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Ecological and Geographical Confinement of Rare Medicinal Plants of Forest Flora of the Kuznetski Alatau in Need of Protection.

Nekratova AN[1]*, and Shilova IV[2].

[1]Federal State Autonomous Educational Institution of Higher Professional Education "National Research Tomsk State University",Tomsk, Lenin Ave., 36.
[2]National Research Institution of Pharmacology and Regenerative Medicine Named after E.D. Goldberg, Tomsk, Lenin Ave, 36.

ABSTRACT

The subject of the study was rare medicinal plants of the forest flora of the Kuznetski Alatau. The species used in officinal, folk and homeopathic medicine were listed as medicinal plants. The list of rare medicinal plants of forest flora of the Kuznetski Alatau in need of protection is recommended on the basis of field research conducted by the author. There are 12 species in the list. The method of regular embedding of key areas and a network of expeditionary routes were used in order to select field data, which enables a reliable estimation of the floristic richness of forest flora of the studied region. Identification of rare species was based on their occurrence and abundance. The basis for ecological and geographical analysis was the assignment of each species by the confinement of its belt and zone to a particular ecological-geographical group. The basis of chronological analysis was assigning each species to a specific geographical group according to a character of areal. The distribution within the Kuznetski Alatau inside geobotanical districts is shown for each species. Endemic and relicts are indicated. Nemoral elements, which are rare in the forests of the Kuznetski Alatau, are attributed to relicts of coniferous-deciduous forests. A complex coenotic character of the studied spectrum of flora, due to substantial participation of species, confined to light coniferous, deciduous and dark coniferous forests, was found. However, the proportion of species of dark coniferous plant communities is considerably inferior to the participation of species associated with cenoses of coniferous and deciduous forests. These exact species are more plastic coenotically and environmentally and they represent the majority of additional, natural mountainous and additional mountainous species.

Keywords: medicinal plants, forest flora.

Corresponding author

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INTRODUCTION

The Kuznetski Alatau is situated on the territory of the Republic of Khakassia and Kemerovo Region. The life-sustaining activity of these large regions of Siberia is connected, particularly but not exclusively, with intensification of the use of natural resources. This creates a preservation problem of populations of medicinal plants.

The aim of our research was to study the ecological and geographical confinement of rare medicinal plants which grow in the Kuznetski Alatau.

There some wild-growing species in need of protection: rare, vulnerable, endemic species [3].

There are 12 species of medicinal plants in need of protection: rare species on the border of areal, relict, endemic and intensively exploited commodity species in the forest flora of the Kuznetski Alatau. Rare species, relicts and endemics are protected only if they grow on protected areas. In the Kuznetski Alatau there is a natural reserve – "Kuznetski Alatau" which is located in Kemerovo Region on the west macroslope (the upper reaches of the rivers Kiya and Verkhniaya Ters, and the upper and middle reaches of the rivers Sredniaya and Nizhniaya Ters). On the eastern macroslope of the Kuznetski Alatau a National Park "Pescherniy Krai", which protects the caves and surrounding areas, was created.

In the forest flora of the Kuznetski Alatau the scientific bases of rational exploitation for a number of officinal medicinal plants were developed [9].

MATERIALS AND METHODS

The subject of the study was rare medicinal plants of the forest flora of the Kuznetski Alatau. The species used in officinal, folk and homeopathic medicine were listed as medicinal plants.

Forest flora is understood as partial flora of the forests of the Kuznetski Alatau and it is distinguished as a set of species growing in forest communities. The method of regular embedding of key areas and a network of expeditionary routes were used in order to select field data, which enables a reliable estimation of the floristic richness of forest flora of the studied region. Identification of rare species was based on their occurrence and abundance.

The basis for ecological and geographical analysis was the assignment of each species by the confinement of its belt and zone to a particular ecological-geographical group [8].

Ecological and geographical groups, distinguished by L.I. Malyshev [6] and then supported by other botanists [4, 15, 16] were adopted in this research. The approach of N.A. Nekratova serves as the basis of this study; it is based not only on the occurrence of species in a certain belt and zone area but also on the quantitative participation of species in the vegetation [11]. The following ecological and geographical groups and subgroups were adopted:

1. The highland group includes species growing mainly in the highlands.

1.1 The Arctic highland subgroup is of a mixed character because it includes the species which grow in the high-mountain belt, arctic and subarctic zones and a range of species descending into the forest belt.
1.2 The mountainous highland subgroup consists of the species which generally grow at high altitudes but descending into the forest belt.

2. The mountainous group combines the species growing in the mountains, mainly below the alpine zone.

1.1 The alpine mountainous subgroup comprises the species which grow in the mountains but entering the highlands.
1.2 The natural mountainous subgroup consists of the species which are spread mainly in the forest belt.
1.3 The mountain-steppe subgroup comprises the species growing mainly in mountainous steppes and entering the forest belt and highlands.

1.4 The additional mountainous subgroup includes plain and mountainous species with ecological and coenotic optimum in the mountainous areals.

2. The additional group consist of the species which are spread equally both on plains and in the mountains.

The basis of chronological analysis was assigning each species to a specific geographical group according to a character of areal.

In our studies the geographical groups distinguished by Revushkin [15] were adopted. In his work A.S. Revushkin was guided by the features of the species range and he proposed a hierarchical classification scheme of geographical elements of flora. The following geographical groups and subgroups were accepted:

1. Cosmopolites – the species widespread across the globe, found on many continents and penetrating into the Southern Hemisphere.
2. The Holarctic group comprises the species widespread in Europe, Asia and North.
3. The Eurasian group includes the species growing both in Europe and Asia. There are several subgroups:

3.1 The Natural Eurasian subgroup includes the species with a wide Eurasian areal.
3.2 The Euro-Siberian subgroup comprises the species with the main part of areal in Siberia, but they also enter the European part, mainly in the North.

4. The North American and Asian group consists of the species found in Asia and North America.
5. The Asian group is represented by the species which grow mainly within Asia.

5.1 The Natural Asian subgroup includes the species with a wide Asian areal.
5.2 The North Asian subgroup comprises the species with areals in Siberia only.
5.3 The Siberian-East Asian subgroup is represented by the species widespread mainly in East Asia with its minor part in Siberian regions.
5.4 The Middle Asian-Siberian subgroup consists of the species widespread in Siberia and entering the regions of Middle Asia and Kazakhstan.
5.5 The Mongolian-Siberian subgroup includes the species widespread in Siberia and entering Mongolia.
5.6 The Mongolian-South Siberian subgroup comprises the species of South Siberia, with minor part of areals in Mongolia.
5.7 The South Siberian-Central Asian subgroup consists of the species with their areal mainly in the mountains of Central and Middle Asia. The mountains of South Siberia are only a small piece of quite extensive areals of these species.
5.8 The Middle Asian-South Siberian subgroup comprises the species with more restricted areal covering the mountains of South Siberia and entering the regions of Central Asia.
5.9 The South Siberian subgroup includes the plants growing only within Altai-Sayan mountain region and Transbaikalia.

EXPERIMENTAL RESULTS AND DISCUSSION

The list of rare medicinal plants of forest flora of the Kuznetski Alatau in need of protection is recommended on the basis of field research conducted by the author [7, 10]. There are 12 species in the list. The distribution within the Kuznetski Alatau inside geobotanical districts is shown for each species: I – Barzasskiy tayozhniy, II – Kuznetsko-Alatausskiy visokogorniy, III – Severo-Kuznetsko-Alatausskiy temnokhvoino-svetlokhvoiniy, IV – Vostochno-Kuznetsko-Alatausskiy srednegorniy temnokhvoino-svetlokhvoiniy, V – Balyksinskiy gorniy chernevoi, VI – Batenevskiy nizkogorniy lesostepnoi [5]. Belt confinement is given: 1 – high mountain belt, 2 – taiga, 3 – black, 4 – subtaiga, 5 – forest-steppe. Endemic and relicts are indicated. Nemoral elements, which are rare in the forests of the Kuznetski Alatau, are attributed to relicts of coniferous-deciduous forests. Almost all of these species are coenotically confined to dark coniferous tallgrass or black forests. The selected species of rare medicinal plants of forest flora of the Kuznetski Alatau with indication of the distribution within geobotanical districts, belt confinement, the reasons for protection on this territory, biologically active substances, biological activity and application in medical practice are

provided further. In addition, there are species, highlighted in the text, which are used as officinal medicinal herbs (*), and in folk medicine (**).

Actaea spicata L. (III, IV; 4). Rare, relict of deciduous forests [2]. In mixed forests.

Biologically active substances: alkaloids, saponins, organic acids (trans-aconitic – 0,4 %). Hypotensive, sedative, anti-malarial, anti-tumor [12].

Alfredia cernua (L.) Cass. (II, IV; 2, 4). Relict of deciduous forests. In the sparse spruce and fir forests, taiga meadows and along rivers.

Biologically active substances: triterpenoids (*α*- and *β*- amyrins, moretenol, lupeol), butirolignans (arktiin), flavonoids (quercetin, isoquercitrin, rutin, etc.). Nootropic, anxiolytic, antidepressant, antioxidant, diuretic, antifungal [17].

Campanula trachelium L. (I-III; 2-4). Rare. Relict of deciduous forests. In coniferous and mixed forests.

Biologically active substances: coumarins, alkaloids, ect. nitrogen-based compounds (betain, stachydrine, choline), cyclitoles. Antiviral [18].

Epilobium montanum L. (I-V; 1-3). Rare (Kemerovo Region, valley of the River Ussa, near the village of Cheksu). Relict of deciduous forests. In black and mixed forests.

Biologically active substances: flavonoids (quercetin, miritsitrin, izomiritsitrin). Antibacterial [25].

***Galium odoratum* (L.) Scop. (I-III; 2-3). Relict of deciduous forests. In black and mixed forests.**

Biologically active substances: iridoids (genipozidovaya and asperulozidovaya acids, skandozid, monotropein, etc.), phenol carbonic acids, phenylpropanoids, naphthalene derivatives, anthraquinones. Antihypertensive, antibacterial, anti-protist, antioxidant, vulnerary [22, 24].

***Galium trifidum* L. (II; 2-4). Relict of deciduous forests. In marshy, wet forests.**

Biologically active substances: iridoids, flavonoids, coumarins (umbelliferone). ** Sedative, diuretic, expectorant, febrifuge, styptic, for skin diseases.

Hedysarum neglectum Ledeb. (II-IV; 1, 2, 4-6). Glacial relict. A valuable medicinal plant, it is harvested. In sparse larch forests and forest meadows.

Biologically active substances: xanthones (magniferine, izomagniferine), flavonoids (quercetin, hyperoside, 3-rhamnopyranoside and 3- rhamnophuranoside of quercetin, polistihozid), alkaloids (cytisin), sterines. Antioxidant, anthypnotic, adaptogenic [19,20].

Hippophae rhamnoides L. (IV; 4-5). Rare (the Republic of Khakassia, surroundings of the village of Efremkino). In poplar lowland forests.

Biologically active substances: carotenoids, triterpenoids, sterines, phospholipids, lignans, flavonoids, alkaloids and nitrogen-based compounds. Oil taken from fruits* as vulnerary, bactericidal, analgetic, antiulcer, juice – vitaminous. Anticarcinogenic, antitumoral, cardioprotective, hypolipidemic, hypoglycemic, immunomodulatory, neuroprotective, antiviral [14].

Rhododendron dauricum L. (II, IV; 1-4). Rare (the Republic of Khakassia, left bank of the river White Iyus above the mouth of the river Bolshaya Siya, north-eastern slope of the creek Karatege). In larch and pine forests.

Biologically active substances: ethereal oil (mono- and sesquiterpenoids, diterpenoids – andromedotoksin), triterpenoids, phenolcarbonic acids, flavonoids (farrerol), chromones, coumarins. Cardiotonic, diuretic, antiinflammatory, vulnerary, antioxidant, antibacterial, antiviral (HIV infection) [13, 23].

***Stachys sylvatica* L. (I-III; 2-4). Relict of deciduous forsets. In larch and birch forests, forest meadows.**

Biologically active substances: iridoids (garpagid, ayugol and their derivatives), ethereal oil (mono- and sesquiterpenoids, diterpenoids), triterpenoids, sterines, phenol carbonic acids, flavonoids. Lactogenic, antioxidant [21].

Vincetoxicum sibiricum (L.) Decne' (IV; 4, 5). Extremely rare (the Republic of Khakassia, the village of Malaya Siya). In pine, larch sparse forests and on rocky slopes.

Biologically active substances: triterpenoids, sterines, phenol carbonic acids, flavonoids, tsiklitoly. Antihypertensive, moderate myotropic, it inhibits the polio virus [26].

Viola mirabilis L. (IV; 4). Relict of deciduous forests. In mixed forests, forest edges.

Biologically active substances: flavonoids (quercetin, kaempferol, akatsetin, leukoanthocyanidins, leykodelfinidin), coumarins (herniarin, scopoletin), phenol carbonic acids (ferulic, chlorogenic), alkaloids, saponins, polysaccharides, amino acids, macro- and microelements. Anti-inflammatory, analgetic, expectorant, diuretic, antibacterial, antioxidant [1].

Ecological and geographical analysis showed that among the rare medicinal plants of forest flora of the Kuznetski Alatau additional (5) and natural mountainous species (4) are dominant. The additional species are: *Actaea spicata* L., *Campanula trachelium* L., *Galium trifidum* L., *Hippophae rhamnoides* L., *Viola mirabilis* L. An impressive part of the additional species is caused by direct adjacently in the north to the area of research of the West Siberian Plain. However, the additional species cannot be considered exclusively lowland, since they grow equally well on the plains and in the mountains. Natural mountainous species grow in the mountains, mainly in forest belt: *Alfredia cernua* (L.) Cass., *Epilobium montanum* L., *Galium odoratum* (L.) Scop., *Rhododendron dauricum* L. Mountainous highland species grow at high altitudes, but they do not descend to the forest belt, there is one related species – *Hedysarum neglectum* Ledeb. Additional mountainous species are ecologically plastic, they grow from plains – foothills – low-hill terrains to highlands. There is only one species in this group as well – *Stachys sylvatica* L., which is explained by the lack of plasticity of rare medicinal plants. The presence of the mountain-steppe group in forest flora of the Kuznetski Alatau is explained by contact with flora of Minusinsk depression. This group comprises the species which grow mainly in the mountain steppes. Mountain-steppe species are represented by *Vincetoxicum sibiricum* (L.) Decne'.

Thus, ecological and geographical analysis of rare medicinal plants is consistent with the analysis of the entire forest flora of the Kuznetski Alatau, the basis of which consists, according to ecological and geographical structure, of additional, natural mountainous and additional mountainous species.

The analysis of geographical distribution showed that most of the species (7) have a Eurasian, as a rule, disjunctive areal: *Actaea spicata* L., *Campanula trachelium* L., *Epilobium montanum* L., *Galium trifidum* L., *Hippophae rhamnoides* L., *Stachys sylvatica* L., *Viola mirabilis* L. These species are the most ancient ones, distributed before glaciation. Each of the rest of the groups has only one representative: Holarctic – *Galium odoratum* (L.) Scop.), Central Asian-South Siberian – *Vincetoxicum sibiricum* (L.) Decne', Middle Asian-South Siberian – *Alfredia cernua* (L.) Cass., South Siberian-Central Asian – *Hedysarum neglectum* Ledeb., Asian, mainly North Asian – *Rhododendron dauricum* L. South Siberian-Central Asian species show a direct connection of forest flora of the Kuznetski Alatau with Iran-Turan floristic region, although there is a connection with this area among other Asian species as well.

CONCLUSIONS

Overall, the highlighted set of rare medicinal plants of forest flora of the Kuznetski Alatau combines mainly the species of wide geographical distribution (Eurasian, Holarctic, Asian), which is consistent with the

chorologic structure of forest flora of Altai and Khakassia and it is characterized by the high biological activity of medicinal plants.

Ecological and geographical analysis showed that among the rare medicinal plants of forest flora of the Kuznetski Alatau additional and natural mountainous species are dominant, which generally corresponds to the whole range of forest flora of the Kuznetski Alatau and reflects its mountainous character. The selected species are characterized by pronounced biological effectiveness, which is caused by accumulation of high concentration of various biologically active substances. There are mainly the species of wide geographical distribution (Eurasian, Holarctic, etc.) in the list. Moreover, the species of the Asian continent constitute a little more than ¼ of the studied flora. The found correspondences of geographical groups in this spectrum of flora are typical for forest floras of South Siberia and they are different from the geographical structure of highland floras of the same territory, where the Asian group plays a more substantial role. Presumably, forest flora of the Kuznetski Alatau was formed largely by means of ancient, widely distributed forests, which is consistent with the ideas of paleobotanists and botanists about the relative uniformity of flora of Northern Eurasia and its close relationship with the flora of North America in the Paleogene.

A complex coenotic character of the studied spectrum of flora, due to substantial participation of species, confined to light coniferous, deciduous and dark coniferous forests, was found. However, the proportion of species of dark coniferous plant communities is considerably inferior to the participation of species associated with cenoses of coniferous and deciduous forests. These exact species are more plastic coenotically and environmentally and they represent the majority of additional, natural mountainous and additional mountainous species.

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