© 2018 Journal compilation
http://mjbs.num.edu.mn
http://biotaxa.org./mjbs
Volume 16(1), 2018

Mongolian Journal of Biological Sciences

ISSN 1684-3908 (print edition)
MJBS
ISSN 2225-4994 (online edition)

http://dx.doi.org/10.22353/mjbs.2018.16.04

Original Article

New Populations of *Artemisia shrenkiana* Ledeb. and *Limonium gmelini (*Willd.*)* Kundze at the Edge of Their Geographical Ranges in Western Transbaikalia (Southern Siberia)

Bimba B. Namzalov[1], Svetlana V. Zhigzhitzhapova[2], Maksar B.-Ts. Namzalov[1], Larisa D. Radnaeva[2], Erzhena V. Semenova[1]

[1]*Buryat State University, Ulan-Ude, Russia*
[2]*Baikal Institute of Nature Management of Siberian Branch of the Russian Academy of Sciences, Ulan-Ude, Russia*

Abstract

Key words: habitat, plant community, *Artemisia schrenkiana, Limonium gmelini,* Transbaikalia
Article information:
Received: 16 May 2017
Accepted: 30 Aug. 2018
Published online:
10 Sept. 2018
Correspondence:
namsalov@bsu.ru

This article contains information on ecology and phytocoenology of Transbaikalia border line populations of the Central Asian xero-halophytic species, *Artemisia schrenkiana* and *Limonion gmelini*. These species were noted in the composition of halophytic Achnatherum steppeficated meadow in the Ivolginskaya Valley of the Selenga Middle Mountain Range. The authors believe that the species are extinct of Pliocene desertified-steppe landscapes of Transbaikalia. The identified species add data on habitats and phytocoenotic association of these valuable medicinal and ether-bearing fodders. Detailed composition of essential oils in *Artemisia schrenkiana* Ledeb in Western Transbaikalia is identified.

Cite this paper as: Namzalov, B. B., Zhigzhitzhapova, S. V., Namzalov, M. B.-Ts., Radnaeva, L. D. & Semenova, E. V. 2018. New populations of *Artemisia shrenkiana* Ledeb. and *Limonium gmelini* (Willd.) Kundze at the edge of their geographical ranges in western Transbaikalia (Southern Siberia). *Mong. J. Biol. Sci*., 16(1): 29-35.

Introduction

Halophyte vegetation (Salineta) is one of the oldest biomes of the intermountain hollows in Transbaikalia (Southern Siberia), which develops on the saline habitats around lakes as well as river terraces. Within this vegetation, communities with dominance of *Achanatherum splendens* (Trin.) Nevski occupy the special position in the system and known as a relic tall grass (*Tussoki*) according to Kamelin (2005). The relic *Achnatherum* meadow communities are genetically related with Paleogene temperate and Subtropical Asian floras, and contain some original xerohalophyte floristic elements. Among them, *Artemisia schrenkiana*, a very rare species, and *Limonium gmelinii* previously unknown in Transbaikalia are found recently in a plain of the Indoga river in Western Transbaikalia.

The aim of this research is to study ecology and phytocoenology of *Artemisia schrenkiana* and *Limoniom gmelinii* in meadows of Western Transbaikalia, as well as to identify of the essential oil composition of local populations in *A. schrenkiana*.

Materials and Methods

The data was collected in the Ivolginskii district of the Republic of Buryatia (Western Transbaikalia).

Investigation of vegetation structure was conducted using the generally accepted geobotanical and floristic methods (Field Geobotanics, 1964). Plot sizes were equal to 100 m2. However, in case of small sized community, the plot size was taken within the natural contours. The abundance of species was defined according to the Drude scale. The nomenclature of taxa follows the compendium "The Flora of Siberia" (1987-1997). The relic concept follows Wulf (1941), Iliin (1958) and Kamelin (2005). The resource significance was determined following Vereshchagin *et al*. (1959) and Demidovskaya *et al*. (1976).

Herbarium samples of *A. schrenkiana* and *L. gmelini* are stored in the Herbarium of the Buryat State University, UUDE (Ulan-Ude), and duplicate samples of *Limonium gmelini* have been sent to TK (Tomsk).

Samples of *Artemisia schenkiana* for identification of the essential oil composition were collected during full bloom phase in August 2015. Essential oil was obtained by hydro-distillation method from the shredded air-dry plant mass (30-40 g) with help of the Clevenger apparatus. The essential oil was then analyzed with use of chromatography mass spectrometer method in the gas chromatographer Agilent Packard HP 6890. The quadrupole mass spectrometer (HP 5973 MSD) was used as a detector. A 30-meter quartz column HP-5 BST with the internal diameter 0.25 mm. was applied. Essential oil composition (in percent) was calculated according to the area of gas chromatographic peaks without correction factors. Qualitative analysis was based on the comparison between the calculated linear retention index values, holding times, full mass spectra and the library of chromatographic-mass spectrometric data for volatile plant source substances. Calculation of linear retention index (*J*) was performed in accordance with Tkachev's method (Tkachev, 2008). Quantitative analysis was performed through internal normalization according to area peaks without correction factors.

Results and Discussion

Sagebrush (Artemisia L.) is the largest genus of the family Asteraceae. Species of this genus are distributed in the Holartic region, and found from the Arctic tundra to the arid ecosystems of Eurasia. In the latter, they often form the original steppe and desert vegetation types. There are two subgenera in the Siberian flora: *Artemisia* and *Dracunculus* (Krasnoborov, 1997). The third subgenus, *Seriphidium* (Bess) Rouy is more typical for Central Asia, and presented in Siberia with small number of species.

Artemisia schrenkiana is one of the most interesting species of the subgenus *Seriphidium*. This is an Altai – Central-Asia – Tien-Shan halophytic species, typical for salt marshes, saline desert-steppe landscapes of Dzungaria and Turan (Goloskokov, 1984). The distribution area of this species reaches eastwards the Great Lakes Basin in Western Mongolia, and Transbaikalia in Southern Siberia. Until now, there are only two known locations in Transbaikalia: Tugnujskaya Valley (Western Transbaikalia) and Borzya steppes in Dahuria (Eastern Transbaikalia).

Recently, we newly found this species in the

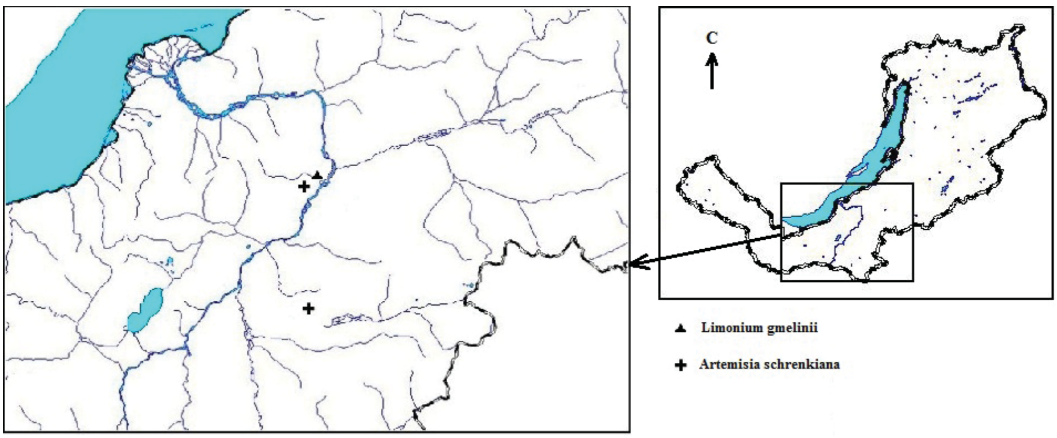

Figure 1. Location of *Artimisia schrenkiana* and *Limonium gmelinii* in Western Transbaikalia (ref. Krasnoborov, 1997 and our data). Legend: +: *A. schrenkiana*, ▲: *L. gmelinii*.

Ivolga River valley situated within the northern borders of the Selenga Middle Mountain range. The population was part of steppeficated *Achnatherum* saline meadow community (Fig. 1), belonging to the Turan – Central Asian halophyton, the special phytocoenotype, according to Kamelin (2005). This finding presents the easternmost peripheral population in this Altai – Central Asian species.

Another interesting finding was *Limonium gmelini* (Willd.) Kundze. Earlier, there were known only two species of this genus recorded in Transbaikalia, e.g. *Limonium aureum* (L.) Hill et Kuntse and *L. flexuosum* (L.) Kuntse (Kovtonuk, 1997). Thus *L. gmelini* is a new species for Western Transbaikalia, and this is the easternmost peripheral population of this Western Palaearctic (European-Western Asian) salt meadow haloxeromesophytic species (Namzalov *et al*., 2015). The nearest location of this species in the Lake Baikal region is in the Angara river basin (Checklist, 2008).

The description of plant community is given below.

Locality: Republic of Buryatia, Ivolginskii District, surroundings of Khubiskhal village (vicinity of the 23 km of the tract Ulan-Ude – Kyakhta), Ivolginskaya valley, ancient river-bed terrace of the Ivolga River, 29.07.2015.

Community name: Aconogonon Limonium Achnatherum halophytic meadow (Halophyton).

Soil – saline hydromorphic meadow; dark-brown silt soil under a saline crust. Some agrologists suppose the saline soil meadows of the Ivolginskaya valley to be of exudative type with atmospheric ground recharge and predominantly favorable water regime. However, large content of salts in the surface horizons of the soil profile has a depressing effect on the development of vegetation (Ubugunov *et al*., 2000).

Community aspect – violet purple (after *Limonium gmelini*), (Fig. 2). General canopy cover – 30%.

Species composition *Achnatherum splendens – cop1-2, Limonium gmelinii – cop1, Aconogonon angustifolium – sp-cop, Puccinellia teniussima – sp, Leymus chinensis – sp-copgr, Lepidium densiflorum – sp, Artemisia shrenkiana – sp-sol, Saussurea davurica – sol, Leymus paboanus – sol Halerpestes salsuginosa – solgr, Astragalus adsurgens – sol-un.*

According to Ilyin (1958), the origin of such halophyte species as *L. gmelini* and *A. shrenkiana* is related to saline wetlands of the desert-steppe depressions of the Central Asia. Our findings located far away north-eastwards in the Western Transbaikalian steppe, leads to a question: How could these plants get into the Western Transbaikalia?

Most likely these species are indigenous for Ivolginskaya valley, reached the Transbaikalia

Figure 2. Limonium steppeficated halophytic meadow (halophyte) with *Artemisia schrenkiana* on the ancient terraces on the Ivolga river (Western Transbaikalia). Photo by B. Namzalov

during the Tertiarian periods of desertification, presumably in Pliocene. Another remarkable species found in the Ivolginskaya Valley, is *Nitraria sibirica* Pall, a relict of the Central Asian Paleogene desert (Anenkhonov *et al*., 2013). The migration track for all these species might be the mountain ranges and intermountain hollows along the lines of the great Trans-Asian mountain chain from the deserts of Dzungaria and Tien-Shan in the north-east over the Altai and Sayan mountains, in Lake Baikal region, Siberia. If this assumption is correct, the Transbaikalian populations of *L. gmelini* and *A. schrenkiana* being as relict fragments of the Paleogene desert-steppe ecosystems of the ancient northern mainland “Angarida”. However, confirmation of the relict origin should be proved (see Wulf, 1941; Namzalov, 2012), and more detailed studies are required.

The peculiarities of marginal populations are expressed not only in development of the unique morphological features, but also in a specific character of the secondary metabolite substances, e.g. biochemical composition and essential oil components. It is quite common that populations on limits of its geographical distribution range have significant differences from the typical race that they are described as special varieties and even new species. This is the case of the *A. subviscosa* Turcz, an endemic of mountain steppes in Northern Baikal area, which is an island of *A. obtusiloba* Ledeb., isolated population (Popov, 1959; Bazarova *et al*., 2002).

It is important to note that these unique species in the Transbaikalian flora have practical value as useful plants. It is known that *A. schrenkiana* is a valuable forage plant in Central Asia. Additionally, it contains high proportions of essential oils. For example, the composition of essential oils in the aerial part of this *Artemisia* in the Kazakhstan population contains phenols (8.7%), cineol (63.5%), camphor (10.25%) and others (Goryaev *et al*., 1962; Demidov *et al*., 1976).

Essential oils were obtained from the *A. schrenkiana* integrate top part, leaves and inflorescences. The stems contain traces of essential oils. Outputs of essential oils from tops accounted to 1.1%, from the leaves, and inflorescences – 1.3% in terms of air-dry raw materials. Essential oils are liquids of jonquil colour. We identified 39 components (90.15%) in the composition of the essential oil extracted from inflorescences, 36 (90.3%) from tops, and 24 (97.9%) components from the leaves. The main components (camphene, sabinene, 1,8-cineol, camphor, borneol, terpinen-4-ol, α-terpineol, bornylacetate, carophyllene, β-selinene) were common in the three fractions (tops, leaves and inflorescences) from *A. schrenkiana* oil (Table 1). Predominance of 1.8-cineol and camphor in the oil coincides with data described in other sources (Goryaev *et al*., 1962; Demidov *et al*., 1976), and is peculiar for many species of the subgenus *Artemisia* (Zhigzhitzhapova *et al*., 2014). The presence of these components in the essential oil of *Artemisia nanschanica* Krasch, was previously identified (Shang *et al*., 2012).

Limonium gmelini refers to tannin plants. So, the roots contain 17-18% of tannins, while the top parts contain alkaloids, flavonoids and Glycoside-miricitrine (Vereshchagin *et al*., 1959). When marsh-root is used as a skin-tanning agent, it acquires a reddish-brown colour. *Limonium* is also known as a wool coloring agent. Folk medicine

Table. 1. Chemical composition of the *A. schrenkiana* essential oil according to chromato-mass spectrometry.

Components	RI	Peak area % (Percentage)		
		Tops	leaves	Inflorescences
Tricyclene	921	0.07	0.13	
3-Thujene	926	0.15	0.17	
α-Pinene	932	0.58	0.47	
Camphene	947	2.58	4.30	0.24
Sabinene	973	3.24	2.12	0.20
β-Pinene	975	1.00	0.82	0.12
α-Phellandrene	1004	0.48	0.19	0.29
α-Terpinene	1017	1.53	2.04	
p-Cymol	1024	1.95	3.09	0.85

Table 1. (Continued)

1.8-Cineol	1031	17.25	41.49	8.04
γ-Terpinene	1058	2.01	3.24	
trans-Sabinene hydrate	1066	0.60	1.32	
Terpinolene	1088	0.40	0.52	0.37
cis-Sabinene hydrate	1098	0.32	0.39	0.54
para-cis-Menth-2-en-1-ol	1121	0.32	0.26	
para- trans-Menth-2-en-1-ol	1141	0.50	0.22	0.25
Camphor	1144	8.36	12.22	8.39
p-Mentha-1,5-dien-8-ol	1156			0.11
Sabinaketone	1157			0.14
Pinocarvone	1164	0.31	0.32	0.26
Borneol	1166	8.39	8.23	7.76
Terpinen-4-ol	1177	4.43	4.39	7.40
α-Thujenal	1190			0.74
α-Terpineol	1191	2.37	0.94	3.76
Piperitol	1195	0.18		0.32
trans-Carveol	1212			0.11
cis-Carveol	1229	0.15		0.19
cis-3-Hexenyl-2-methylbutyrate	1233	0.25		0.37
Bornyl acetate	1287	1.51	1.26	1.68
Eugenol	1359	0.18		
Copaene	1376	0.17		0.35
β-Elemene	1392	0.35		
(*E*)- Jasmone	1392	0.22		0.17
Caryophyllene	1422	3.81	1.78	4.56
Germacrene D	1484	0.92		
β-Selinene	1486	16.35	7.61	16.86
Phenethyl 2-methylbutyrate	1488			0.31
Bicyclogermacrene	1576			0.28
Spathulenol	1576			1.92
Caryophyllene oxide	1581	3.99		2.35
Caryophylla-4(12),8(13)-dien-5-one	1601	1.00		
Caryophylla-4(12),8(13)-diene-5α-ol	1637	1.13		0.17
Selin-6-en-4α-ol	1638			0.40
Intermedeol	1660	3.12		2.69
β-Santalol	1715			0.22
7-Isopropenyl-1,4a-dimethyl-4,4a,5,6,7,8-hexahydro-3H-naphthalen-2-one	1755			3.69
Costol	1778			1.39
Methyl isocostate	1792			11.12
trans-Valerenyl acetate	1832			0.86
Dihydrodehydrocostus lactone	1954			0.68
Total		90.30	97.88	90.15

uses the roots in the form of decoction or powder as an astringent remedy for diarrhea, and as a styptic agent, while Tibetan medicine applies this plant for gynecological diseases (Wild-growing useful …, 1985).

Thus, we identified a new location of *A. schrenkiana* and *L. gmelini* in Transbaikalia. The populations of these predominantly Asian species are not only border and easternmost edge, but also relicts for Transbaikalia region. It is important that these species enrich the gene pool of useful wild plants in the Lake Baikal region of Siberia.

Conclusion

It should be noted that the finding of new ecotone populations of *A. shrenkiana* and *L. gmelini* in Transbaikalia (Southern Siberia) not only expands their distribution area in the eastern borders, but also updates the information on ecology-phytocoenotic characteristics of these species. The chemical analysis validated richness and diversity of the *A. schrenkiana* essential oil composition. The future research is important in understanding of the processes that followed species' adaptation to the extreme continental climate of the Lake Baikal region of Siberia.

Acknowledgements

The research project was undertaken with the financial support of the Russian Foundation for Basic Research and the Republic of Buryatia's Government (project draft № 15-44-04233r_Sibir_a; № 15-44-04112r_Sibir_a).

References

Anenhonov, O.A., Badmaeva, N.K., Tubanova, D.Ya. 2013. Findings of the rare and alien species of vascular plants in southern Buryatia. *Bulletin Moskovskogo Obshestva Ispytatelei Prirody. Otdel, Biologii*,118(3): 72–73. (In Russian)

Bazarova S.V. (Zhigzhitzhapova S.V.), Bodoev N.V., Namzalov B.B. 2002. Chemical composition of essential oil of Artemisia obtusiloba. *Himiya rastitelnogo syrjya*. 1: 81–84. (In Russian)

Chen S.L., Fu P.C., Zhang F.Q. 2014. Composition of essential oil of Artemisia hedinii Ostenf. Et Pauls. on the Qinghai-Tibetan Plateau. *Industrial Crops and Products*. 62. 293–298. (In Russian)

Demidovskaya L.F., Egeubaeva R.A., Averina V.Yu. 1976. Artemisia of Kazakhstan as a raw material for obtaining essential oils and their valuable components // *Novyie lekarstvennyie i efirnomaslichnyie rasteniya Kazahstana*. Alma-Ata: 61–73. (In Russian)

Goloskokov V.P. 1984. Flora of Dzungarian Alatau: (abstract and analysis). Nauka, Alma-Ata. 224 (In Russian)

Goryaev M.I., Bazilitskaya V.S., Lishtvanova L.N. 1962. Chemical composition of Artemisia. Alma-Ata. 151. (In Russian)

Il'in M.M. 1958. The flora of the deserts of Central Asia, its origin and stages of development. *Materialyi po istorii floryi i rastitelnosti SSSR*. 3. AS SSSR Press, Moscow-Leningrad: 129–229. (In Russian)

Kamelin R.V. 2005. Types of vegetation (florocenotypes) of the Altai mountainous country. *Flora Altaya*. 1. Azbuka Press, Barnaul: 31–47. (In Russian)

Krasnoborov I.M. 1997. Artemisia L. – Wormwood. *Flora Sibiri*. 13*: Asteraceae (Compositae)* – Nauka. Sib. predpriyatie RAS, Novosibirsk: S. 90–141. (In Russian)

Kovtonyuk N.K. 1997. Limonium Miller – Kermek . *Flora Sibiri*. *– 11: Pyrolaceae – Lamiaceae (Labiatae)*. Nauka. Sib. izdatelskaya firma RAS, Novosibirsk: 50–56. (In Russian)

Lavrenko E. M., Korchagin A. A. 1964. Field geobotany. 3. Nauka Press, Moscow-Leningrad: 530 (In Russian)

Malyshev L. I. 2008. Abstract of the flora of the Irkutsk region (vascular plants). Izd-vo Irkut. gos. un-ta, Irkutsk: 327. (In Russian)

Namzalov B.B. 2012. The concept of "relics" in geobotany: the history of the issue and modern approaches. *Izvestiya Samarskogo nauchnogo tsentra RAS*. 14,№ 1 (7). 1799–1804. (In Russian)

Namzalov B.B., Sahyaeva A.B Namzalov., M. B-Ts., Burdukovskiy A.I. 2015. Limonium gmelinii (Willd.) Kundze. – a new species in the flora of Buryatia (Western Transbaikalia). *Issledovaniya prirodnyih fenomenov i sotsialno-ekonomicheskih protsessov v Aziatskoy Rossii i Mongolii*. Buryat State university Press, Ulan-Ude: 74–78. (In Russian)

Popov M.G. 1959. Artemisia L. – Wormwood. *Flora Sredney Sibiri*. 2. AS SSSR Press, Moscow-Leningrad: 730–740. (In Russian)

Tkachev A.V. 2008. Research of volatile

substances of plants. Ofset Press, Novosibirsk: 969 (In Russian)

Shang, Z.H., Hou, Y., Long, R.J. 2012. Chemical composition of essential oil of Artemisia nanschanica Krasch. from Tibetan plateau. *Industrial Crops and Products*. 40, 35–38. (In Russian)

State pharmacopoeia of USSR. General methods of analysis. Medicinal herbal raw material. 1990. 2. Meditsina Press. Moscow: 400. (In Russian)

Ubugunov L.L., Lavrenteva I.N., Ubugunova V.I., Merkusheva M.G. 2000. Diversity of soils in the Ivolginsky Basin: ecological and agrochemical aspects. BGSHA Press. Ulan-Ude: 208 (In Russian)

Vereschagin V.I., Sobolevskaya K.A., Yakubova A.I. 1959. Useful plants of Western Siberia. AS SSSR Press, Moscow-Leningrad. 348. (In Russian)

Vulf E.V. 1941. The concept of a relic in botanical geography. *Materialy po istorii flory i rastitelnosti SSSR.* Moscow-Leningrad. 1: 28–60. (In Russian)

Wild-growing useful plants of the flora of the Mongolian People’s Republic. 1985. Nauka Press. Leningrad: 236. (In Russian)

*****