J. Entomol. Res. Soc., 25(2): 275-286, 2023
https://doi.org/10.51963/jers.2023.86

Research Article
Online ISSN:2651-3579

Composition and Structure of the Entomofauna of *Ferula* (*Ferula kuhistanica*) in Different Sections of the Zarafshan Ridge

Fazlitdin KHALIMOV[1*] Mukhammadtuichi RAKHIMOV[2] Rafik KHAMZAEV[3]
Erkin ABDULLAEV[4] Ulugbek USANOV[5]

[1]Gulistan State University, Faculty of Natural Sciences, 4th Microdistrict, Gulistan, 120100, UZBEKISTAN
[1,2,3,4] Samarkand State University, Faculty of Biology, Samarkand, University Boulevard 15, UZBEKISTAN
[5]Jizzakh Pedagogical Institute, Faculty of Natural Sciences, Jizzakh, Sh.Rashidov St.4, UZBEKISTAN
e-mails: [1]xalimov1968@list.ru, [2]muhammadtuychi@gmail.com, [3]xamzayev1988@mail.ru
[4]abdullayev.erkin.n@gmail.com, [5]Usanov0892@mail.ru
ORCID IDs: [1]0000-0003-0624-4586, [2]0000-0003-4098-8028, [3]0000-0003-2076-6356
[4]0000-0001-6142-7380, [5]0000-0002-1224-784X
*Corresponding author

ABSTRACT

The article analysis the species composition of the entomofauna of the Kuhistan ferula (*Ferula kuhistanica*) in different parts of the Zarafshan ridge. The study revealed 115 species of insects belonging to 92 genera, 48 families, and eight orders. The identified species belong to the following orders: Thysanoptera (1 species), Neuroptera (3 species), Homoptera (1 species), Hemiptera (17 species), Coleoptera (36 species), Lepidoptera (5 species), Hymenoptera (14 species) and Diptera (38 species). By the nature of the relationship with the ferula, the entomofauna is divided into six ecological groups. Phytophages, including four ecological groups, accounted for 36.5% (42 species), pollinators 49.6% (57 species) and entomophagous 13.9% (16 species). A comparative analysis of the diversity of entomofauna in different parts of the Zeravshan Range was carried out, and a dendrogram of the similarity of the entomofauna of the studied territories was compiled. The horizontal and vertical isolation of the entomofauna was revealed. The most peculiar in the composition is the entomocomplex of ferula on the highest site of Saridukon. The daily activity of pollinating insects was analysed.

Keywords: Biodiversity, entomophagous, phytophagous, pollinators, Syrphidae.

Khalimov, F., Rakhimov, M., Khamzaev, R., Abdullaev, E., & Usanov, U. (2023). Composition and structure of the entomofauna of *Ferula* (*Ferula kuhistanica*) in different sections of the Zarafshan Ridge, *Journal of the Entomological Research Society*, 25(2), 275-286.

Received: May 12, 2022 *Accepted: April 04, 2023*

INTRODUCTION

Uzbekistan is very rich in medicinal plants, which have been widely used in folk medicine to treat many ailments since ancient times. More than 750 species of such plants grow on the republic's territory, among which representatives of the umbellifer family (Apiaceae) (119 species) prevail. At present, studies of the natural stock, cultivation on an industrial scale, and factors affecting the number and productivity of medicinal plants are gaining importance (Belolipov, Arabova, Ravshanov, & Buriyeva, 2015).

Some of the valuable medicinal plants are species of the genus Ferula. In many countries globally, various types of ferula are successfully used to treat many diseases (Iranshahy & Iranshahi, 2011; Mahendra & Bisht, 2012). In addition, *Ferula* has antioxidant (Ben Salem, Jabrane, Harzallah-Skhiri, & Ben Jannet, 2013*),* antiviral (Nazari & Iranshahi, 2011), antifungal (Kavoosi, Tafsiry, Ebdam, & Rowshan, 2013*),* and anti-diabetic (Abu-Zaiton, 2010) effects. The dried surface parts of *Ferula* (*Ferula ovina*) can be incinerated to fight the Varroa destructor mite, a dangerous parasite of bees (Shahram, Nozari, & Hosseininaveh, 2016).

Fifteen species of plants of this genus grow on the Zaravshan ridge, among which nine species are monocarpic (they bloom or bear fruit only once during their life) (Khakimzhonov, 2020). Such monocarpic species include the Ferula kuhistanica Korovin, widespread in Central Asia. This species is a perennial herb with large leaves, which are widely used as fodder and as a medicinal plant. Therefore, the demand for this plant's raw material is increasing from year to year. This led to the intensification of research on studying the plant's botanical properties and preserving its natural resources (Mukumov, Amriddinova, & Khuzhakulov, 2020).

The biological productivity of such plants largely depends on several environmental factors, among which insects are one of the most important. On the one hand, insects, as pests, cause severe damage to plants. On the other hand, pollinating insects are an essential factor in ensuring the reproduction of offspring. At present, the entomofauna of the *Ferula* is insufficiently studied. The literature data do not fully cover this issue. The available data mainly relate to the desert regions of Central Asia. In particular, VP Nevsky mentions ten species of insects closely related to plants of the stinking ferula (*Ferula assa-foetida*) in the Konimex Desert (Nevsky, 1953), and 11 species on the territory of Betpokdala (Serkova, 1958).

The entire complex of the entomofauna of the Zarafshan Range has been insufficiently studied. However, in recent years, an intensive study of individual elements of the entomofauna of this territory has been carried out, particularly syrphid flies (Rakhimov, 2021) and ground beetles (Khalimov, 2020, 2023; Zokirova & Khalimov, 2022).

Particular studies on the entomocomplex of the *Ferula assa-foetida* L. and *Ferula kyzylkumica* K. were carried out in the conditions of Southwest Kyzylkum, and more than 50 species of insects associated with these plants were identified (Davletshina & Radzivilovskaya, 1965). There are also some data on Northern

Turkmenistan and the Aydar-Arnasai lake system (Soyunov, Kamalov, & Jallieva, 1988; Avalbaev, Usanov, Umirov, & Zoirova, 2020).

However, for other regions of the world, there are some detailed studies on the role of insects in the pollination of plants from the family Apiaceae (Lindsey, 1984; Lindsey & Bell, 1985; Lamborn & Ollerton, 2000; Zych, 2002; Rovira, Bosch, Molero, & Blanche, 2004), in particular, representatives of the genera *Thaspium* and *Zizia* (Lindsey, 1984; Lindsey & Bell, 1985) and *Daucus carota* (Lamborn & Ollerton, 2000).

On the hogweed (*Heracleum sphondylium* L.), 108 species of insects were found to visit the flowers among them, medium-sized flies *Eriozona syrphoides* and *Lucilia* spp. are noted as the most effective pollinators (Zych, 2007).

The flowers of the endangered European *Ostericum palustre* Besser (Apiaceae) are visited by more than 81 anthophilous insect species and the plant is thought to be mainly pollinated by large Diptera, which are often responsible for over 90% of the total pollination (Zych, Michalska, & Krasicka-Korczyńskal, 2014). And on the flowers of Angelica sylvestris (Apiaceae), the majority of insect visits (70–91%) were made by Diptera (muscoid flies and Syrphidae) and beetles (Zych, Junker, Nepi, Stpiczynska, Stolarska, & Roguz, 2019).

MATERIAL AND METHODS

The research was carried out in 2017-2020 at 10 points of the Zarafshan ridge: Kumbelsay (39°20’ N 67°19’ E) (1400-1800 m above sea level), Saridukan pass (39°19’ N 67°11’ E) (2300-2600 m), Kamangaransay (39°22’ N 67°11’ E) (1500-2000 m), Sariktepasay (39°21’ N 67°07’ E) (1400-1900 m), Ettuilisay (39°26’ N 66°59’ E) (1100-1300 m), Takhtakaracha pass (39°18’ N, 66°53’ E) (1700-2000 m); Amankutan (39°18’ N 66°57’ E) (1400-1500 m), Ayrikoya village (39°18’ N, 66°53’ E) (1400-2000 m), Agalyksay (39°27’ N 66°49’ E) (1000-1900 m) (northern slope of the ridge) and Bashyr (39°16’ N 67°06’ E) (1000-1200 m) (southern slope of the ridge) (Fig. 1).

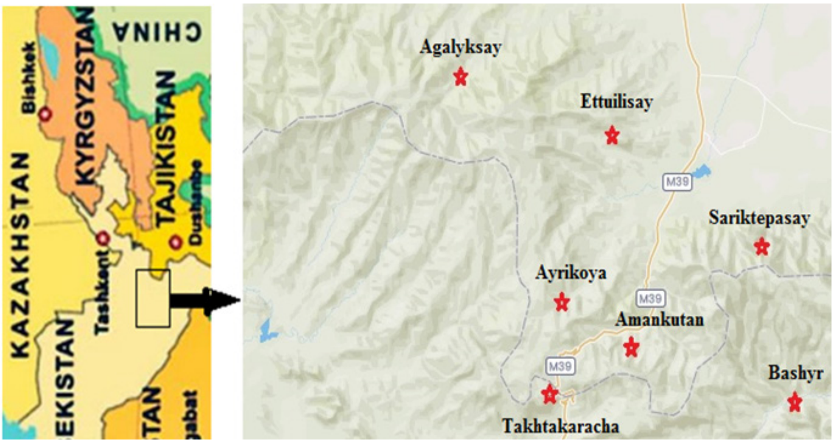

Figure 1. Map of the research area.

The study was carried out in 2018-2021 during the growing season of *F. kuhistanica* (from March to August). Materials were collected using general entomological methods: larger and less active insects were collected manually, agile, fast-flying insects were collected with an entomological net, and small insects were collected with an exhauster. During the collection, the lifestyle and behavior of individuals of significant species were studied.

To study the role of pollinators, a quantitative analysis of insects that arrived at the plants was carried out. Accounting was carried out on three plots of different heights (Ettiuilisay, Takhtakaracha and Saridukon) on different dates depending on the ferula flowering period (3 times: at the beginning, at the peak and at the end of flowering). Recording dates: at the Ettiuilisay site - 25.03.2019, 9.04.2019, 8.05.2019; at the Takhtakaracha section - 1.04.2019, 14.04.2019, 13.05.2019; at the Saridukon site on 15.05.2019, 1.06.2019, 1.07.2019. The counts were carried out three times a day (9:00, 12:00 and 17:00).

To study the daily activity of syrphid flies for 10 minutes at the beginning of each hour of the day, the visit of syrphid to ferula flowers was taken into account. The counts were carried out during the period of mass flowering of plants from 6:00 to 18:00 days in three repetitions. The results of these counts are presented in Figure 2.

A comparison of the entomocomplex of the studied areas was carried out based on the Chekanovsky-Sørensen coefficient (Dunaev ,1997). The Chekanovsky-Sørensen coefficient was calculated using the formula $Cs = 2j / (a + b)$, where: *Cs*-Chekanovsky-Sørensen coefficient; *j*- is the number of species common to two biotopes; *a* and *b* - the number of species in the compared biotopes.

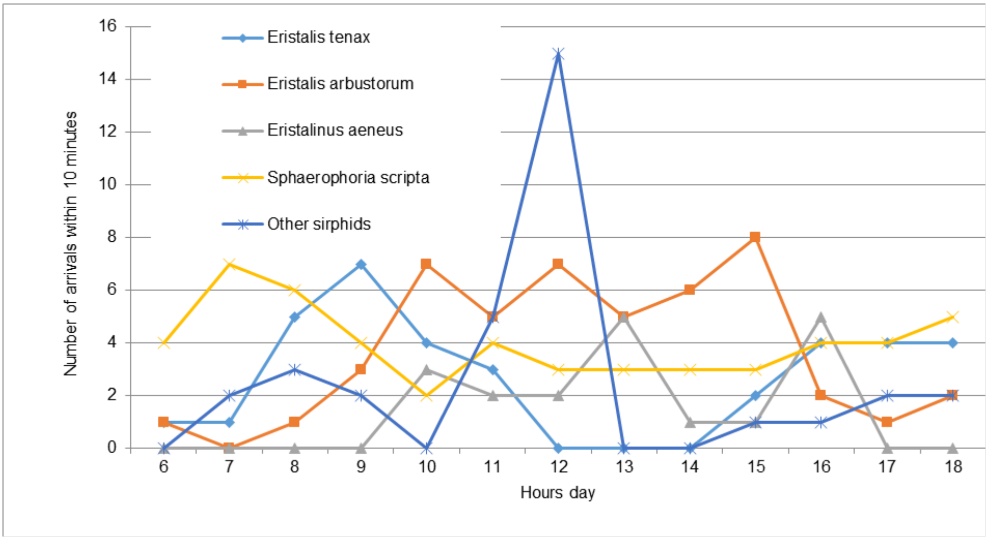

Figure 2. Diurnal dynamics of Syrphidae on *Ferula kuhistanica*.

RESULTS AND DISCUSSION

One hundred fifteen species of insects have been identified that are somehow associated with the ferula. The identified species belong to 8 orders: Thysanoptera (1 species), Neuroptera (3 species), Homoptera (1 species), Hemiptera (17 species), Coleoptera (36 species), Lepidoptera (5 species), Hymenoptera (14 species), and Diptera (38 species). We conditionally divided these insects into three ecological groups, depending on their relationship with the ferula: phytophages (feeding on different parts of plants), pollinators, and entomophagy (Table 1). It should be noted that many pollinators are phytophages, but their harm is not perceptible to plants (Fengri & van der Peil, 1982).

Table 1. Species composition of the entomofauna *Ferula kuhistanica* L.

Ordo	Family	Species
PHYTOPHAGES FEEDING ON ROOTS AND STEM		
Hemiptera	Pentatomidae	*Carpocoris purpureipennis* (De Geer, 1773)
	Thripidae	*Tenothrips frici* Uzel, 1895
Coleoptera	Scarabaeidae	*Protaetia (Netocia) turkestanica* (Kraatz, 1886)
	Buprestidae	*Anthaxia anatolica lucidiceps* Gory 1841
		Anthaxia plavilschikovi Obenb. 1935
	Cerambycidae	*Plocaederus scapularis* Fischer, 1821
	Curculionidae	*Cyphocleonus tigrinus* (Panzer, 1789)
		Mecaspis alternans (Herbst, 1795)
		Lixus capiomonti Faust, 1883
LEAF-FEEDING PHYTOPHAGOUS		
Homoptera	Aphididae	*Dysaphis* sp.
	Pentatomidae	*Antheminia lunulata* (Goeze, 1778)
		Dolycoris penicillatus Horvath, 1904
		Dolycoris varicornis montandoni Sienkiewicz, 1954
Hemiptera	Miridae	*Dicyphus orientalis* Reuter, 1879
		Orthop campestris (Linnaeus, 1758)
	Tingitidae	*Tingis cardui* Linnaeus, 1758
	Myodochidae	*Lygaeus equestris* (Linnaeus, 1758)
	Coreidae	*Corpus* sp.
Coleoptera	Chrysomelidae	*Ichyronota conicicollis* Weise, 1890
Lepidoptera	Nymphalidae	*Melitaea acareina* Staudinger, 1886
	Noctuidae	*Autographa gamma* (Linnaeus, 1758)
FLOWER-EATING PHYTOPHAGOUS		
Hemiptera	Pentatomidae	*Grafosoma lineolatum* (Linnaeus, 1758)
Coleoptera	Scarabaeidae	*Oxythyrea cinctella* (Schaum, 1841)
		Cetonia trojan Gory & Percheron, 1833
	Staphylinidae	*Omalium rivulare* (Payk., 1789)
		Stenus sp.
	Nitidulidae	*Meligethes* sp.
	Meloidae	*Mylabris frolovi* Germar, 1824
		Mylabris magnoguttata (Heyden, 1881)
		Meloe violaceus Marsham, 1802
		Teratolytta pilosella (Solsky, 1881)
		Cerocoma schreberi (Fabricius, 1781)
		Rhampholyssa antennata Reitter, 1906
		Aloysius syriacus (Linnaeus, 1758)

Ordo	Family	Species
Coleoptera	Alleculidae	*Omophlus curtus* Kuster, 1850
		Omophlus deserticola (Kirsch, 1869)
	Mordellidae	*Mordella aculeata* Linnaeus, 1758
	Prionoceridae	*Lobonyx* sp.
	Cerambycidae	*Agapanthus soror* Kraatz, 1882
	Elateridae	*Lacon funebris* (Solsky, 1881)
SEED-FEEDING PHYTOPHAGOUS		
Hemiptera	Myodochidae	*Ryparochromus quadratus* (Fabricius, 1798)
	Coreidae	*Camptopus lateralis* (Germar, 1817)
POLLINATORS		
Coleoptera	Canthariididae	*Cantharis forticornis* Heyden, 1885
		Cantharis livida Linnaeus, 1758
	Dermestidae	*Paranovelsis quadricolor* (Sumakov, 1907)
		Attagenus pictus Ballion, 1871
	Cleridae	*Trichodes axillaris* Fischer de Waldheim, 1842
	Melyridae	*Malachius bipustulatus* (Linnaeus, 1758)
Lepidoptera	Lycaenidae	*Tomares callimachus* (Eversmann, 1848)
	Nymphalidae	*Argynnis paphia* (Linnaeus, 1758)
		Satyrus sp.
Hymenoptera	Crabronidae	*Crabro albilabris* Fabricius, 1793
		Ectemnius fossorius (Linnaeus, 1758)
	Andrenidae	*Andrena carbonaria* (Linnaeus, 1767)
		Andrena sp.
	Megachilidae	*Megachile apicalis* Spinola 1808
		Anthidium sp.
		Coelioxys sp.
	Pompilidae	*Agenioideus apicalis* (Vander Linden, 1827)
	Vespidae	*Polistes dominula* (Christ, 1791)
	Apidae	*Anthophora semperi* Fedtschenko 1875
	Halictidae	*Halictus* sp.
Diptera	Syrphidae	*Episyrphus balteatus* (De Geer, 1776)
		Eupeodes corollae (Fabricius, 1794)
		Eupeodes nuba (Wiedemann, 1830)
		Scaeva albomaculata (Macquart, 1842)
		Scaeva latimaculata (Brunetti, 1923)
		Scaeva pyrastri (Linnaeus, 1758)
		Spaerophoria scripta (Linnaeus, 1758)
		Sphaerophoria rueppellii (Wiedemann, 1830)
		Syrphus vitripennis Meigen, 1822
		Xanthogramma hissarica Violovitsh, 1975
		Chrysotoxum bacterium Violovitsh, 1973
		Chrysotoxum vernale Loew, 1841
		Melanostoma mellinum Linnaeus, 1758
		Platycheirus ambiguus Fallén, 1817
		Paragus bicolor (Fabricius, 1794)
		Paragus haemorrhous Meigen, 1822
		Paragus tibialis (Fallén, 1871)
		Paragus quadrifasciatus Meigen, 1822
		Pipizella mesasiatica Stackelberg, 1952
		Cheilosia aerea Dufour 1848

Ordo	Family	Species
Diptera	Syrphidae	*Cheilosia lola* Zimina, 1970.
		Cheilosia stackelbergi Barkalov & Peck, 1994
		Chrysogaster musatovi Stackelberg, 1952
		Chrysogaster tadjikorum Stackelberg, 1952
		Eumerus aristatus Peck, 1969
		Eumerus coeruleus (Becker, 1913)
		Eumerus kondarensis Stackelberg, 1952
		Eumerus pamirorum Stackelberg, 1949
		Eumerus ursiculus Stackelberg, 1949
		Merodon tarsatus Sack, 1913
		Eristalis (Eoseristalis) arbustorum (Linnaeus, 1758)
		Eristalis (Eristalis) tenax (Linnaeus,1758)
		Myathropa semenovi (Smirnov, 1925)
		Syritta pipiens (Linnaeus, 1758)
	Bibionidae	*Bibio hortulanus* (Linnaeus, 1758)
	Scatophagidae	*Scatophaga stercoraria* Linnaeus, 1758
	Calliphoridae	*Calliphora erythrocephala* Macquart, 1834
ENTOMOPHAGOUS		
Hemiptera	Anthocoridae	*Orius niger* Wolff, 1841
	Nabidae	*Nabis maracandicus* Reuter, 1890
		Nabis palifer Seidenstucker, 1954
	Reduviidae	*Rhynocoris iracundus* (Poda, 1761)
		Coranus aegyptius (Fabricius, 1775)
Neuroptera	Ascalaphidae	*Ascalaphus macaronius* (Scopoli, 1763)
	Chrysopidae	*Chrysopa vulgaris* Schneider, 1851
		Chrysopa abbreviate Curtis, 1834
Coleoptera	Coccinellidae	*Coccinella septempunctata* Linnaeus, 1758
		Hippodamia variageta (Goeze, 1777)
		Adalia bipunctata (Linnaeus, 1758)
	Carabidae	*Poecilus liosomus* Chaudoir,1876
Hymenoptera	Braconidae	*Microplitis spinolae* (Nees, 1834)
	Ichneumonidae	*Ophion luteus* (Linnaeus, 1758)
	Sphecidae	*Sphex* sp.
Diptera	Asilidae	*Satanas gigas* (Eversmann, 1855)

As the results show, the species diversity of the ferula entomocomplex on different parts of the ridge, depending on the biotope and altitude above sea level, differs significantly (Table 2). The most diverse species composition is the biotopes of Amankutan (1400-1500 m above sea level) (82 species). The main reason for this diversity is, most likely, the hydrological regime of the area, since these biotopes are the most hydrated compared to other biotopes. The smallest diversity of the ferula entomofauna was noted in the biotopes of Sariktepasai (1400-1900 m) and Airikoya (1400-2000 m) (37 species each).

As reported in the literature, the formation of entomfauna depends on both the vertical and horizontal isolation of biocenoses. To find out which of them is primary in the formation of the entomocomplex of the ferula, we grouped the studied biotopes by height and latitude. Three zones were distinguished by height: low (1000-1400 m above sea level), medium (1400-2000 m above sea level), and high

(2000-2600 m above sea level). The following are identified horizontally: Northern Chakalikalyan (sections Kumbelsay, Saridukon, Kamangaransay, Sariktepasay), Karatepa (sections Takhtakaracha, Amankutan, Airikoya, Ettiuilisay and Agalyksay) and South Chakalikalyan (section Bashyr). We proceeded from the fact that if the entomocomplex of the ferula will differ to a greater extent in vertical zones, then in the formation of the entomocomplex of the ferula of the Zarafshan ridge, vertical zoning is more pronounced, and if the entomocomplex of the ferula will differ to a greater extent in the horizontal zones, then the formation of the entomocomplex of the ferula is characteristic of (mosaic). Conventionally considering each site as one biotope, the Chekanovsky-Sørensen coefficient was used for a comparative analysis of entomocomplexes (Table 3).

Table 2. Diversity of the ferula entomocomplex (number of species) in different parts of the Zarafshan ridge (The relative abundance of species is calculated on the basis of the proportion of species of a particular point from the total number of species).

The main components of the entomofauna	Total	Kumbelsay	Saridukan pass	Kamangaransay	Sariktepasay	Ettuilisay	Takhtakaracha pass	Amankutan	Ayrikoya village	Agalyksay	Bashyr
Phytophages	42	21	26	25	18	21	32	36	22	29	33
Pollinators	57	15	36	18	14	19	28	37	11	21	29
Entomophagy	16	6	9	5	5	5	6	9	4	4	9
Total species	115	42	71	48	37	45	66	82	37	54	71
Relative abundance of species,%	100	36.5	61.7	41.7	32.2	39.1	57.4	71.3	32.2	47.0	61.7

Table 3. Similarity coefficient of the ferula entomocomplex at ten sites of the Zarafshan Range (Chekanovsky-Sørensen coefficient / number of common species).

Sites	Kumbelsay	Saridukan pass	Kamangaransay	Sariktepasay	Ettuilisay	Takhtakaracha pass	Amankutan	Ayrikoya village	Agalyksay	Bashyr
Kumbelsay		25	29	25	23	33	39	20	21	24
Saridukan pass	0.44		29	25	20	38	41	21	23	23
Kamangaransay	0.64	0.49		35	25	32	43	23	16	28
Sariktepasay	0.63	0.46	0.82		26	27	30	20	21	25
Ettuilisay	0.53	0.35	0.54	0.63		39	44	26	35	22
Takhtakaracha pass	0.61	0.56	0.56	0.52	0.70		56	35	31	34
Amankutan	0.63	0.54	0.66	0.50	0.69	0.76		36	30	33
Ayrikoya village	0.51	0.39	0.54	0.54	0.63	0.68	0.61		32	25
Agalyksay	0.44	0.37	0.31	0.46	0.71	0.52	0.44	0.70		19
Bashyr	0.43	0.32	0.47	0.46	0.38	0.50	0.43	0.46	0.30	

The analysis showed that the most remarkable similarity of the entomofauna of the ferula is observed between the sites of Sariktepasai and Kamangaransay (0.82) and between the Takhtakaracha Pass and Amankutan (0.76). The entomofauna of the Bashyr site is peculiar since the least similarity was observed here compared to the sites Agalyksay (0.30) and Saridukon Pass (0.32). For clarity of the results obtained, based on the Chekanovsky-Sørensen coefficient, a dendrogram was drawn up (Fig. 2).

Analyzing the obtained data, it can be concluded that for the formation of the entomocomplex of the ferula, horizontal zoning is more important than vertical zoning. Thus, the areas of Northern Chakalikalyan (Kumbelsai, Kamangararansay, Sariktepasai) are similar in the composition of the entomofauna (the exception is the Saridukon area), while the Karatepa areas (Takhtakaracha, Amankutan, Airikoya, Ettiuilisay and Agalyksai differ significantly from them. The entomocomplex of the ferula of South Chakalikalyan (Bashyr) is isolated. However, one cannot ignore the fact that vertical zoning also significantly affects the formation of entomofauna. So, for example, the ferula entomocomplex at the highest research site (Saridukon) turned out to be the most peculiar and significantly differs even from the neighboring areas of Northern Chakalikalyan (Fig. 2).

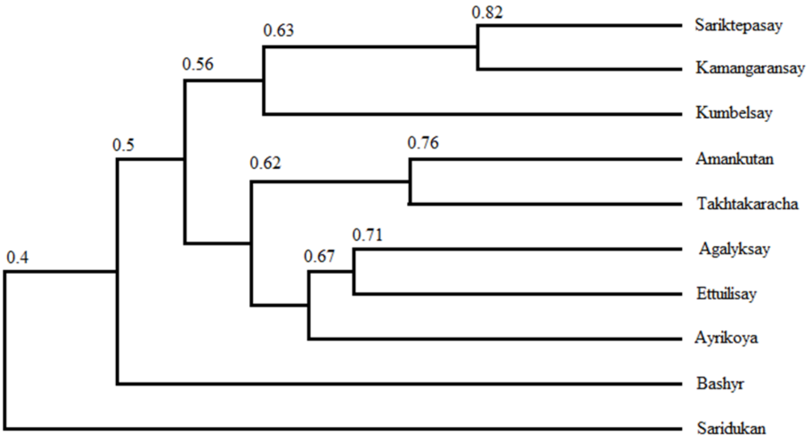

Figure 2. Dendrogram of the similarity of the ferula entomocomplex in different parts of the Zarafshan Range, built using the UPGMA method based on the Czekanowski-Sørensen coefficient.

In recent years, as mentioned above, in the Republic of Uzbekistan, due to the significant interest in medicinal plants, there has been an expansion of ferula crops on agricultural land in the foothills (Republic of Uzbekistani, 2020). In this regard, many questions arise on the cultivation and cultivation of this valuable medicinal plant, one of which is the need to study saw-sawing insects, which play an essential role in seed reproduction.

To elucidate the activity of individual groups of insects in the pollination of ferula flowers, we selected three stationary sites (Ettiuilisay, Takhtakaracha, and Saridukon). In these plots, three times a day (900, 1200, and 1700) for 30 minutes, the number of insects that arrived or were on the flowers of the ferula were caught and counted. The experiments were carried out three times per season: at the beginning of flowering plants, after two weeks, and after 45 days. Although the results will be relative, they may well be suitable for comparing the number and activity of different pollinating insects (Faegri & van der Pijl, 1982).

The results show that representatives of the families Crabronidae and Megachilidae from the order Hymenoptera and the family Syrphidae from the order Diptera are numerous in all research areas. Together, these three families make up 60% of all pollinators (Table 4).

Table 4. The composition and activity of pollinating insects in the Kuhistan ferula (the number of insects that arrived every 30 minutes)As can be seen from the table, the number of pollinating insects decreases in the order of Hymenoptera - Diptera –Coleoptera –Hemiptera –Lepidoptera.

Main groups of pollinators		Research sites						A total of three sites	
		Ettiuilisay		Takhtakaracha		Saridukon			
		number of visits	%	number of visits	%	number of visits	%	number of visits	%
Hemiptera		0.67	0.98	5.0	4.75	0.67	2.11	6.33	3.08
Coleoptera		3.33	4.9	16.7	15.8	3.33	10.5	23.3	11.4
Lepidoptera		0.33	0.49	1.67	1.58	2.0	6.33	4.0	1.95
Diptera	Syrphidae	9.0	13.2	9.33	8.86	14.7	46.3	33.0	16.1
	others	3.33	4.9	6.67	6.33	8.33	26.4	18.33	8.94
Hymenoptera	Crabronidae	21.7	31.9	33.0	31.3	1.67	5.26	56.3	27.5
	Megachilidae	11.3	16.7	22.3	21.2	-	-	33.7	16.4
	Andrenidae	6.67	9.8	2.0	1.9	-	-	8.67	4.23
	others	11.7	17.2	8.67	8.23	1.0	3.16	21.3	10.4
Total		68.0	100	105.3	100	31.7	100	205.0	100

However, it should be noted that the effectiveness of pollinators depends not only on their number but also on their behavior. For example, due to the absence or paucity of hairs on the body, many bugs and beetles are of little importance in plant pollination (Faegri & van der Pijl, 1982).

The ferula has several inherent characteristics that create the conditions for the effectiveness of many pollinators. Firstly, the perianth of the ferula is not very deep, which facilitates access to nectar, especially for many dipterans. Secondly, the flowers of the ferula are yellow light, which is attractive to many insects. Another feature of the ferula is its smell, which attracts pollinators, saprophages, and necrophages. Therefore, on the ferula, you can always find many different insects.

Pollinator activity changes significantly during the day. We have studied the daily activity of pollinating insects using the example of Diptera species from the family Syrphidae (Fig. 2).

Studies show that different types of syrphids are active at different times of the day. For example, the species Sphaerophoria scripta and Eristalis tenax are more active in the morning and afternoon. The Eristalis arbustorum species is most active from 10:00 to 15:00 hours. In general, many species of hoverflies are most active by 12:00 hours of the day. The activity of the ferula pollinators is significantly influenced by illumination, temperature, and wind speed, which requires special additional study.

REFERENCES

Abu-Zaiton, A. S. (2010). Anti-diabetic activity of Ferula assafoetida extract in normal and alloxan-induced diabetic rats. *Pakistan Journal of Biological Sciences*, 13(2), 97-100.

Avalbaev, O.N., Usanov, U.N., Umirov, N.U., & Zoirova, K.A. (2020). Aydar-Arnasoy ko'llar tizimi atrofida tarqalgan *Ferula* L. turkumi turlarining zararkunandasi [Pest of *Ferula* L. species distributed around the Aydar-Arnasay lake system]. *Life Sciences and Agriculture*, 2(1), 24-27. [in Uzbek].

Belolipov, I.V., Arabova, N.Z., Ravshanov, D.G., & Buriyeva, Kh.P. (2015). Natural flora of Uzbekistan as sources for new medicinal products-botanical nutraceuticals. *International academic bulletin*, 3(9), 9-11.

Ben Salem, S., Jabrane, A., Harzallah-Skhiri, F., & Ben Jannet, H. (2013). New bioactive dihydrofurano-coumarins from the roots of the Tunisian *Ferula lutea* (Poir.) *Maire/ Bioorganic and Medicinal Chemistry Letters*, 23(1), 4248-4252.

Davletshina, A.G. & Radzivilovskaya, M.A. (1965). Entomofauna kavraka [Entomofauna of ferula]. *Uzbek Biological Journal*, 1, 57-62. [in Russian].

Dunaev, E.A. (1997). *Metodyi ekologo-entomologicheskih issledovaniy [Methods of ecological and entomological research].* MosgorSYUN, Moskow [in Russian].

Faegri, K. & van der Pijl, L. (1982). *Osnovyi ekologii opyileniya [Fundamentals of pollination ecology]*. Moscow, Mir, 380 p. [in Russian].

Iranshahy, M. & Iranshahi, M. (2011). Traditional uses, phytochemistry, and pharmacology of asafoetida (*Ferulaassa-foetida* oleo-gum-resin) - a review. *Journal of Ethnopharmacology*, 134(1), 1-10.

Kavoosi, G., Tafsiry, A., Ebdam, A. A., & Rowshan, V. (2013). "Evaluation of antioxidant and antimicrobial activities of essential oils from *Carum copticum* Seed and *Ferula assafoetida* latex, *Journal of Food Science*, 78(2), 356-361.

Khakimzhonov, L.S., Mukumov, I.U., & Rasulova, Z.A. (2020). The genus *Ferula* L. in the flora of the Zarafshan Range. *International scientific journal "Bulletin of Science",* 3(24), 111-116.

Khalimov, F. (2020). The ground beetles (Coleoptera, Carabidae) of the Karatepa and Chakilkalyan mountains (west part of Zarafshan Mountains Range, Uzbekistan). *Biosystems Diversity*, 28, 265-271. https://doi.org/10.15421/012035

Khalimov, F. (2023). Composition and structure of the fauna of ground beetles (Coleoptera, Carabidae) of the Zerafshan Range. *Acta Biologica Sibirica*, 9, 113-125. https://doi.org/10.5281/zenodo.7725474

Lamborn, E. & Ollerton, J. (2000). Experimental assessment of the functional morphology of inflorescences of Daucus carota (Apiaceae): testing the 'fly catcher effect'. *Functional Ecology, 14, 445-454.*

Lindsey, A. H. (1984). Reproductive biology of Apiaceae. I. Floral visitors to *Thaspium* and *Zizia* and their importance in pollination. *American Journal of Botany,* 71, 375-387.

Lindsey, A. H. & Bell, C. R. (1985). Reproductive biology of Apiaceae. II. Cryptic specialization and floral evolution in *Thaspium* and *Zizia*. American Journal of Botany, 72, 231-247.

Mahendra P. & Bisht S. (2012). *Ferula asafoetida*: Traditional uses and pharmacological activity. *Pharmacognosy Reviews*, 6(12), 141-146.

Mukumov, I.U., Amriddinova, D.Zh., & Khuzhakulov, D. (2020). Rod *Ferula* (*Ferula* L.) vo flore Kashkadarinskoy oblasti [The genus *Ferula* (*Ferula* L.) in the flora of the Kashkadarya region]. *International scientific journal "Bulletin of Science",* 1(22), 275-284 [in Russian].

Nazari, Z. E. & Iranshahi, M. (2011). Biologically active sesquiterpene coumarins from *Ferula* species. *Phytotherapy Research*, 25(3), 315-323.

Nevsky, V.P. (1953). Entomofauna of the Kenimeh desert. *Proceedings of the Institute of Zoology and Parasitology of the Academy of Sciences of the UzSSR*, 1, 123-153.

Republic of Uzbekistan. (2020). On measures for the protection, cultivation, processing of wild medicinal plants and the rational use of available resources. *Resolution of the President of the Republic of Uzbekistan*. No. PP-4670, 10.04.2020.

Rakhimov, M.R. (2021). To the fauna of hoverflies (Diptera, Syrphidae) of the Zarafshan Range. *Bulletin of the Khorezm Academy of Mamun*, 1, 49-54. [in Russian]

Rovira, A. M., Bosch, M., Molero, J., & Blanche´, C. (2004). Pollination ecology and breeding system of the very narrow coastal endemic Seseli farrenyi (Apiaceae). Effects of population fragmentation. *Nordic Journal of Botany*, 22, 727-740.

Serkova, L.G. (1958). Nasekomyie – vrediteli trav Betpakdalinskih pastbisch [Insects are pests of grasses of Betpakdala pastures]. *Proceedings of the Kazakh Institute of Plant Protection*, 4, 104-129 [in Russian].

Shahram, D., Nozari, J., & Hosseininaveh, V. (2016). The study on *Ferula ovina* fumigation to control *Varroa destructor* (Acari: Varroidae), a severe pest of *Apis mellifera* (Hymenoptera: Apidae). *Persian Journal of Acarology*, 5(4), 355-358.

Soyunov, O.S., Kamalov, K.K., & Jallieva, K.R. (1988) Entomokompleks na chomuche (*Ferula litwinowiana*) v Zaunguzkih Karakumah [Entomocomplex on chomuche (*Ferula litwinowiana*) in Zaunguz Karakum]. *Entomokopleksy deserts of Northern Turkmenistan*. Ashgabat, 46-56. [in Russian].

Zokirova, D.F. & Khalimov, F.Z (2022). Morphometric features of the beetle *Acinopus* (*Acinopus*) *laevigatus* Menetries, 1832 (Coleoptera, Carabidae) in the mountain ecosystems of Uzbekistan. *Bulletin of the Iraq natural History Museum,* 17(2), 141-153. https://doi.org/10.26842/binhm.7.2022.17.2.0141

Zych, M. (2002). Pollination biology of *Heracleum sphondylium* L. (Apiaceae). The advantages of being white and compact. *Acta Societatis Botanicorum Poloniae,* 71, 163-170.

Zych, M. (2007). On flower visitors and true pollinators: The case of protandrous *Heracleum sphondylium* L. (Apiaceae). *Plant Systematics and Evolution*, 263, 159-179. https://doi.org/10.1007/s00606-006-0493-y

Zych, M., Michalska, B., & Krasicka-Korczyńska, E. (2014). Myophily in the critically endangered umbelliferous plant *Ostericum palustre* Besser (Apiaceae). *Plant Systematics and Evolution*, 300, 187-196. https://doi.org/10.1007/s00606-013-0870-2

Zych, M., Junker, R.R., Nepi, M., Stpiczynska, M., Stolarska, B., & Roguz, K. (2019). Spatiotemporal variation in the pollination systems of a supergeneralist plant: is *Angelica sylvestris* (Apiaceae) locally adapted to its most effective pollinators? *Annals of Botany,* 123(2), 415-428. https://doi.org/10.1093/aob/mcy140