theroscopus sp1	0.8783	0.9056	90.93	0.143	0
Agrothereutes abbreviatus	0.8783	0.9056	91.83	0.143	0
Cryptus vitrefrontalis	0.854	0.8806	92.71	0	0.202
Diadromus collaris	0.854	0.8806	93.59	0	0.202
Mastrulus marshalli	0.6387	0.6586	94.25	0	0.143
Cryptus titubator	0.6387	0.6586	94.91	0	0.143
Platylabops mimus	0.6387	0.6586	95.57	0	0.143
Ischnus migrator	0.6387	0.6586	96.23	0	0.143
Charitopes areolaris	0.6387	0.6586	96.89	0	0.143
Spilothyrateles nuptatorius	0.6039	0.6226	97.51	0	0.143
Obtusodonta equitatoria	0.6039	0.6226	98.13	0	0.143
Charitopes sp1	0.6039	0.6226	98.75	0	0.143
Ctenichneumon melanocastaneus	0.6039	0.6226	99.38	0	0.143
Cratichneumon flavifrons	0.6039	0.6226	100	0	0.143
Stibeutes sp.	0	0	100	0	0
Rhembobius perscrutator	0	0	100	0	0
Hoplocryptus coxator	0	0	100	0	0
Phygadenon vexator	0	0	100	0	0
Sphecophaga vesparum	0	0	100	0	0
Hoplocryptus bellosus	0	0	100	0	0
Buathra laborator	0	0	100	0	0
Orthizema nigriventre	0	0	100	0	0
Mesoleptus laticinectus	0	0	100	0	0
Megacara sp	0	0	100	0	0
Megacara hortulana	0	0	100	0	0
Lysibia nanus	0	0	100	0	0
Mesostenus sp	0	0	100	0	0
Lochetica westoni	0	0	100	0	0
Mastrus deminuens	0	0	100	0	0
Apaeleticus inimicus	0	0	100	0	0
Hemiteles rubropleuralis	0	0	100	0	0
Ateleute linearis	0	0	100	0	0
Stenodontus marginellus	0	0	100	0	0

Taxa	Av. dissim	Contrib. %	Cumulative %	Mean Shast kalateh	Mean Chahar bagh
Gelis sp1	0	0	100	0	0
Phaeogenes sp	0	0	100	0	0
Meringopus attentorius	0	0	100	0	0
Stenichneumon culpator	0	0	100	0	0
Charitopes sp2	0	0	100	0	0
Ichneumon sp	0	0	100	0	0

Table A4 Results from SIMPER analysis between Shast kalateh (forest) and Souz javal (rangeland) on Ichneumonidae assemblages.

Taxa	Av. dissim	Contrib. %	Cumulative %	Mean Shast kalateh	Mean Souz javal
Hoplocryptus murarius	9.148	9.362	9.362	0.571	0
Thaumatogelis sp	8.194	8.386	17.75	0.878	0.143
Trychosis legator	7.299	7.47	25.22	0.651	0
Stenodontus meridionator	5.335	5.46	30.68	0.429	0
Aritranis director	4.384	4.487	35.16	0.449	0
Ischnus alternator	4.29	4.39	39.55	0.39	0
Hoplocryptus confector	3.195	3.27	42.82	0.143	0
Gelis sp2	3.031	3.102	45.93	0.143	0.143
Phygadenon sp2	2.952	3.021	48.95	0.202	0.143
Theroscopus sp3	2.9	2.967	51.92	0.345	0
Aritranis nigripes	2.591	2.652	54.57	0.286	0
Endasys sp	2.555	2.615	57.18	0.247	0
Phygadenon sp1	2.517	2.576	59.76	0.143	0
Vulgichneumon deceptor	2.319	2.374	62.13	0.143	0
Vulgichneumon suavis	2.139	2.189	64.32	0.286	0
Barichneumon sexalbatus	2.088	2.137	66.46	0	0.143
Cryptus vitrefrontalis	1.887	1.931	68.39	0	0.286
Myrmeleonostenus italicus	1.887	1.931	70.32	0	0.286
Aptesis jejunator	1.581	1.618	71.94	0	0.202
Theroscopus sp2	1.475	1.51	73.45	0.143	0
Orthizema sp	1.447	1.481	74.93	0.202	0
Polytribax perspicillator	1.4	1.433	76.36	0	0.143
Charitopes areolaris	1.4	1.433	77.8	0	0.143
Misetus oculatus	1.327	1.358	79.15	0.143	0
Aptesis sp	1.327	1.358	80.51	0.143	0
Cubocephalus sp	1.327	1.358	81.87	0.143	0
Mesostenus sp	1.118	1.144	83.01	0	0.143
Hoplocryptus heliophilus	1.118	1.144	84.16	0	0.143
Melanichneumon leucocheilus	1.118	1.144	85.3	0	0.143
Stibeutes tricinctor	1.116	1.142	86.44	0.143	0
Gelis bicolor	1.116	1.142	87.59	0.143	0
Idiolispa analis	1.116	1.142	88.73	0.143	0
Pterocryptus sp	1.023	1.047	89.77	0.143	0
Tycherus sp	1.023	1.047	90.82	0.143	0
Theroscopus sp1	1.023	1.047	91.87	0.143	0
Agrothereutes abbreviatus	1.023	1.047	92.92	0.143	0
Cryptus inculator	0.769	0.787	93.7	0	0.143
Cryptus macellus	0.769	0.787	94.49	0	0.143
Ichneumon sp	0.769	0.787	95.28	0	0.143
Charitopes sp1	0.769	0.787	96.06	0	0.143
Cratichneumon culex	0.769	0.787	96.85	0	0.143
Aclastus solutus	0.769	0.787	97.64	0	0.143
Charitopes sp2	0.769	0.787	98.43	0	0.143
Coelichneumon melanocastaneus	0.769	0.787	99.21	0	0.143
Coelichneumon comitator	0.769	0.787	100	0	0.143
Aptesis flagitator	0	0	100	0	0
Xylophrurus sp	0	0	100	0	0
Hoplocryptus coxator	0	0	100	0	0

Taxa	Av. dissim	Contrib. %	Cumulative %	Mean Shast kalateh	Mean Souz javal
Sphecophaga vesparum	0	0	100	0	0
Hoplocryptus bellosus	0	0	100	0	0
Buathra laborator	0	0	100	0	0
Orthizema nigriventre	0	0	100	0	0
Mesoleptus laticinectus	0	0	100	0	0
Megacara sp	0	0	100	0	0
Megacara hortulana	0	0	100	0	0
Phygadenon vexator	0	0	100	0	0
Mastrulus marshalli	0	0	100	0	0
Lysibia nanus	0	0	100	0	0
Rhembobius perscrutator	0	0	100	0	0
Lochetica westoni	0	0	100	0	0
Stibeutes sp.	0	0	100	0	0
Apaeleticus inimicus	0	0	100	0	0
Hemiteles rubropleuralis	0	0	100	0	0
Mesostenus transfuga	0	0	100	0	0
Cryptus titubator	0	0	100	0	0
Ateleute linearis	0	0	100	0	0
Apaeleticus bellicosus	0	0	100	0	0
Gelis sp1	0	0	100	0	0
Meringopus sp	0	0	100	0	0
Gelis vicinus	0	0	100	0	0
Diadromus collaris	0	0	100	0	0
Meringopus attentorius	0	0	100	0	0
Cryptus spiralis	0	0	100	0	0
Virgichneumon albosignatus	0	0	100	0	0
Dichrogaster sp	0	0	100	0	0
Ischnus migrator	0	0	100	0	0
Platylabops mimus	0	0	100	0	0
Obtusodonta equitatoria	0	0	100	0	0
Ichneumon sarcitorius	0	0	100	0	0
Ichneumon molitorius	0	0	100	0	0
Ctenichneumon melanocastaneus	0	0	100	0	0

Table A5 Results from SIMPER analysis between Garmabdasth (orchard) and Chahar bagh (rangeland) on Ichneumonidae assemblages.

Taxa	Av. dissim	Contrib. %	Cumulative %	Mean Garmabdasht	Mean Chahar bagh
Aritranis director	4.907	4.974	4.974	1.15	0
Trychosis legator	4.708	4.772	9.746	0.812	0
Phygadenon sp2	4.015	4.07	13.82	0.631	0
Hemiteles rubropleuralis	3.746	3.797	17.61	0.286	0
Melanichneumon leucocheilus	3.58	3.629	21.24	0.429	0.488
Idiolispa analis	3.565	3.613	24.86	0.807	0
Meringopus sp	3.482	3.529	28.38	0	0.286
Stibeutes tricinctor	3.313	3.358	31.74	0.778	0
Charitopes sp2	2.895	2.935	34.68	0.143	0
Hoplocryptus murarius	2.895	2.935	37.61	0.143	0
Ischnus alternator	2.895	2.935	40.55	0.143	0
Orthizema nigriventre	2.895	2.935	43.48	0.143	0
Xylophrurus sp	2.63	2.666	46.15	0	0.286
Coelichneumon nobilis	2.446	2.479	48.63	0.143	0.143
Mesostenus transfuga	2.391	2.424	51.05	0.143	0.286
Gelis sp2	2.292	2.323	53.37	0.286	0.143
Barichneumon derogator	2.132	2.161	55.53	0	0.345
Thaumatogelis sp	2.091	2.119	57.65	0	0.286
Virgichneumon albosignatus	2.011	2.038	59.69	0	0.143
Gelis sp1	1.873	1.899	61.59	0.143	0
Mesoleptus laticinectus	1.873	1.899	63.49	0.143	0

Taxa	Av. dissim	Contrib. %	Cumulative %	Mean Garmabdasht	Mean Chahar bagh
Apaeleticus inimicus	1.873	1.899	65.39	0.143	0
Misetus oculatus	1.873	1.899	67.29	0.143	0
Aptesis flagitator	1.657	1.68	68.97	0	0.39
Acroricnus seductor	1.471	1.491	70.46	0	0.143
Myrmeleonostenus italicus	1.46	1.48	71.94	0	0.345
Endasys sp	1.382	1.401	73.34	0.286	0
Zoophthorus sp	1.344	1.362	74.7	0.345	0
Apaeleticus bellicosus	1.305	1.323	76.02	0	0.143
Gelis vicinus	1.305	1.323	77.35	0	0.143
Dichrogaster sp	1.305	1.323	78.67	0	0.143
Coelichneumon melanocastaneus	1.204	1.22	79.89	0	0.286
Cryptus spiralis	1.073	1.087	80.98	0	0.247
Hoplocryptus heliophilus	1.013	1.026	82	0	0.247
Aptesis jejunator	0.8757	0.8877	82.89	0	0.202
Cryptus vitrefrontalis	0.8268	0.8381	83.73	0	0.202
Diadromus collaris	0.8268	0.8381	84.57	0	0.202
Phygadenon vexator	0.7309	0.7409	85.31	0.143	0
Mastrus deminuens	0.7309	0.7409	86.05	0.143	0
Vulgichneumon suavis	0.7309	0.7409	86.79	0.143	0
Lochetica westoni	0.6929	0.7024	87.49	0.202	0
Bathythrix pellucidator	0.6929	0.7024	88.19	0.202	0
Arotrephes sp	0.6929	0.7024	88.9	0.202	0
Agrothereutes abbreviatus	0.6929	0.7024	89.6	0.202	0
Stibeutes sp.	0.6511	0.6599	90.26	0.143	0
Crypteffigies lanius	0.6511	0.6599	90.92	0.143	0
Mastrulus marshalli	0.6192	0.6277	91.55	0	0.143
Cryptus titubator	0.6192	0.6277	92.17	0	0.143
Ischnus migrator	0.6192	0.6277	92.8	0	0.143
Platylabops mimus	0.6192	0.6277	93.43	0	0.143
Charitopes areolaris	0.6192	0.6277	94.06	0	0.143
Obtusodonta equitatoria	0.5847	0.5926	94.65	0	0.143
Charitopes sp1	0.5847	0.5926	95.24	0	0.143
Spilothyrateles nuptatorius	0.5847	0.5926	95.83	0	0.143
Ctenichneumon melanocastaneus	0.5847	0.5926	96.43	0	0.143
Cratichneumon flavifrons	0.5847	0.5926	97.02	0	0.143
Sphecophaga vesparum	0.49	0.4966	97.52	0.143	0
Lysibia nanus	0.49	0.4966	98.01	0.143	0
Gelis bicolor	0.49	0.4966	98.51	0.143	0
Stenichneumon culpator	0.49	0.4966	99.01	0.143	0
Ichneumon sarcitorius	0.49	0.4966	99.5	0.143	0
Aritranis longicauda	0.49	0.4966	100	0.143	0
Rhembobius perscrutator	0	0	100	0	0
Hoplocryptus coxator	0	0	100	0	0
Phygadenon sp1	0	0	100	0	0
Orthizema sp	0	0	100	0	0
Hoplocryptus bellosus	0	0	100	0	0
Buathra laborator	0	0	100	0	0
Pterocryptus sp	0	0	100	0	0
Megacara sp	0	0	100	0	0
Megacara hortulana	0	0	100	0	0
Mesostenus sp	0	0	100	0	0
Ateleute linearis	0	0	100	0	0
Tycherus sp	0	0	100	0	0
Stenodontus meridionator	0	0	100	0	0
Stenodontus marginellus	0	0	100	0	0
Phaeogenes sp	0	0	100	0	0
Meringopus attentorius	0	0	100	0	0
Vulgichneumon deceptor	0	0	100	0	0
Ichneumon sp	0	0	100	0	0
Cryptus macellus	0	0	100	0	0

Table A6 Results from SIMPER analysis between Garmabdasth (orchard) and Souz javal (rangeland) on Ichneumonidae assemblages.

Taxa	Av. dissim	Contrib. %	Cumulative %	Mean Garmabdasht	Mean Souz javal
Trychosis legator	5.697	5.803	5.803	0.812	0
Aritranis director	5.502	5.605	11.41	1.15	0
Phygadenon sp2	5.324	5.423	16.83	0.631	0.143
Hemiteles rubropleuralis	5.035	5.129	21.96	0.286	0
Charitopes sp2	4.929	5.021	26.98	0.143	0.143
Ischnus alternator	4.47	4.553	31.54	0.143	0
Orthizema nigriventre	4.47	4.553	36.09	0.143	0
Hoplocryptus murarius	4.47	4.553	40.64	0.143	0
Idiolispa analis	4.012	4.087	44.73	0.807	0
Stibeutes tricinctor	3.716	3.785	48.51	0.778	0
Melanichneumon leucocheilus	3.153	3.212	51.73	0.429	0.143
Gelis sp1	2.517	2.564	54.29	0.143	0
Mesoleptus laticinectus	2.517	2.564	56.85	0.143	0
Apaeleticus inimicus	2.517	2.564	59.42	0.143	0
Misetus oculatus	2.517	2.564	61.98	0.143	0
Barichneumon sexalbatus	2.504	2.551	64.53	0	0.143
Gelis sp2	2.022	2.06	66.59	0.286	0.143
Myrmeleonostenus italicus	1.88	1.915	68.51	0	0.286
Cryptus vitrefrontalis	1.88	1.915	70.42	0	0.286
Aptesis jejunator	1.597	1.627	72.05	0	0.202
Endasys sp	1.566	1.595	73.65	0.286	0
Zoophthorus sp	1.493	1.521	75.17	0.345	0
Thaumatogelis sp	1.471	1.499	76.67	0	0.143
Charitopes areolaris	1.471	1.499	78.17	0	0.143
Polytribax perspicillator	1.471	1.499	79.66	0	0.143
Mesostenus sp	1.129	1.15	80.81	0	0.143
Hoplocryptus heliophilus	1.129	1.15	81.96	0	0.143
Phygadenon vexator	0.833	0.8486	82.81	0.143	0
Mastrus deminuens	0.833	0.8486	83.66	0.143	0
Vulgichneumon suavis	0.833	0.8486	84.51	0.143	0
Lochetica westoni	0.7602	0.7744	85.28	0.202	0
Arotrephes sp	0.7602	0.7744	86.06	0.202	0
Bathythrix pellucidator	0.7602	0.7744	86.83	0.202	0
Agrothereutes abbreviatus	0.7602	0.7744	87.61	0.202	0
Cratichneumon culex	0.751	0.765	88.37	0	0.143
Ichneumon sp	0.751	0.765	89.14	0	0.143
Charitopes sp1	0.751	0.765	89.9	0	0.143
Coelichneumon melanocastaneus	0.751	0.765	90.67	0	0.143
Cryptus inculator	0.751	0.765	91.43	0	0.143
Cryptus macellus	0.751	0.765	92.2	0	0.143
Aclastus solutus	0.751	0.765	92.96	0	0.143
Coelichneumon comitator	0.751	0.765	93.73	0	0.143
Stibeutes sp.	0.7329	0.7466	94.47	0.143	0
Mesostenus transfuga	0.7329	0.7466	95.22	0.143	0
Crypteffigies lanius	0.7329	0.7466	95.97	0.143	0
Coelichneumon nobilis	0.7329	0.7466	96.71	0.143	0
Sphecophaga vesparum	0.5375	0.5476	97.26	0.143	0
Lysibia nanus	0.5375	0.5476	97.81	0.143	0
Ichneumon sarcitorius	0.5375	0.5476	98.36	0.143	0
Stenichneumon culpator	0.5375	0.5476	98.9	0.143	0
Aritranis longicauda	0.5375	0.5476	99.45	0.143	0
Gelis bicolor	0.5375	0.5476	100	0.143	0
Aptesis flagitator	0	0	100	0	0
Xylophrurus sp	0	0	100	0	0
Hoplocryptus coxator	0	0	100	0	0
Phygadenon sp1	0	0	100	0	0
Orthizema sp	0	0	100	0	0
Hoplocryptus bellosus	0	0	100	0	0
Rhembobius perscrutator	0	0	100	0	0

Taxa	Av. dissim	Contrib. %	Cumulative %	Mean Garmabdasht	Mean Souz javal
Buathra laborator	0	0	100	0	0
Pterocryptus sp	0	0	100	0	0
Megacara sp	0	0	100	0	0
Megacara hortulana	0	0	100	0	0
Mastrulus marshalli	0	0	100	0	0
Cryptus titubator	0	0	100	0	0
Ateleute linearis	0	0	100	0	0
Tycherus sp	0	0	100	0	0
Stenodontus marginellus	0	0	100	0	0
Meringopus sp	0	0	100	0	0
Gelis vicinus	0	0	100	0	0
Diadromus collaris	0	0	100	0	0
Meringopus attentorius	0	0	100	0	0
Cryptus spiralis	0	0	100	0	0
Virgichneumon albosignatus	0	0	100	0	0
Dichrogaster sp	0	0	100	0	0
Ischnus migrator	0	0	100	0	0
Platylabops mimus	0	0	100	0	0
Obtusodonta equitatoria	0	0	100	0	0
Aritranis nigripes	0	0	100	0	0
Ichneumon molitorius	0	0	100	0	0
Ctenichneumon melanocastaneus	0	0	100	0	0