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Fluorosenotypes of Phlomoides Moench Species Distributed in the Fergana Valley: Central Asia

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Abstract---*This article presents the results of targeted field research in the Fergana Valley in 2020-2021 and the analysis of the literature, the belonging of Phlomoides species to 15 florocenotypes, and the level of activity of each species based on their phytogeographic, ecological, phytocenotic range. In this case, the species are divided into 4 groups: the most active, active, moderately active and passive species. The interdependence of existing florocenotypes was prepared based on the program UPGMA (version 3.22) and their analysis is presented.*
Keywords---*Fergana valley, florotsenotype, phlomoides, phytocenocycle, species activity*

Introduction

The composition and structure of plant communities are determined by the specific ecological conditions formed during the historical development of the region. They are characterized by a set of climatic, edaphic, orographic, geological, hydrological conditions of the external environment. The florocenotype of plants is a historical developmental process of plant communities that exist in a particular area, interact with other species of plants, but are objectively independent, maintaining their characteristics and changing their habitat in a specific way (Kamelin, 2002). The florocenotypes combines the concepts of "flora" and "plant", while evolution, florocenotypes are formed that reflect the ways of ecological and phytocenotic differentiation of flora (Safarov, 2018).

Natural territories of the Fergana valley (Bondarenko, 1950; Arifkhanova, 1967; Rakhimova & Vernik, 1982; Tojibaev et al., 2018; Karimov, 2016), conducted a lot of floristic and geobotanical studies, in which no specific targeted research on the florocenotypes of species of the family Phlomoides distributed in the valley. We aimed to shed light on the relationship between plant species by determining the level of activity of the specific species in florocenotypes.

Materials and Methods

In determining the affiliation of species to florocenotypes, along with national and foreign literature, herbarium materials stored in appropriate funds (LE, TASH, FRU, MW) were used effectively. The distribution of Phlomoides species in the Fergana Valley by florocenotypes is based on the classification used by Arifkhanova (1967), to describe the vegetation of the Fergana Valley and the latest classification of florocenotypes proposed by Kamelin (1979), for Central Asia. Determination of the level of activity of species on florocenotypes was carried out based on the classification used by Karimov (2019). The interrelationships between florocenotypes were prepared using UPGMA (version 3.22), and a topographic map of the Fergana Valley was prepared using ArcGIS 10.0.

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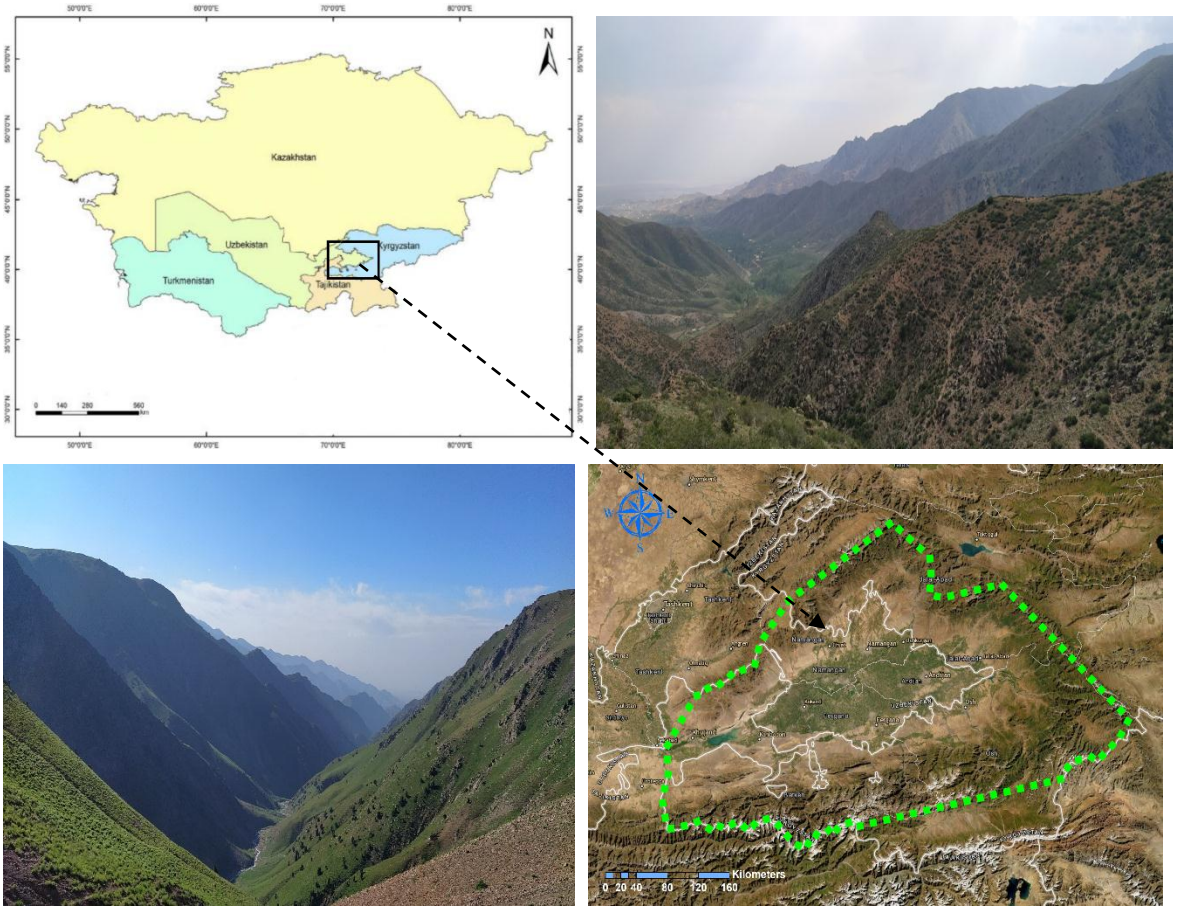

Figure 1. Topography of the Fergana Valley

Map of the Fergana Valley for the administrative regions prepared by the State Enterprise of Cartography Research and Production of the Republic of Uzbekistan in determining the existing soil types in the territory of the valley (2013), Harmonized World Soil Database (HWSD, version 1.2) (2021, https://www.fao.org/soils-portal) from international databases and Caryophyllaceae and flora of Kyrgyzstan (Lazkov, 2016), as an additional source, the literature on Rastitelniy pokrov Uzbekistana (Gorbunov & Kimberg, 1971), National Strategy and Action plan on conservation and sustainable use of biodiversity was used.

Results and Discussions

The results of research and analysis of florocenotypes of the species *Plomoides* distributed in the Fergana Valley revealed that they belong to 15 florocenotypes of Gumid, Cryoarimgumid, Semigumid and Arid character. During the study, the distribution of the identified species according to the existing florocenotypes in the Fergana Valley was analyzed (Table 1). According to the results of the analysis, among the species of the *Phlomoides* genus, Mesophile leafy shrubs, Juniper forests, Xerodrymion orientalemediterraneum, Tallgrass mountain semisavanna, Variegate colored outcrops and Iran-Turanian phryganoid vegetation communities have the highest number of preferred species (Soltanmuradova & Teimurov, 2014; Singh, 2016).

According to the phytocoenocycle of each species, the level of activity was determined based on their phytogeographic, ecological, phytocenotic range. According to the phytocenocycle of *Phlomoides* species distributed in the Fergana Valley, they are divided into 4 groups:

- The most active species – are the species distributed in 6 or more florocenotypes (*P. nuda, P. speciosa*).
- Active species – are species that occur in a community of up to 4 or 5 florocenotypes (*P. ebracteolata, P. oreophila, P. isochilla, P. stellate*).

- Medium active species – species distributed in 2 or 3 florocenotypes (*P. labiosa, P. urodonta P. ostrowskiana, P. canescens, P. alaica, P. adylovii, P. kirghisorum, P.integior, P. lehmanniana, P. cordifolia, P. brachystagia, P. codonantha, P. michaelis, P. aydarovae, P. kurpsaica P. ferganensis, P. pulchra*).
- Species with low levels of activity are species that occur within a single florocenotypes (*P. eriocalyx, P. hypovirides, P. pratensis*).

The following is a detailed analysis of the available florocenotypes.

A group of florocenotypes of humid character

- Mountain taiga (*Peucedrymion hoalrcticum, Taiga*) – The Chatkal and Fergana ridges are among the most interesting elements of vegetation. They are well expressed in the south-eastern corner of the Chatkal ridge (*Picea schrenkiana, Abies semenovii*), forming small populations on the northern, partly north-western slopes of the Fergana ridge and intersect in the belt of walnut forests (Arifkhanova, 1967). These florocenotypes include *P. oreophila, P. speciosa, P. urodonta* species.
- Mountain grasslands (*Coryphiopoion uralosibiricum*) – Black forest and broad-leaved forests are formed, in part, in direct contact with the mountain taiga. Most meadows are in the upper parts of forests and are directly related to forest change processes. This florocenotype includes the species *P. speciosa*, which is distributed in all altitude regions (Karimov et al., 2012; Horst et al., 2005).
- Mountain mesohpilic grasslands (*Geimesonanocoryphion oreoasiaticum*) – It is closely related to mountain taiga communities on the one hand and juniper forests and mountain meadow-steppe communities on the other, and differs from meadows in its simple stage of formation and prevalence of mesophilic grasses in communities (Kamelin, 2002). The species of *P. oreophila, P. speciosa, P. ebracteolata, P. urodonta* were included in this florocenotype.
- Black forest and broad-leaved forests (*Therodrymion nemorale*) – In this type, complex and multi-layered communities are formed and occupy a central position among the plant communities associated with the warm, temperate regions of southern Galartica (including the ancient Mediterranean). They are mainly well represented in the Fergana ridge in the eastern part of the valley (Pereira et al., 2009; Conrad et al., 2013). The most important elements of the Black Forest in this florocenotype group are walnut forests, which are formed mainly in the wetlands of the Fergana (Baubash-Ata) and Chatkal (Bozbutoo) ridges. The species *P. adylovii, P.cordifolia, P. speciosa* were attached to this florocenotype.

Table 1
Specific features associated with florocenotypes of Phlomoides species distributed in the Fergana Valley

№	Species	Mountain ridges of the Fergana Valley	Ecology Species height indicator	Soil types	Florocenotype groups
1. The most active species					
1	*P. nuda* (Regel) Adylov, Kamelin & Makhm.	Chatkal, Fergana, Alay, Turkestan, Mogoltog	900-1800 m	Dark, typical gray and colorful soils	Mesophile leafy shrubs, Iran-Turanian phryganoid vegetation, Shiblyak, Iran-Turanian semisavanna, Variegate coloured outcrops, Anthropophyton
2	*P. speciosa* (Rupr.) Adylov, Kamelin & Makhm.	Kurama, Chatkal, Fergana, Alay, Turkestan	1000-3200 m	Dark, gray-brown and typical gray soils, as well as dark brown, black-forest and meadow-steppe mountain soils	Mountain taiga, Mountain grasslands, Mountain mesohpilic grasslands, Black forest and broad-leaved forests, Mesophile leafy shrubs, Juniper forests, Shiblyak, Tragakanta and thorny cushions
2. Active species					
3	*P.ebracteolata* (Popov) Adylov, Kamelin &	Kurama, Chatkal	1800-3000 m	Alpine steppe, meadow-steppe	Mesophile leafy shrubs, Juniper forests, Shiblyak

	Makhm.			mountain soil, light and dark brown mountain soils	Cryoxerophile cushion plants
4	*P. isochila* (Pazij & Vved.) Salmaki	Kurama, Chatkal, Fergana, Alay, Mogoltog	900-1600 m	Typical and light gray soils	Shiblyak, Iran-Turanian phryganoid vegetation, Iran-Turanian semisavanna, Variegate coloured outcrops
5	*P.oreophila* (Kar. & Kir.) Adylov, Kamelin & Makhm.	Chatkal, Fergana, Alay, Turkestan	1800-3200 m	Dark brown, podzol and black-forest soils	Mountain taiga, Mountain mesohpilic grasslands, Juniper forests, Shiblyak, Tall grassland, Iran-Turanian phryganoid vegetation, Tallgrass mountain semisavanna
6	*P. stellate* Lazkov	Alay, Turkestan	1200-2600 m	Typical gray soil and dark brown mountain soil	Mesophile leafy shrubs, Juniper forests, Tallgrass mountain semisavanna, Variegate coloured outcrops
3. Medium active species					
7	*P. adylovii* Lazkov	Chatkal, Fergana	900-1600 m	Typical gray soil,	Black forest and broad-leaved forests, Mesophile leafy shrubs
8	*P. alaica* (Knorring) Adylov, Kamelin & Makhm.	Chatkal, Fergana, Alay	1000-2600 m	Typical gray soil, colorful soils	Mesophile leafy shrubs, Variegate coloured outcrops
9	*P. ajdarovae* Lazkov	Turkestan	1400-2200 m	Mountain light brown and dark gray soil	Mesophile leafy shrubs, Shiblyak
10	*P. labiosa* (Bunge) Adylov, Kamelin & Makhm.	Chatkal, Alay, Turkestan, Mogoltog	600-1600 m	Dark, brown and typical gray soils as well as light brown mountain soils	Mesophile leafy shrubs, Shiblyak, Iran-Turanian semisavanna, Variegate coloured outcrops
11	*P. ostrowskiana* (Regel) Adylov, Kamelin & Makhm.	Kurama, Chatkal	1800-2800 m	Light brown and mountain meadow-steppe soils	Mesophile leafy shrubs, Tall grassland, Juniper forests, Tallgrass mountain semisavanna
12	*P. canescens* (Regel) Adylov, Kamelin & Makhm.	Alay, Turkestan	1600-3200 m	Dark brown and brown spruce soil	Juniper forests, Tallgrass mountain semisavanna,
13	*P.brachystagia* Bunge) Adylov, Kamelin & Makhm.	Kurama, Chatkal	1600- 2200 m	The brown-brown soils of the mountains	Mesophile leafy shrubs, Juniper forests, Shiblyak, Tallgrass mountain semisavanna
14	*P.ferganensis* (Popov) Adylov, Kamelin & Makhm.	Chatkal	1700-2600 m	Grassland-steppe mountain soil	Juniper forests, Tallgrass mountain semisavanna
15	*P. integior* (Pazij & Vved.) Adylov, Kamelin & Makhm.	Kurama, Chatkal, Fergana, Alay, Turkestan, Mogoltog	1000-2000 m	Dark, brown and typical gray soils	Shiblyak, Variegate coloured outcrops
16	*P. kirghisorum* Adylov, Kamelin & Makhm.	Chatkal, Alay	1000-1200 m	Typical gray soil, colorful soils	Shiblyak, Variegate coloured outcrops
17	*P. cordifolia* (Regel) Adylov, Kamelin & Makhm.	Fergana, Alay	1600-2600 m	Black and forest-grassland steppe soils	Black forest and broad-leaved forests, Mesophile leafy shrubs
18	*P. codonantha* Sennikov	Kurama, Chatkal, Alay, Turkestan	600-1600 m	Dark, light and typical gray soils	Shiblyak, Iran-Turanian phryganoid vegetation, Iran-Turanian semisavanna
19	*P.lehmanniana* (Bunge) Adylov, Kamelin & Makhm.	Alay, Turkestan	1600-3200 m	Typical gray soil	Mesophile leafy shrubs, Juniper forests, Tallgrass mountain semisavanna
20	*P.michaelis* Adylov, Kamelin & Makhm.	Alay	600-1600 m	Typical and light gray soils	Shiblyak, Variegate coloured outcrops

21	*P. pulchra* (Popov) Adylov, Kamelin & Makhm.	Alay	1600-2200 m	Dark and typical gray soils	Mesophile leafy shrubs, Juniper forests, Shiblyak
22	*P. kurpsaica* Lazkov	At-Oynok	1000-2600 m	Brown soil	Mesophile leafy shrubs, Shiblyak
23	*P. urodonta* (Popov) Adylov, Kamelin & Makhm.	Chatkal	1600-2500 m	Black forest and podzol (taiga) soils	Mountain taiga, Mountain mesohpilic grasslands, Mesophile leafy shrubs
4. Species with low levels of activity					
24	*P. eriocalyx* (Regel) Adylov, Kamelin & Makhm.	Mogoltog	900-1200 m	Gray brown soil	Iran-Turanian semisavanna
25	*P. pratensis* (Kar. & Kir.) Adylov, Kamelin & Makhm.	Alay	1500-2600 m	grassland-steppe mountain soils	Mesophile leafy shrubs
26	*P. hypovirides* Lazkov	At-Oynok	900-1100 m	Brown soil	Shiblyak

- Mesophile leafy shrubs (*Mesothamnion nemorale*) – Although a significant proportion of mesophytic shrubs are associated with mesophytic forests, in some areas they form independent, well-formed communities with distinctive ecological and florocenotic characteristics (Safarov, 2018). In this florocenotype community *P. lehmanniana, P. adylovii, P. speciosa, P. ebracteolata, P. brachystegia, P. ostrowskiana, P.pratensis, P.aydarovae, P.stellata, P.nuda, P. labiosa, P. urodonta, P. cordifolia, P. kurpsaica, Phl. alaica, Phl. species* such as pulchra are involved.
- Tall grassland (*Megalocoryphyion nemorale*) – The origin of this community is directly related to the cenoses of mesophytic black forests (decumbation) and rich communities of broad and coniferous forests, formed on an arcto-tertiary basis from the Neogene to the post-Pleistocene (Kamelin, 1979, Safarov, 2018). This type of plant communities can be found in the northern regions of the Fergana and Alay ridges of the valley, and in part in the Turkestan, Chatkal and Kurama ridges. *P. ostrowskiana* and *P. oreophila* species were attached to this fluorocenotype.

Cryoarimgumid and semigumid florocenotypes group

- Juniper forests (*Pitydrymion holarcticum*) – Spruce forests are bright in the southern regions of the Fergana Valley in the Turkestan and Alay ridges (rare in the Kurama, Chatkal and Fergana ridges) and form a wide belt of vegetation (along with tragacanths and steppes) (Karimov et al., 2014; Löw et al., 2017). At least three lines are separated on these belts. The lower part is occupied by *Juniperus seravschanica*, the middle part by *Juniperus semiglobosa*, *Juniperus turkestanica*, the upper part by *Juniperus turkestanica*. The lower limit of *Juniperus turkestanica* participation is significantly reduced to the east. In a number of regions of the Alay ridge (Isfayram, Akbura) *Juniperus seravschanica* forms modern belts. *P. lehmanniana, P. canescens, P. speciosa, P. ebracteolata, P. brachystegia, P. ostrowskiana, P. ferganensis, P. oreophila, P. stellata, P. rulchra* species were formed in direct connection with the juniper florocenotype.
- Tragakanta and thorny cushions (*Tragacanthion mediterraneum*) – This group was originally listed as thorns (Stanyukovich, 1997), tragacanths, cryophyte friganoids. They are a florocenotype of warm and temperate flora formed in the Neogene-Pleistocene on the basis of cryophyte spruce forests and shibleak (Kamelin, 1979). This group is fully visible in the southern part of the Fergana ridge, in the western part of the Chatkal ridge, and in the formations of *Astragalus, Acanthalimon, Cousinia P. speciosa, P. ebracteolata* species participate together.
- Eastern Mediterranean deciduous xerophytic forests or shiblyak (*Xerodrymion orientalemediterraneum*) – Some Central Asian researchers (Kamelin, 1979), use the term “Shibleyak” as a synonym for sparse forests. We understand them as deciduous xerophilous forests, sparse forests and shrubs, or deciduous xerophilous forests of the Eastern Mediterranean, based on the classification of Kamelin (1979); (Safarov, 2018). The genesis of ulras is directly related to juniper trees (Kamelin, 2002). The main period of shibleak formation in mountainous Central Asia corresponds to the post-Pleistocene xerothermal period. It is formed from an ancient shibleak complex in the Neogene as part of the ancient Mediterranean florocenotype (Safarov, 2018). This type is well represented in the middle and lower belts of all ridges along the Fergana Valley. This florocenotype includes *P. canescens, P. speciosa, P. nuda, P. labiosa, P. isochila, P. integior, P. kirghisorum,*

P. codonantha, P. hypovirides, P. kurpsaica, P. ebracteolata, P. aydarovae, P. pulchra, P. michaelis species were attached.

- Iran-Turanian phryganoid vegetation or xerophytic semi-shrubs (*Phryganion = Xerohemithamnion iranoturanicum*) – They originated in the Neogene as a florocenotype of warm and temperate plants on the basis of the ancient Mediterranean, uniting mainly mesoxerophytic shrubs and semi-shrubs as well as some perennial herbaceous communities (Kamelin, 1979). This zonal type of foothills and lowlands of Central Asia is well represented in the Fergana Valley, mainly in the western and southern parts. This florocenotype community includes species such as *P. nuda, P. speciosa, P.codonantha, P. isochila*.
- Tallgrass mountain semisavanna (*Megaloxerocoryphion medioasiaticum*) – The term semisavanna belongs to Tojibaev et al. (2018), and was originally called "Himalayan meadows" by Korovin (1934). They are a florocenotype of warm and temperate mountain subtropical flora that originated in the Neogene on the basis of the ancient Mediterranean, closely related to xerophilous deciduous forests and spruce forests (Kamelin, 2002, Safarov, 2018). This florocenotype is well expressed in the western and southern regions of the valley. Species such as *P. alaica, P. lehmanniana, P. stellata, P. brachystegia, P. ostrowskiana, P. canescens, P. oreophila, P. ferganensis, P..ebracteolata* were included in this florocenotype.
- Iran-Turanian semisavanna (*Xerocoryphion iranoturanicum*) – The florocenotype of warm temperate and mountainous subtropical plants was originally described by the tonom of Kamelin (1979), and originated in the Neogene and postpleistocene in the ancient Mediterranean. Closely associated with the Shiblyak community, it is well represented in the low mountains surrounding the Fergana Valley basin and combines xerophilic, mesothermal, and ephemeroid plants (Kamelin, 2002, Safarov, 2018). *P. labiosa, P. eriocalyx, P. nuda, P. codonantha, P. isochila, P. speciosa* species were attached to this florocenotype.
- Cryoxerophile cushion plants (*Pycnocoryphion oreoasiaticum*) – These florocenotype communities, well adapted to cold ecotopes, are gradually creating conditions for microthermal-cryomezophilic plant communities. These florocenotype communities probably formed on the basis of the Arctic tertiary flora in the Neogene-Quaternary period instead of the glacial areas (Safarov, 2018). Chatkal and Kurama of the Fergana Valley are widespread in some areas of the Alay ridges. *P. ebracteolata* was found to be present in these florocoenotype communities.

A group of florosenotypes of arid character

- Variegate coloured outcrops – This florocenotype is directly related to the foothills of the valley and is well represented in the Fergana Valley, such as Isfara, Isfayram, Sokh, Shohimardon, Aravan, Akbura, Gulcha, Maylisay, Aksu, Tashkumir, Kyzyl-Jar. Species such as *P. alaica, P. stellata, P. integior, P. kirghisorum, P. nuda, P. labiosa, P. isochila, P. michaelis* were attached to this florocenotype.

Table 2
Interaction of species of the genus Phlomoides with florosenotypes

№	Florocenotypes	Number of species (number of specific species)	Total number of species with other florocenotypes														
			Mountain taiga	Mountain grasslands	Mountain mesohpilic grasslands	Black forest and broad-leaved forests	Mesophile leafy shrubs	Tall grassland	Juniper forests	Tragakanta and thorny cushions	Shiblyak	Iran-Turanian phryganoid vegetation	Tallgrass mountain semisavanna	Iran-Turanian semisavanna	Cryoxerophile cushion plants	Variegate coloured outcrops	Anthropophyton
1	Mountain taiga	3 (0)	+	1	3	1	2	1	2	1	1	1	1	1	0	0	0
2	Mountain grasslands	1 (0)	1	+	1	1	1	0	1	1	1	1	0	1	0	0	0

3	Mountain mesohpilic grasslands	4 (0)	2	1	+	1	3	1	3	2	9	1	2	1	1	0	0
4	Black forest and broad-leaved forests	3 (0)	1	1	1	+	3	0	1	1	1	1	0	1	0	0	0
5	Mesophile leafy shrubs	16 (1)	3	1	3	3	+	1	7	2	7	3	1	4	1	4	1
6	Tall grassland	2 (0)	1	0	1	0	0	+	2	0	0	0	2	0	0	0	0
7	Juniper forests	10 (0)	2	1	3	1	7	1	+	2	3	1	8	1	1	1	0
8	Tragakanta and thorny cushions	2 (0)	1	1	2	1	2	0	2	+	2	1	1	1	1	0	0
9	Shiblyak	14 (1)	1	1	2	1	7	0	4	2	+	4	2	4	1	6	1
10	Iran-Turanian phryganoid vegetation	4 (0)	1	1	1	1	2	0	1	1	4	+	0	4	0	2	1
11	Tallgrass mountain semisavanna	9 (0)	1	0	3	0	6	1	9	1	2	0	+	0	1	2	0
12	Iran-Turanian semisavanna	6 (1)	1	1	1	1	3	0	1	1	5	4	0	+	0	3	1
13	Cryoxerophile cushion plants	1 (0)	0	0	1	0	1	0	1	1	1	0	1	0	+	0	0
14	Variegate coloured outcrops	8 (0)	0	0	0	0	4	0	1	0	6	2	2	2	0	+	1
15	Anthropophyton	1 (0)	0	0	0	0	1	0	0	0	1	1	0	1	0	1	+

- Anthropophyton (Agrophyton) – This florocenotype is characterized by plant communities distributed in areas under anthropogenic influence, such as residential areas, irrigated meadows and gardens formed on developed lands. In some cases, the P. nuda species can be found in habitats in urbanized areas (Suaria et al., 2017; Reddy et al., 2013).

The results of the analysis of the distribution of Phlomoides species across different plant communities allow us to determine their phytocenocycle (Table 2).

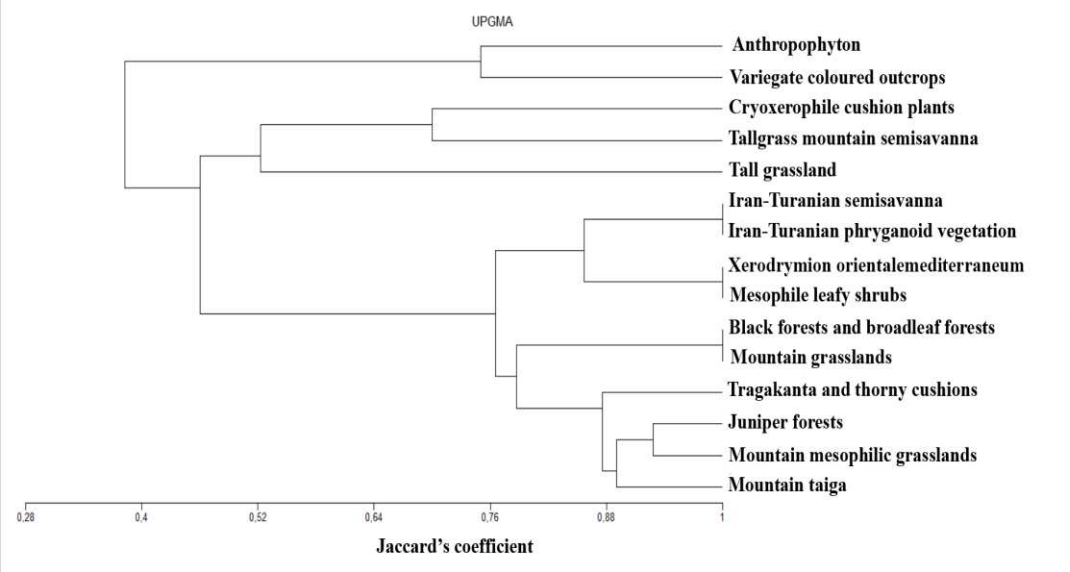

Figure 2. Relationship of Phlomoides species distributed in the Fergana Valley with florocenotypes (dendrogram of 15 florocenotypes prepared based on UPGMA program)

A dendrogram representing the interdependence of 15 florocenotypes prepared using the UPGMA (version 3.22) program above is based on Jaccard's coefficient (Figure 2). The occurrence rate of species within similar florocenotypes is explained by the origin of the region, the distribution of the species in interconnected ecological spaces, the emergence of most plants simultaneously in two, three or more different interconnected habitats, not

limited to a specific phytocoeno-ecological location. The inclusion of species in new florocenotypes is characterized by the fact that the region and the community are stable, mature and the plant community is not formed in a weak state (Conrad et al., 2017; Ibrakhimov et al., 2018).

Conclusion

The high rate of moderately active species in the phytocenocycle is explained by the abundance of endemic and subendemic species adapted to individual florocenotypes and individual ecotopes within them. The fact that most of the species are distributed in the florocenotypes, which are typical for the regions of Mountainous Central Asia and part of the Turan provinces, allows to consider the mountainous regions of Central Asia as a region of special importance in the formation of species.

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