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The Comparative Analysis of the Taxonomic Composition of *Boraginaceae* Juss. Distributed in Azerbaijan and Phytogeographic Regions of Adjacent Countries

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This article presents the comparative analysis of genus and species of *Boraginaceae* Juss. distributed in Azerbaijan and its neighboring countries (the Dagestan Autonomous Republic (Russian Federation), Georgia, Armenia, Turkey and the Islamic Republic of Iran). In order to compare the similarity of plant species distributed in two neighbor countries the floristic similarity coefficient was determined using the floristic similarity coefficient of Jaccard index. The results of the analysis showed that *Boraginaceae* distributed in Azerbaijan has a closer commonness with the flora of Armenia, Georgia and Dagestan for its taxonomic composition, than with the floras of Turkey and Iran. This may be attributed to the degree of comparison of the measured areas of the investigated territories, the type of areal or geographic elements that affect the formation of these territories, similarity and differences in climatic conditions.

Keywords: *Phyto-geographical regions, Boraginaceae* Juss*., Jaccard method, similarity indices, taxon of the flora of Azerbaijan*

INTRODUCTION

In order to come to a final conclusion about the species composition and systematics of *Boraginaceae* Juss. distributed in Azerbaijan it is not enough to study the systematics composition of species belonging to this family and distributed only in the Republic separately. In order to reach our goal, it will be appropriate to carry out a critical study of the representatives of *Boraginaceae* distributed in the floras of neighboring countries of Azerbaijan and make a comparative analysis of their similar and different properties.

The article gives the comparative analysis of species of the family *Boraginaceae* Juss. distributed in Azerbaijan with ones distributed in phyto-geographical regions surrounding Azerbaijan. As we know the Republic of Azerbaijan is bordered by the Caspian Sea in the East, the Russian Federation in the North (the Dagestan Autonomous Republic), the Republic of Georgia in the North-West, the Republic of Armenia in the West, the Republic of Turkey in the South-West (the Nakhchivan Autonomous Republic) and the Islamic Republic of Iran in the South (Figure 1). If we glance at the general number of *Boraginaceae* distributed in the flora of the mentioned phyto-geographical regions, then we will notice that this number consists of 473 species belonging to 54 genera which are not so low in comparison with the general area of the studied countries. In fact, if we determine that 502 species belonging to 54 genera are distributed in the study areas, it is supposed that 29 species are distributed in these areas and as the distribution of these species is not confirmed completely, then we do not consider these species in our studies. We can only briefly note that the number of species of which is probably distributed in the flora of Azerbaijan is 8 species (*Heliotropium dolosum, Onosma dichroantha, O setosa, O.isauricum, Nonea pulla, Lycopsis arvensis, Myosotis sylvatica, Lappula marginata*), in the flora of Turkey – 14 species (mainly *Onosma* – 7 species, *Alkanna* – 1 species, *Anchusa* – 1 species, *Nonea* – 1 species, *Pulmonaria* – 2 species, *Moltkia* – 2 species), in the flora of Iran – 21 species *Heliotropum* – 4 species, *Arnebia* – 3 species, *Onosma* – 3 species, *Nonea* – 2 species, *Myosotis* – 4 species, *Eritrichium* – 1 species, *Lappula* – 1 species, *Cynoglossum* – 1 pecies, *Solenanthus* – 1 species, *Paracaryum* – 1 species).

The results of the first studies showed that totally 31 species belonging to 18 genera such as *Argusia sibirica, Heliotropium ellipticum, H.europaeum, H.suaveolens, Huynhia pulchra, Lithospermum officinale, Aegonichon purpureocoeruleum, Buglossoides arvensis, B.tenuiflora, Onosma sericeum, O.microcarpa, Cerinthe minor, Echium maculatum (E.russicum), E.italicum, Nonea lutea, N.rosea, N.caspica, Symphytum asperum, Anchusa italica, Lycopsis orientalis,* (*Anchusa arvensis, subsp.orientalis*), *Myosotis micrantha* (*M.stricta*), *M.arvensis, M.caespitosa, M.lithospermifolia, Strophiostoma sparsiflora (M.sparsiflora), Asperugo procumbens, Lappula*

barbata, L.squarrosa, L.patula, Cynoglossum officinale and *C.creticum* are common species encountered in the flora of all studied countries.This comprises about 6% of general number of species distributed in the region. If we glance at the number of common species we will notice a different picture. 21 genera out of 54 of which species distributed in the studied geography are represented in the flora of Azerbaijan and its surrounding countries. This number comprises about 39% of common species distributed in the studied geography. These percentages can also be accepted as the similarity coefficient of the family *Boraginaceae* for the studied general geography.

MATERIALS AND METHODS

Studies were carried out in nature and herbarium materials of the family *Boraginaceae* in 2000-2016 (Karimov, 1999, 2000, 2013, 2014, 2016 a, b, c). Materials kept at the Institute of Bota-ny of Russian Academy of Sciences (RAS), the Herbarium Foundation in Tbilisi and the Herbarium Foundation of the Institute of Botany of ANAS were analyzed. References were made to the literature and internet resources, various maps and the results of monitoring's carried out by authors in nature (Flora of Armenia, 1980; Flora of Georgia, 1985; Flora of Caucasus, 1967; Flora of Azerbaijan, 1957; Flora of Turkey, 1978; Flora of Iran, 2002; Grossheim 1936, 1948; Cherepanov, 1995; Asgarov, 2011; Khokhrayakov, 1993; Murtuzaliyev, 2009). Comparative morphological, systematical, botanical, florogenetic and other methods were used during the study.

The article presents the comparative analysis of the taxonomic composition of *Boraginaceae* of 5 phyto-geographical regions neighboring with Azerbaijan on the basis of the floristic similarity coefficient of Jaccard. As a result similarity coefficient of genus and species was determined.

CONCLUSIONS AND DISCUSSION

In order to form a clear picture about *Boraginaceae* of the widely studied geography it is important to review the modern condition of some taxa belonging to this family.

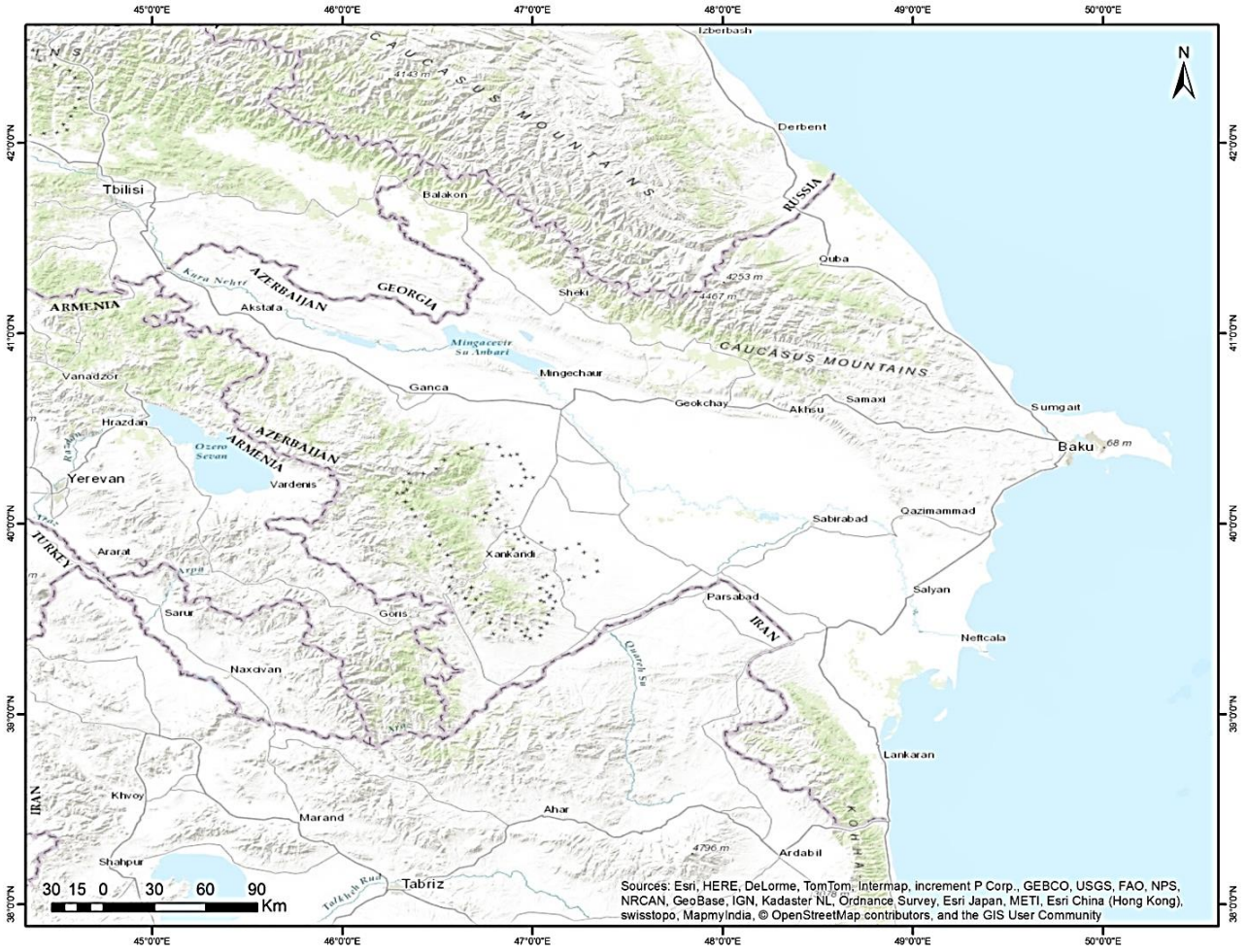

Figure 1. Map of Azerbaijan Republic and surrounding phytogeographical regions.

Two genera - *Hormuzakia* Gusuleac and *Phyllocara* Gusuleac, which were described by Gushulyakh are separated from the genus *Anchusa* in the flora of Iran (Flora Iranica, 2002), where the same genera are recorded as a subgenus - subgen. *Hormuzakia* (Gusuleac) Chamb. and subgen. *Phyllocara* (Gusuleac) Chamb. in the flora of Turkey. As both of these descriptions are justified, but taking into consideration that Gushulyak was described before and is high-rank taxon in terms of systematics, we accept both genera in the genus status for the flora of both Turkey and Iran and carry out our comparison. On the other hand, Buassye separated several species belonging to the genera *Paracaryum* and described separately as the genus *Mattiastrum* Boiss. This taxon is presented as subgen. *Mattiastrum* (Boiss.) R.Mill. in semi-genus status in the flora of Turkey and Iran. This taxon is given in an independent genus status in several modern literature sources (Murtuzaliyev, 2012). We accept this approach to be true and present the species referred to this genus by Buassye which are distributed both in Azerbaijan and its neighbouring countries in the composition of the genus *Mattiastrum* (Boiss.) R.Mill.A species *P.imeretinum* M.Pop. (*P.glochidiatum* (Wall. ex Benth.) Popov ex Czukav) which is belonging to other genus *Paracynoglossum* M.Pop. described by M.G.Popov from Georgia, were also determined in the flora of Turkey. But the difference is that here this species is presented as species *Cynoglossum glochidiatum* Wall. ex Benth. If we consider that this species is described for morphological properties differed markedly from other species of genus *Cynoglossum*, mainly for properties with constant and diagnostical importance in the structure of flower and fruit, then we accept *Paracunoglossum* in the genus status and carry out our comparative analysis on this basis. Besides the matter that tens of species in these floras are named on the basis of personal approaches of separate authors is clarified by taking as a basis the revisions of S.K.Cherepanov (1995). Without applying these revisions it will be impossible to clarify the taxonomic composition of *Boraginaceae* of region as a whole, as well as separate phyto-geographical regions.

The family *Boraginaceae* is presented with 107 species belonging to 32 genera in the flora of the Republic of Azerbaijan. 73 species belonging to 26 genera of this family are found in the Dagestan Autonomous Republic of Russian Federation, north neighbor of Azerbaijan, 92 species belonging to 35 genera of this family in the Republic of Georgia, north-west neighbor of Azerbaijan, 83 species belonging to 29 genera of this family in the Republic of Armenia, west neighbour of Azerbaijan, 302 species belonging to 41 genera of this family in the Republic of Turkey, south-west neighbor of Azerbaijan and 218 species belonging to 46 genera of this family in the Islamic Republic of Iran, south neighbor of Azerbaijan (Figure 2).

The comparative analysis of the family *Boraginaceae* of Azerbaijan and its surrounding regions was carried out, similarity coefficient on genus and species were determined and the following conclusions are provided (Table 1):

1. As mentioned above the family *Boraginaceae* is represented with 73 species belonging to 26 genera in the flora of the Dagestan Autonomous Republic (Russian Federation). Species belonging to 8 genera such as *Caccinia, Suchtelenia, Alkanna, Paracarium, Heterocarium, Rindera, Arnebia* and *M oltkia* included to the list of Azerbaijan *Boraginaceae* are not found in the Dagestan Autonomous Republic and contrary species belonging to 2 genera such as *Trigonotis* and *Pulmonaria* encountered in the flora of Dagestan are not found in the flora of Azerbaijan. So the number of common species found both in the flora of Azerbaijan and Dagestan is 24.

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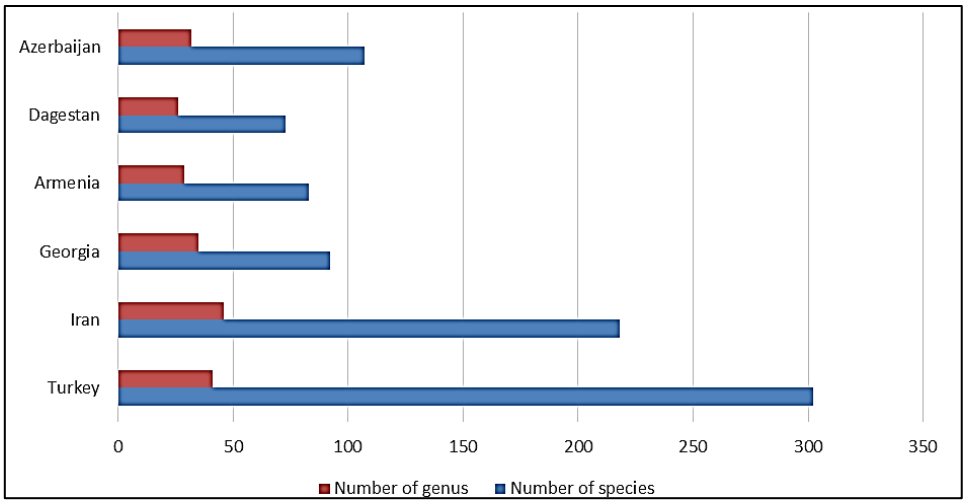

Figure 2. Number of genera and species of *Boraginaceae* of Azerbaijan and surrounding phytogeographical regions.

Table 1. *Boraginaceae* Juss. species occurrences and their comparative analysis at the Azerbaijan and its surrounding phytogeographical regions

No	The number of genus in Latin	General number of species distributed in Azerbaijan	Dagestan Autonomous Republic (AR)				The Republic of Georgia				The Republic of Armenia				Turkey				Islamic Republic of Iran			
			General number of species	A	B	C	General number of species	A	B	C	General number of species	A	B	C	General number of species	A	B	C	General number of species	A	B	C
1	***Cardia***														1			1	4			4
2	***Ehretia***																		1			1
3	***Argusia***	1	1	1			1	1			1	1			1	1			1	1		
4	***Tournephortia***																		1			1
5	***Heliotropium***	7	6	4	3	2	5	3	4	2	8	7		1	14	6	1	8	31	5	2	26
6	***Echiochilon***																		2			2
7	***Arnebia***	3			3		1	1	1		2	2	1		3	2		1	8	2	1	6
8	***Huynhia***	1	1	1			1	1			1	1			1	1			1	1		
9	***Lithospermum***	1	1	1			1	1			1	1			1	1			1	1		
10	***Lithodora***														1			1				
11	***Aegonychon***	1	1	1			1	1			1	1			1	1			1	1		
12	***Buglossoides***	3	2	2	1		3	3			2	2	1		3	2	1	1	3	2	1	1
13	***Moltkiopsis***																		1			1
14	***Neotostema***														1			1				
15	***Moltkia***	1			1		1	1			1	1			2	1		1	1	1		
16	***Onosma***	10	9	6	4	3	5	5	5		8	7	2	1	88	8	2	80	37	4	6	33
17	***Alkanna***	1			1		1	1			1	1			31	1		30	4	1		3
18	***Trigonotis***		1			1																
19	***Cerinthe***	2	2	2			2	2			2	2			4	2		2	1	1	1	
20	***Echium***	4	3	3	1		4	3	1	1	3	3	1		9	3	1	6	4	3	1	1
21	***Nonea***	18	10	10	8		9	9	9		8	7	11	1	18	9	9	9	9	5	13	4
22	***Symphytum***	3	2	2	1		5	2	1	3	3	2	1	1	20	1	2	19	2	1	2	1
23	***Borago***						1			1					1			1				
24	***Trachistemon***						1			1					1			1				
25	***Trigonocaryum***	1	1	1			1	1					1				1				1	
26	***Brunnera***	1	1	1			1	1					1		2	1		1	1		1	1
27	***Anchusa***	3	1	1	2		3	1	2	2	1	1	2		12	2	1	10	3	1	2	2
28	***Lycopsis***	1	1	1			1	1			1	1			1	1			1	1		
29	***Gastrocatyle***																		1			1
30	***Phyllocaria***														1			1	1			1
31	***Hormuzakia***														1			1	1			1
32	***Suchtelenia***	1			1		1	1					1				1		1	1		
33	***Pulmonaria***		1			1	1			1	1			1	2			2				
34	***Myosotis***	11	9	8	3	1	12	7	4	5	12	8	3	4	20	7	4	13	12	6	5	6
35	***Strophiostoma***	3	2	1	2	1	4	3		1	3	2	1	1	4	2	1	2	3	3		
36	***Heterocarium***	3			3		2	2	1		1	1	2		1	1	2		5	3		2
37	***Asperugo***	1	1	1			1	1			1	1			1	1			1	1		
38	***Rochelia***	4	1	1	3		1	1	3		4	4			3	2	2	1	8	3	1	5
39	***Eritrichium***						1			1									1			1
40	***Lappula***	8	8	7	1	1	6	6	2		8	7	1	1	7	6	2	1	10	6	2	4
41	***Lepechinella***																		3			3
42	***Trichodesma***														1			1	8			8
43	***Omphalodes***	1	1	1			7	1		6			1		3		1	3	1		1	1
44	***Cynoglossum***	5	4	4	1		4	4	1		3	3	2		6	5		1	4	2	3	2
45	***Paracynoglossum***						1			1					1			1				
46	***Trachelanthus***														1			1	1			1
47	***Solenanthus***	4	2	2	2		1	1	3		2	2	2		3	2	2	1	5	3	1	2
48	***Mattiastrum***	1	1	1			1	1			1	1			23	1		22	10	1		10
49	***Paracarium***	1			1				1		1	1			4	1		3	9		1	8
50	***Microparacaryum***																		3			3
51	***Caccinia***	1			1		1	1			1	1			1	1			4	1		3
52	***Heliocaria***																		1			1
53	***Rindera***	1			1				1		1	1			3	1		2	6	1		5
54	***Lindelofia***																		1			1
	Total	**107**	**73**	**63**	**44**	**10**	**92**	**67**	**40**	**25**	**83**	**72**	**35**	**11**	**302**	**73**	**34**	**229**	**218**	**62**	**45**	**156**

A – The number of common species of genus distributed in both Azerbaijan and in the noted country;

B – The number of species of genus which is distributed in Azerbaijan, not distributed in the noted country;

C – The number of species of genus which is distributed in the noted country, not distributed in Azerbaijan.

In order to determine the number of common species of *Boraginaceae* distributed in both regions and how they close to each other in terms of taxonomic composition, the above mentioned the floristic similarity coefficient of Jaccard was used (Jaccard, 1912; Sukhachev, 1930):

$$k = \frac{a \cdot 100}{b}$$

here K is the floristic similarity coefficient, a– the number of common species or genera of the compared areas, b –general number of species and genera found in these areas. So if we consider that general number of species of genera of the family *Boraginaceae* found in the floras of Dagestan and Azerbaijan is 34, the number of common species is 24, then the floristic similarity coefficient will be as k=(24x100%):(32+2)=~71% according to the calculation by Jaccard similarity index.

The picture of the comparion of species will be a little bit different. So while 63 species of *Boraginaceae* out of 107 found in the flora of Azerbaijan are encountered in the Dagestan Autonomous Republic, only 10 species out of 73 distributed in Dagestan are not encountered in Azerbaijan (Murtuzaliyev, 2009).

So the general number of species of the family *Boraginaceae* found in the flora of Dagestan and Azerbaijan is 117, the number of common species-63. If we estimate the floristic similarity coefficient, we will obtain k=(63x100%):117=~54%. As the floristic similarity coefficient of species is assumed as a basis, we can surely note that the floristic similarity coefficient of *Boraginaceae* of these two neighbor regions is ~54%. Though these regions are adjacent and have almost the same climate condition, the difference can be probably explained with the existence of impassable mountains always covered in snow which separates these regions from each other.

2. Species belonging only to 5 genera -*Borago, Pulmonaria, Trachistemon, Paracynoglossum* and *Eritrichium* out of 92 species belonging to 35 genera of *Boraginaceae* distributed in the Republic of Georgia are not found in Azerbaijan. In defiance only two genera -*Rindera* and *Paracaryum* are not represented in the flora of Georgia, it became clear from the first view that the floristic composition of these two regions are close (Flora of Georgia, 1985). So if we consider that the general number of genera is 37, the number of common genera is 30, then we will observe that the floristic similarity coefficient of genera belonging to the family *Boraginaceae* of these regions is k=(30x100%):37= ~81%.

But the comparison of species is completely different. The number of species of *Boraginaceae* encountered in Georgia out of 107 species distributed in the flora of Azerbaijan is 67. Though 25 species are found in the flora of Georgia, we can note that these species are not encountered in Azerbaijan. The general number of floristic species of these regions is 107+25=132, the number of common species is 67. If we calculate the floristic similarity coefficient we will notice it to be as k=(67x100%):132=~51%. In comparison with the similarity percentages of genera the reason why similarity percentages of species is so low can be explained with a big difference in the number of species in the genera as *Omphalodes* and *Nonea*. While genus *Omphalodes* is represented with one species in Azerbaijan, 7 species of this genus are found in Georgia or while genus *Nonea* is represented with 18 species in Azerbaijan, distribution of totally 9 species of this genus in the flora of Georgia is shown which stipulates the similarity coefficient of species to be relatively small number. On the other hand, it is explained with the fact that the elements of Europe and Caucasus have a relative great influence on the formation of the flora of Georgia in comparison with the flora of Azerbaijan (Flora of Georgia, 1985; V.Z. Gulisashvili, 1964). It shall be noted that flora elements of Mediterranean Sea have a great influence on the flora of Azerbaijan.

3.If we compare the *Boraginaceae* of the flora of Armenia, the additions of K.G.Tamanyan who prepared this family for publication of new flora shall be taken into consideration. According to the analysis we can note that the family *Boraginaceae* was represented with 83 species belonging to 29 genera in Armenia (Flora of Armenia, 1980; Tamanyan K.G., 2011). Species belonging to 4 genera such as *Brunnera, Omphalodes, Suchtelenia and Trigonocaryum* distributed in the flora of Azerbaijan are not totally found in the flora of Armenia. There is visual evidence that besides the geographic features of Caucasus, the features of ancient Mediterranean Sea have an influence on the formation of the flora of Armenia.

Species *P.molissima* belonging to genus *Pulmonaria L.* of which only one genus is found in the flora of Armenia is represented in the flora of Azerbaijan. This is also an example of rich flora of Azerbaijan in comparison with the flora of west neighbor. So if we consider that the general number of *Boraginaceae* distributed in the flora of Azerbaijan and Armenia is 32+1=33, the number of common genera is 28, so the similarity coefficient of genera of these neigbour countries will be as k=(28x100%):33=~85%.

So if we consider that the general number of common species of *Boraginaceae* distributed in the flora of these regions is 72 and only 11 species of *Boraginaceae* distributed in the flora of Armenia

are not found in the flora of Azerbaijan, then the similarity coefficient for these both regions will be as k=(72x100%):118=~61%.

4. If we pay attention to the taxonomic composition of *Boraginaceae* distributed in the flora of Turkey, south-west neigbour of Azerbaijan we will observe that this family is represented with 302 species belonging to 41 genera out of which species belonging to 11 genera such as *Cordia* L., *Trachystemon* D. Don, *Pulmonaria* L., *Lithodora* Griseb., *Trachelanthus* Kunze, *Trichodesma* R. Br., *Borago* L., *Paracynoglossum* M.Pop., *Neatostema* Johnston, *Hormuzakia* Gusulaec and *Phyllocara* Gusulaec are not found in the flora of Azerbaijan. The species of genera such as *Trigonocaryum* and *Suchtelenia* found in the flora of Azerbaijan are not distributed in the flora of Turkey. So if we take into consideration that the number of common genera is 30, the total number of genera is 43, then the similarity coefficient of genera for both regions will be – k=(30x100%):43=~70%.

229 species distributed in the flora of Turkey are not found in the flora of Azerbaijan, contrary 34 species distributed in the flora of Azerbaijan are not found in the flora of Turkey. If we consider that the number of common species in both regions is 73, the general number of species is 107+229=336, then the similarity coefficient of species will be as k=(73x100%):336=~22%. The reason why the similarity coefficient of species is so different and low can be explained in the following way: several genera represented with a lower number in Azerbaijan are distributed with numerous species in Turkey. For example: the genus *Onosma* is represented with 10 species in Azerbaijan, 88 species in Turkey, the genus *Alkanna* is represented with only 1 species in Azerbaijan, 31 species in Turkey, the genera *Symphutum* and *Anchusa* are represented with 3 species in Azerbaijan, 20 and 14 species in Turkey which stipulates the difference and low percentage of the similarity coefficient of species.

5. The flora of Iran is represented with many Taxons- 218 species belonging to 46 genera as in the flora of Turkey, which is explained as follows: the area of Iran is nearly 10 times larger than the area of other regions and the flora is formed under the influence of geographical elements of the ancient Mediterranean Sea, Indian Himalaya, Sahara, Irani-Turan and etc.

Species belonging to 15 genera out of 46 such as *Cordia* L., *Ehretia* L., *Tournefortia* (L.) Dandy., *Echiochilon* Desf., *Moltkiopsis*I. M. Johnst., *Gastrocotyle* (Bge) Bentham etHooker, *Phyllocara* Gusuleac, *Hormuzakia* Gusulaec, *Eritrichium* Schrad., *Lepechiniella* M.Pop., *Trichodesma* R.Br., *Microparacaryum* (Pop.) Hilger et Podlech, *Heliocarya* Bunge, *Trachelanthus* Kunze and *Lindelofia* Lehm. encountered in the flora of Iran are not found in the flora of Azerbaijan. Similarly only one genus –*Trigonocaryum* distributed in the flora of Azerbaijan is not represented in the flora of Iran. So if we take into consideration that the number of common genera represented in Iran and Azerbaijan is 31, the general number of genera is 47, then the similarity coefficient of common genera for these countries will be as k=(31x100%):47=66%.

If we pay attention to species then we will observe that 45 species distributed in Azerbaijan are not found in the flora of Iran and at the same time 156 species distributed in Iran are not found in the flora of Azerbaijan. As the general number of species of these neigbour regions is 218+45=263, the number of common species is 62, then the similarity coefficient of species will be - k=(62x100%):263=~23,5%.

If we compare *Boraginaceae* of Iran and Azerbaijan, the reason why the similarity coefficient of species as in the comparison with the flora of Turkey are so low, can be explained in the following way: the genera such as *Onosma* (37 species), *Heliotropium* (31species), *Paracaryum* (19 species) and *Rindera* (6 species) are represented with numerous species in the flora of Azerbaijan and *Trichodesma* of which none species is noted in Azerbaijan is represented with 8 species in the flora of Iran.

The floristic similarity coefficient of species composition of *Boraginaceae* distributed in Azerbaijan is different from one distributed in Iran and Turkey, therefore several questions are arisen: What will show the comparison of flora of Iran and Turkey? How close or different is the influence of geographical and ecological factors for both these countries?

Therefore, we also decided to determine the floristic similarity coefficient for the taxonomic composition of *Boraginaceae* distributed in Iran and Turkey. As mentioned above *Boraginaceae* is represented with 302 species belonging to 41 genera in the flora of Turkey, with 218 species belonging to 46 genera in the flora of Iran. If we pay attention to the genera we can observe that 11 genera represented in the flora of Iran such as *Ehretia* L., *Tournefortia* (L.) Dandy., *Echiochilon* Desf., *Moltkiopsis* İ. M. Johnst., *Gastrocotyle* (Bge.) Bentham et Hooker, *Eritrichium* Schrad., *Lepechiniella* M.Pop., *Suchtelenia* Kar.ex Meissn, *Microparacaryum* (Pop.) Hilger et Podlech, *Heliocarya* Bunge and *Lindelofia* Lehm. are not found in the flora of Turkey and contrary five genera represented in the flora of Turkey such as *Paracynoglossum* M.Pop., *Neatostema* Johnston, *Borago* L., *Trachystemon* D. Don, *Lithodora* Griseb. are not found in the flora of Iran. The species of 2 genera aren't recorded

both in flora of Turkey and Iran. If we consider that the general number of genera is 52, the number of common genera is 35, then the floristic similarity coefficient for genera of *Boraginaceae* of these countries will be accepted as k=(35x100%):52=67%.

While estimating the floristic similarity coefficient for genera of *Boraginaceae* of these countries, it became clear that the number of general species is 433, the number of common species is 96 (k=(96x100%):433=~22%). Though the similarity coefficient of species is relatively high, the reason of low percentage of species in the comparison of species is that the formation of species proceeds in different direction under the influence of different factors which results in high percentage of endemism in both floras.

The following table shows the comparative analysis, similarity coefficient of genus and species of taxons in the family of *Boraginaceae* of Azerbaijan with its surronding 5 phytogeographical regions, as well as between *Boraginaceae* of the floras of Iran and Turkey (Table 2).

As shown from the table *Boraginaceae* distributed in Azerbaijan is closer to *Boraginaceae* distributed in Armenia, Dagestan and Georgia for its taxonomic composition (both for genus and similarity coefficient of species), different from *Boraginaceae* distributed in Iran for the similarity coefficient of genera (totally 66%) and *Boraginaceae* distributed in Turkey for the similarity coefficient of species (totally -22%). This difference is explained by the fact that the area of Iran and Turkey is larger than the area of the Republic of Azerbaijan and the flora of these countries are formed under the influence of more different phyto-geographical properties.

The similarity analyses comparing the number of genera and species of *Boraginaceae* compostion per country or 6 phyto-geographical regions surrounding of the Azerbaijan show that only Caucasian countires for number of genera and species have similarity indices above 70%, and 50%, respectively (Table 3).

According to the flora references, when comparing the number of genera and species of *Boraginaceae* present in the Azerbaijan and the other neighbouring countries, the similarity indices (Figure 3) indicate that none of the pairs of countires or regions have a similarity above 85% and 61%, respectively.

The reason why the floristic similarity coefficient of species of *Boraginaceae* found in the flora of Azerbaijan is high in comparison with the Republic of Georgia, Dagestan and Armenia can be explained with the formation of the Caucasus, including Azerbaijan *Boraginaceae* under the influence of Alban flora. A.A.Grosseim who analysed the flora of the Caucasus noted a great role of Alban elements in the formation of general Caucasus flora (Grossheim, 1936).

Table 2. Comparative analysis, similarity coefficient of genus and species of taxons in the family of *Boraginaceae* Juss. of Azerbaijan

Phyto-geographical regions surrounding Azerbaijan	Total number of genus (piece)	The number of common genera (piece)	Similarity coefficient of genus (by %)	Total number of species (piece)	The number of common species (piece)	Similarity coefficient of spesies (by %)
Dagestan (AR)	34	24	71%	117	63	54%
Georgia	37	30	81%	132	67	51%
Armenia	33	28	85%	118	72	61%
Turkey	43	30	70%	336	73	22%
Iran	47	31	66%	263	62	23,5%
Comparison of *Boraginaceae* between Iran and Turkey	52	35	67%	433	96	22%

Table 3. Similarity indices comparing the *Boraginaceae* present in the phyto-geographical regions surrounding of the Azerbaijan. Jaccard index values for number of genera in the upper triangle. Jaccard index values for number of species in the lower triangle. The highest similarity values are shown in bold.

	Azerbaijan	Dagestan AR	Georgia	Armenia	Turkey	Iran
Azerbaijan	100	71	**81**	**85**	70	66
Dagestan AR (Russia)	54	100	69	67	56	47
Georgia	51	51	100	73	73	59
Armenia	**61**	49	45	100	71	60
Turkey	22	16	21	21	100	67
Iran	23.5	15	16	23	21	100

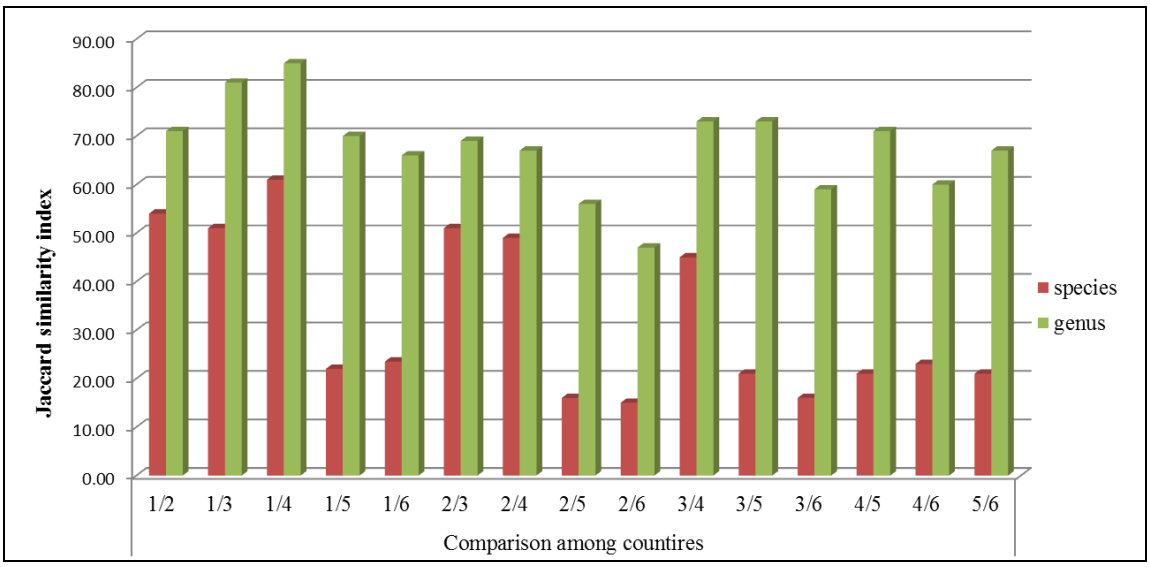

Figure 3. Jaccard similarity index for studied phyto-geographical regions or countries surrounding of the Azerbaijan (1 - Azerbaijan, 2 - Dagestan AR (Russia), 3 - Georgia, 4 - Armenia, 5 - Turkey, 6 - Iran).

On the other, hand species of Azerbaijan *Boraginaceae* have a floristic similarity coefficient with a low percentage in comparison with the flora of the Iran and the Turkey (23,5% and 22% correspondingly), which corresponds to our previous floragenetics outcomes (V.N.Karimov, 2016 a, b, c). It means that while more than 50% (54 species) of 107 species of *Boraginaceae* distributed in Azerbaijan belong to areal types of Caucasus, Atropatan and Europe, a greater part of the flora of Iran and Turkey (70-80%), especially where flora elements of Iran-Turan and Iran-Central Asia played an important role, belong to the areal type of the ancient Mediterranean Sea.

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Azərbaycan və Onu Əhatə Edən Fito-Coğrafi Regionların Göyzəbankimilərinin (*Boraginaceae* Juss.) Taksonomik Tərkibinin Müqayisəli Analizi

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Məqalədə Göyzəbankimilərin (*Boraginaceae* Juss.) Azərbaycan və ona qonşu olan ərazilərdə (Dağıstan Muxtar Respublikası (Rusiya Federasiyası), Gürcüstan, Ermənistan, Türkiyə və İran İslam Respublikası) yayılmış cins və növlərinin müqayisəli analizi verilmişdir.İki qonşu ərazidə yayılmış olan bitki növlərinin oxşarlığını müqayisə etmək üçün Jakarın floristik eynilik əmsalı üsulundan istifadə edərəkfloristik eynilik əmsalları müəyyənləşdirilmişdir. Aparılan analizin nəticəsi göstərmişdir ki, Azərbaycan Göyzəbankimiləri öz taksonomik tərkibinə görə Ermənistan, Gürcüstan və Dağıstan floraları ilə daha çox yaxın, Türkiyə və İran floraları ilə daha uzaq ortaqlığa malikdir.Bu da öyrənilən ərazilərin sahə ölçülərinin müqayisəolunma dərəcəsi, həmin ərazilərin floralarının hansı areal tipi yaxud da coğrafi elementlərin təsiri ilə formalaşması, nə qədər oxşar və fərqli iqlim şəraitinə malik olmaları ilə izah oluna bilər.

Açar sözlər: *Fito-coğrafi regionlar, Boraginaceae* Juss.*, Jakar metodu, eynlik əmsalı, Azərbaycan florası taksonları*

Сравнительный Анализ Таксономического Состава Семейства *Boraginaceae* Juss., Распространенного В Азербайджане и Фитогеографических Регионах Сопредельных Стран

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В статье представлен сравнительный анализ распространенных в Азербайджане и соседних с ним странах (Дагестанской Автономной Республике, Российской Федерации, Грузии, Армении, Турции и Иранской Исламской Республике) родов и видов семейства Бурачниковые (*Boraginaceae* Juss.). Для сравнения схожести видов растений, распространенных на двух соседних территориях был использован метод флористической общности - коэффициент Джакара. Результаты проведенных исследований показывают, что Бурачниковые Азербайджана по таксономическому составу более близки к флорам Армении, Грузии и Дагестана, тогда как с флорами Турции и Ирана свойственно более далекое сходство. Это можно объяснить степенью сравнения измеренных площадей исследованных территорий, типом ареала или географических элементов, влияющих на формирование этих территорий, сходством и различием климатических условий.

***Ключевые слова*:** *Фитогеографические регионы, Boraginaceae Juss., метод Джакара, коэффициент сходства, таксоны Азербайджанской флоры*