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Flora accompanying *Prunus ledebouriana* (Schltdl.) Y.Y.Yao in the Tarbagatai State National Park in Kazakhstan

Abstract. The current state of the *Prunus ledebouriana* (Schltdl.) Y.Y. Yao population growing at various altitudes on the shrub and steppe belts of the Tarbagatai ridge and its species composition were studied. The methods of floristic composition analysis were applied for the first time. The complete composition of accompanying species including *Prunus ledebouriana* was studied on the territory of Tarbagatai State National Park. The originality of this work was in creation of a distribution map for the *Prunus ledebouriana* population. Samples collected in the park from various sources were used as material. The results are presented in the form of a list including 511 species (52 families) that grow together with *Prunus ledebouriana* in this area. The leading families in terms of species number: *Asteraceae* Dumort. (75 species/ 35.2%), *Fabaceae* Lindl. (56 species/ 40.8%), *Poaceae* Barnhart. (52 species/ 32.5%), *Rosaceae* Juss. (43 species/ 44.3%), and *Ranunculaceae* Juss (39 species/ 50%). Species diversity of the families: *Asteraceae* Dumort. 22%, *Fabaceae* Lindl. 17%, *Poaceae* Barnhart. 16%, *Rosaceae* Juss. 13%, *Ranunculaceae* Juss. 12%, *Brassicaceae* Burnett. 7%, *Apiaceae* Lindl. 7%, and *Scrophulariaceae* Juss. 6% of all species growing with *Prunus ledebouriana*. The results of research can be used for species identification and organization of conservation activities for the rare plant species *Prunus ledebouriana*. The studied herbarium samples of *Prunus ledebouriana* (Institute of plant biology and biotechnology, Almaty, Kazakhstan) were transferred to the herbarium fund of the Institute of Botany and Phytointroduction (Almaty, Kazakhstan).

Key words: *Tarbagatai ridge, endemic species, shrub, cenopopulation, floristic composition.*

Introduction

Organization of specially protected natural areas (SPNA) network is the most effective activity for the preservation of rare, endangered species, unique and virgin areas of nature in the East Kazakhstan [1]. Tarbagatai State National Park was founded on the territory of the Tarbagatai ridge in the East Kazakhstan region (EKR), on the border with the Xinjiang Uygur Autonomous Region of China [2, 3] in accordance with the Resolution No. 382 of the Government of the Republic of Kazakhstan dated from June 27, 2018 [4]. Tarbagatai State National Park is located in the semi-desert landscape of the temperate zone, and it is part of the Tarbagatai physical-geographical province of the Saur-Tarbagatai physical-geographical region of the Dzungar-Saur-Tarbagatai mountainous country [5].

Nowadays, the flora of the Tarbagatai ridge is represented by about 1,640 plant species. The species

composition changes vertically. The southern slope of the Tarbagatai ridge consists of desert-steppe sub-belt – 500-700 m; steppe belt – 700 (600) – 1000 (1200) m; shrubs belt – 1000 (1200) – 1700 (1800) m; subalpine belt – 1700 (1800) -2400 m; and alpine belt – 2400-3100 m. The flora of Tarbagatai ridge is still poorly studied; the information on the plant species diversity of this region was presented in the work of E.F. Stepanova [6]. According to the natural scientific substantiation of 2014, species on the studied territory belong to 80 families and 504 genera including 14 species of ferns (0.9%), 4 species of horsetails (0.2%), 6 species of gymnosperms (0.4 %), 334 species of monocotyledons (20.5%) and 1269 species of dicotyledons (78%); 169 species of them are endemic plants [7].

A rare, endemic, and ornamental shrub Ledebour almond (*Prunus ledebouriana* (Schltdl.) Y.Y.Yao) (Figure 1) of the family *Rosaceae* grows on the park

territory and forms large stripes and thickets in the central part of the Tarbagatai ridge's southern slope [8].

Amygdalus ledebouriana Schltdl. was discovered and identified for the first time by German botanists Schlechtendahl. The first information about this species was published in 1854: *Abhandlungen der Naturforschenden Gesellschaft zu Halle* 2 [9]. This species was presented in the tenth volume of "Flora of the USSR" [10], in the fourth volume of "Flora of Kazakhstan" [11], and in the first part of the "Illustrated guide of plants in Kazakhstan" [12]. *A. ledebouriana* was included in the "Red Book of the Kazakh SSR" [13], as a rare and endangered plant species. In all of the abovementioned sources, this

plant species is described as a rare and endemic plant species found in East Kazakhstan. The main species trait can be found in generative plants at the fruiting phase and is observed in half-open fruits with a formed pit, the base of which is obliquely drawn [14, 15].

Species name *Prunus ledebouriana* (Schltdl.) Y.Y. Yao is valid and widespread in English sources [16-19], but the synonymous name *Amygdalus ledebouriana* (Ledebour or ledebourian almond) is common for endemic plant species listed in the "Red Book of Central Asia" [20] and "Red Book of the Republic of Kazakhstan" [21]. It has the status of Endangered (EN) (IUCN Red List) according to various world source [22].



Figure 1 – *Prunus ledebouriana* (Schltdl.) Y.Y. Yao, growing along the road near Urjar village (photo by A.E. Orazov, 2020)

The species grows in a meadow or mesoxerophilic steppes, on mountains, steppe slopes and plateaus, in river valleys and in meadow hollows. It occurs in the foothills of the southwestern Altai, Tarbagatai ridge, Dzhungar Alatau. It is found in floristic regions of Kazakhstan under numbers 22 – "Altai" and 23 – "Tarbagatai" (Figure 2).

The studies were carried out on the territory of the Tarbagatai State National Park with the official permission of the organization (permission letter from the director of the

Tarbagatai State National Park Tokymtaev A.B. No 5-182 from 24.06.2020) within the framework of the project AP05131621 "Informational system for molecular-genetic and botanical documentation of wild flora in Kazakhstan" [23] for 2018-2020 by specialists of the Molecular Genetics Laboratory of the Institute of Plant Biology Biotechnology and Biotechnology (IPBB) the Committee of Science of the Ministry of Education and Science of the Republic of Kazakhstan (CS MES RK) (Almaty).

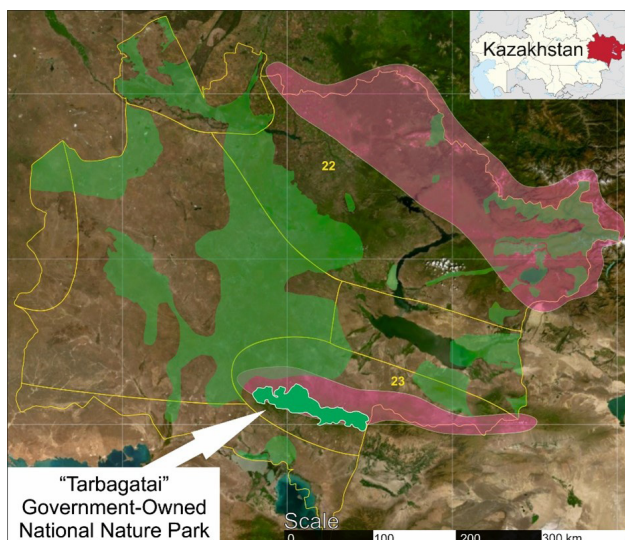


Figure 2 – Google maps Earth view of Geographic location of the Tarbagatai State National Park among SPNA (green) and distribution areas of *Prunus ledebouriana* (pink)

Materials and methods

The generally accepted botanical and floristic methods described in the work of Bykov B.A. [24] were used for the description of plant communities

with the participation and dominance of the studied plant species. The Latin names of these species were checked in various international plant databases [25–28]. Also, classical sources were used in accordance with the rules adopted in the summary of Cherepanov S.K. [29] and Abdulina S.A. [30]. The maps were constructed using ArcMap 10.4 and CorelDRAW 2017 software based on the functional zoning map, projected infrastructure and tourism facilities of the Tarbagatai State National Park (“Tarbagatai Mountains” section). The map of East Kazakhstan from the Google maps service was used as an original (Figure 2).

The survey was carried out according to the route-reconnaissance method [31]. The field research routes were compiled based on cartographic forest management materials of land use, administrative maps of the Urdzhar region, and maps of the Tarbagatai State National Park. The location of thickets was determined using the biological characteristics and ecological confinement of the studied species, as well as using herbarium material from this area. Herbarium fund of higher plants of the Institute of botany and phytointroductions: Tarbagatai ridge, southern slope, Kusak river gorge, 1200 m above sea level, on the western slope, from July 31, 1955 were collected and identified by Stepanova E. and others (Figure 3).



Figure 3 – Herbarium specimens of *Prunus ledebouriana* (collected and identified by A.E. Orazov, J.K. Alemseytova, and Sh.T. Tustubayeva, 2020)

The species names of plants were determined using the “Flora of Kazakhstan” [32], “Illustrated guide to plants of Kazakhstan” [12], “Illustrated

encyclopedia” [33]. Pictures in the nature (Figure 4) were uploaded to the site: www.inaturalist.org [34].



Figure 4 – *Prunus ledebouriana* (Schltdl.) Y.Y. Yao at the fruiting phase near Urjar village (photo by A.E. Orazov, June 2020)

Seeds and herbarium specimens were transferred to the herbarium fund (Laboratory of higher plants flora) and the seed fund (Laboratory of seed production) of the Institute of Botany and Phytointroduction (Almaty) for the identification and storage. Biological samples were also collected and transferred to the Laboratory of Molecular Genetics of the Institute of Plant Biology and Biotechnology (Almaty) and to the MTA-DE “Lendulet” Evolutionary phylogenomics department of botany (Debrecen, Hungary) for subsequent genetic analysis.

Results and discussion

As a result of the survey in the southern slope of the Tarbagatai ridge, several large coenopopulations of *Prunus ledebouriana* were identified (Table 1).

Individual plants of this species form dense stripes (almonds), heterogeneous along the entire length of the ridge on low-mountain, mid-mountain and high-mountain shrub belts (from 700/800-1200 m to 1700-1800 m).

To identify the species composition, were studied three cenopopulations located on different shrub belts (low-mountain, mid-mountain, high-mountain) at the beginning and middle part of the Tarbagatai range (from south to east).

In the lower part of the southern slope, within 700-1500 m, was occupied by thickets of bushes, mainly *Prunus ledebouriana* (Figure 5), in combination with roses (*Rosa spinosissima* L.), aspen lines (*Populus tremula* L.) and apple thickets (*Malus sieversii* (Ledeb.) M. Roem.) with a well-developed shrub layer of *Rosa spinosissima* and *Prunus ledebouriana*.

Table 1 – Characteristics of the *Prunus ledebouriana* cenopopulations on the south slope

No. CP	Administrative territory	GPS coordinates	Altitude (m)	Habitat
	EKR, Urjar district, neighborhood of Urjar village	47°07'17.4"N 81°39'18.5"E	520	Low-mountain shrub belt
	EKR, Urjar district, neighborhood of Karabuirat village	47.0600554 N; 81.8995046 E	760	Mid-mountain shrub belt
	EKR, Urjar district, neighborhood of Koldenen village	47°15'24.9"N 81°86'39.6"E	862	High-mountain shrub belt

Notes: CP – cenopopulation, EKR – East Kazakhstan region.

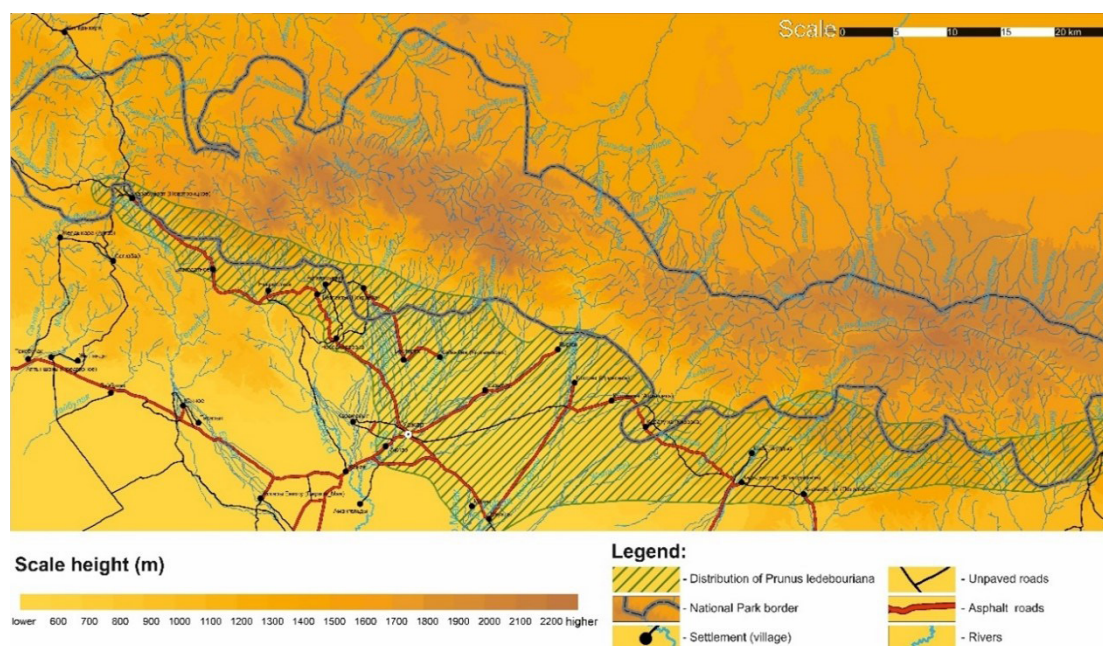


Figure 5 – Distribution of *Prunus ledebouriana* on the territory of the Tarbagatai State National Park

Thickets of shrubs occur on the rocky southern slopes. Here, many individuals of *Atraphaxis laetevirens* Jaub. et Spach, *Calophaca hovenii* Schrenk, and *Spiraea hypericifolia* L. are found in addition to *P. ledebouriana*. *Poaceae* family in these shrubs is mostly represented by *Bothriochloa ischaemum* (L.) Keng. Meadowsweet and caragana thickets (*Spiraea hypericifolia* L., *S. trilobata* L., *Caragana camilli-schneideri* Kom., *C. frutex* (L.) K. Koch) prevail together with dry steppe's wormwood-turf-grasses communities (*Stipa capillata* L., *S. sareptana* A.K. Becker, *Festuca valesiaca* Schleich. ex Gaudin, *Phleum phleoides* H.Karst., *Artemisia marschalliana* Spreng., *A. sublessingiana* Krasch. ex Poljakov, *A. compacta* Fisch. ex DC., and *Carex pediformis* C.A.Mey). In the middle mountains, they form a belt at an altitude from 800-900 m to 1350-1450 m above sea level and represent a regular alternation with meadow-steppe and meadow communities. Roses (*R. spinosissima*) with honeysuckle (*Lonicera tatarica* L.), *S. hypericifolia*, *Helictotrichon pubescens* (Huds.) Pilg., *Festuca valesiaca*, and *Artemisia sericea* Weber ex Stechm. prevail in this region. On the southern slopes, they also include *Cotoneaster melanocarpus* Fisch. ex Blytt and *C. oliganthus* Pojark. In the herbaceous layer, mesophytic forbs and grasses prevail (*Bromopsis pumpelliana* (Scribn.) Holub, *Bromopsis inermis* (Leyss.) Holub, *Fragaria viridis* (Duch.) Weston, *Lathyrus gmelinii* (Fisch.) Fritsch, *Peucedanum morisonii* Besser ex Schult., and *Thalictrum simplex* L.), *S. hypericifolia*, *F. valesiaca*, *Poa stepposa* (Krylov) Roshev., *Stipa pennata* L., *Helictotrichon desertorum*,

Origanum vulgare L., *Artemisia vulgaris* L., *Thymus stepposus* Klokov & Des.-Shost., and *Medicago falcata* L.

Meadowsweet (*S. hypericifolia*) thickets are common in the intermontane valleys at an altitude of 1200-1300 m together with motley grasses (*H. pubescens*, *Dactylis glomerata* L., *Poa angustifolia* L., *Galium verum* L., and *A. sericea*). Alpine shrubs, usually juniper (*J. sabina*, *J. sibirica*) and meadowsweet (*S. trilobata*, *S. hypericifolia*), grow in the upper belt of mountains together with *C. uniflorus* Bunge shrubs and a grass layer of *Potentilla acaulis* L., *Orostachys spinosa* (L.) Sweet, *Patrinia intermedia* Roem. ex Schult., *Helictotrichon pubescens*, *Helictotrichon desertorum* (Less.) Pilg.

Shrub thickets at the top of the hills are represented by small groups under the rocks with the dominating meadowsweet (*S. trilobata*), *C. uniflorus*, and juniper (*J. sibirica*) with fescue and petrophytic grasses in the lower level (*F. valesiaca*, *S. capillata*, *P. acaulis*). The meadows are occupied by dense meadows and rose hips with honeysuckle (*S. hypericifolia*, *R. spinosissima*, *L. tatarica*); sometimes with the participation of *Padus avium* Mill. and grasses layer (*C. pediformis*, *D. glomerata*, *P. angustifolia*, *Paeonia anomala* L., *F. viridis*). On the edges they are framed by almonds (*P. ledebouriana*). Almonds disappear at the height above 1500-1800 m. As a result of the study of the ridge's shrub belt, an annotated list of plant species growing with *P. ledebouriana* was developed.

The annotated list of plant species growing in the cenopopulation of *Prunus ledebouriana*:

1. Fam. Polypodiaceae Bercht. & J. Presl

Asplenium septentrionale (L.) Hoffm.

Ceterach officinarum Willd.

2. Fam. Equisetaceae Rich. ex DC.

Equisetum pratense Ehrh.

3. Fam. Ephedraceae Dumort.

Ephedra equisetina Bunge

4. Fam. Poaceae Barnhart.

Bothriochloa ischaemum (L.) Keng

Stipa caucasica Schmalh.

S. orientalis Trin.

S. macroglossa P. A. Smirn.

S. kirghisorum P. A. Smirn.

S. zalesski Wilensky.

S. capillata L.

Milium effusum L.

M. vernale Bieb.

Agrostis canina L.

A. gigantea Roth.

Trisetum sibiricum Rupr.

Helictotrichon pubescens (Huds.) Pilg.

H. schellianum (Hack.) Kitag.

Phragmites australis (Cav.) Trin. ex Steud.

Eragrostis starosselskyi Grossh.

Melica transsilvanica Schur.

M. altissima L.

Dactyctis glomerata L.

Poa sibirica Roshev.

P. remota Forselles.

P. pratensis L.

P. angustifolia L.

P. palustris L.

P. nemoralis L.

P. stepposa (Krylov) Roshev.

P. korshunensis Golosk.

Festuca pratensis Huds.

F. gigantea (L.) Vill.

Bromopsis inermis (Leyss.) Holub

Brachypodium pinnatum (L.) Beauv.

Agropyron dshungaricum (Nevski) Nevski

A. desertorum (Fisch ex Link) Schult.

Elytrigia repens (L.) Nevski

Elymus gmelinii (Ledeb.) Tzvel.

E. fedtschenkoi Tzvel.

E. abolinii (Drob.) Tzvel.

E. caninus L.

E. drobovii (Nevski) Tzvel.

E. sibiricus L.

Carex polyphylla Kar. et Kir.

C. cinerea Poll.

C. acuta L.

C. media R. Br.

C. melananthaeformis Litv.

C. pauciflora Lightf.

C. supina Willd. ex Wahlenb.

C. turkestanica Regel.

C. macroura Meinsh.

C. pediformis C.A.Mey

C. riparia Curtis

C. vesicaria L.

5. Fam. Liliaceae Juss.

Veratrum nigrum L.

V. lobelianum Bernh.

Eremurus altaicus (Pall.) Steven

Gagea alberti Regel.

Allium fischeri Regel

A. flavidum Ledeb.

A. lineare L.

A. strictum Schrad.

A. rubens Schrad. ex Willd.

A. nutans L.

A. petraeum Kar. et Kir.

A. galanthum Kar. et Kir.

A. robustum Kar. et Kir.

A. saxatile Bieb.

A. pallasii Murray

* *Lilium martagon* L.

Fritillaria verticillata Willd.

* *Tulipa uniflora* (L.) Bess. ex Baker

Asparagus neglectus Kar. et Kir.

A. persicus Baker.

Polygonatum roseum Kunth.

6. Fam. Amaryllidaceae J. St. – Hil.

Ixiolirion tataricum (Pall.) Herb. & Traub

7. Fam. Iridaceae Juss.

Iris loczyi Kanitz.

I. ruthenica Ker Gawl.

I. bloudowii Ledeb.

8. Fam. Orchidaceae Juss.

Coeloglossum viride (L.) Hartm.

Dactylorhiza umbrosa (Kar. & Kir.) Nevski

9. Fam. Salicaceae Mirb.

Populus tremula L.

10. Fam. Cannabaceae Endl.

Humulus lupulus L.

11. Fam. Urticaceae Juss.

Parietaria micrantha Ledeb.

12. Fam. Santalaceae R. Br.

Thesium refractum C. A. Mey

13. Fam. Polygonaceae Juss.

Rumex acetosella L.

R. thyrsiflorus Fingerh.

Rheum altaicum Losinsk.

R. wittrockii Lundstr.

Atraphaxis compacta Ledeb.

- A. laetevirens* Jaub. et Spach.
A. frutescens (L.) Eversm.
A. virgate Krasn.
Aconogonon alpinum (All.) Schur
A. coriarium (Grig.) Soják
A. alpinum (All.) Schur
Polygonum bistorta L.
14. Fam. Chenopodiaceae Vent.
Axyris hybrida L.
15. Fam. Caryophyllaceae Juss.
Stellaria dichotoma L.
S. graminea L.
Cerastium pauciflorum Steven ex Ser.
C. bungeanum Vved.
C. davuricum Fisch. ex Spreng
C. arvense L.
C. dichotomum L.
Eremogone longifolia (Bieb.) Fenzl.
Moehringia umbrosa Fenzl.
Oberna behen (L.) Ikonn.
O. commutata (Guss.) Ikonn.
Silene lithophila Kar. et Kir.
S. alexandrae B. Keller.
S. repens Patrin
S. incurvifolia Kar. et Kir.
S. wolgensis Besser ex Spreng.
S. multiflora Pers.
S. viscosa Pers.
Lychnis chalconica L.
Gypsophila altissima L.
Petrorhagia alpina (Hablitz) P.W.Ball & Heywood
Dianthus versicolor Fisch. ex Link
D. ramosissimus Pall. ex Poir.
D. acicularis Fisch. ex Ledeb.
D. superbus L.
D. hoeltzeri C. Winkl.
16. Fam. Paeoniaceae Rudolphi.
Paeonia anomala L.
P. hybrida Pall.
17. Fam. Ranunculaceae Juss.
Trollius altaicus C. A. Mey
Aquilegia lactiflora Kar. et Kir.
Delphinium dasyanthum Kar. et Kir.
D. elatum L.
D. dictyocarpum Steud.
D. aemulans Nevski
D. cheilanthum Fisch. ex DC.
D. cyananthum Nevski
Aconitum anthora L.
A. septentrionale Koelle
Anemone sylvestris L.
Anemonoides caerulea (DC.) Holub
Pulsatilla patens (L.) Mill.
P. campanella Fisch. ex. Regel
P. ambigua (Turcz.) Juz.
Atragene sibirica L.
Clematis integrifolia L.
C. songarica Siev. ex Steud.
C. glauca Willd.
C. orientalis L.
Halerpestes salsuginosa Greene
Ranunculus longicaulis var. *pulchellus* (C.A. Mey.) Gubanov
R. longicaulis var. *pseudohirculus* (Schrenk) Gubanov
R. auricomus L.
R. pedatifidus Smith.
R. repens L.
R. polyanthemos L.
R. acris L.
R. longicaulis C. A. Mey
R. propinquus C. A. Mey
R. paucidentatus Schrenk.
R. pedatus Waldst. et Kit
Thalictrum foetidum L.
T. isopyroides C. A. Mey
T. minus L.
T. simplex L.
T. flavum L.
Adonis sibirica Patrin ex Ledeb.
A. villosa Ledeb.
18. Fam. Berberidaceae Juss.
Leontice altaica Pall.
Berberis heteropoda Schrenk.
B. sphaerocarpa Kar. et Kir.
19. Fam. Papaveraceae Juss.
Chelidonium majus L.
Papaver nudicaule L.
Corydalis ledebouriana Kar. et Kir.
C. nobilis (L.) Pers.
C. stricta Steph. ex DC.
C. capnoides Pers.
20. Fam. Brassicaceae Burnett.
Sisymbrium brassiciforme C. A. Mey
S. loeselii L.
S. polymorphium (Murr.) Roth.
Erysimum hieraciifolium L.
E. canescens Roth.
Barbarea arcuata Reichenb.
Rorippa palustris Bess.
Cardamine impatiens L.
C. parviflora L.
Turritis glabra L.
Arabis pendula L.
Isatis costata C. A. Mey
I. lasiocarpa Ledeb.
Hesperis pseudonivea Tzvel.

- H. sibirica* L.
Clausia aprica Trotzky
Chorisporea sibirica (L.) DC.
Berteroa incana (L.) DC.
Alyssum desertorum Stapf.
Draba hirta L.
D. sibirica (Pall.) Thell.
D. nemorosa L.
Camelina microcarpa Andrzej. ex DC.
Ptilotrichum tenuifolium C.A. Mey
21. Fam. Crassulaceae DC.
Hylotelephium triphyllum (Haw.) Holub.
Sedum alberti Regel.
Orostachys spinosa (L.) A. Berger
Rosularia platyphylla A. Berger
22. Fam. Grossulariaceae DC.
Ribes hispidulum (Jancz.) Pojark.
R. meyeri Maxim.
R. atropurpureum C. A. Mey
R. nigrum L.
R. heterotrichum C. A. Mey
R. saxatile Pall.
Grossularia acicularis Spach
23. Fam. Rosaceae Juss.
Spiraea hypericifolia L.
S. crenata L.
Cotoneaster multiflorus Bunge.
C. oliganthus Pojark.
Malus sieversii (Ledeb.) M. Roem.
Crataegus chlorocarpa Lenne & K. Koch
Rubus saxalilis L.
Fragaria vesca L.
F. viridis (Duch.) Weston
Potentilla sericea L.
P. evestita Th. Wolf.
P. virgata Lehm.
P. argentea L.
P. impolita Wahlenb.
P. longifolia Willd. ex Schltdl.
P. canescens Bess.
P. recta L.
P. pedata Willd. ex Hornem.
P. desertorum Bunge.
P. chrysantha Trevir.
P. schrenkiana Regel.
Chamaerhodos altaica Bunge
C. sabulosa Bunge.
Geum rivale L.
G. urbanum L.
G. aleppicum Jacq.
Filipendula ulmaria (L.) Maxim.
F. vulgaris Moench
Alchemilla cyrtopleura Juz.
A. pachyphylla Juz.
A. tianschanica Juz.
A. bungei Juz.
Agrimonia asiatica Juz.
Sanguisorba officinalis L.
S. alpina Bunge.
Rosa acicularis Lindl.
R. alberti Regel.
R. majalis Herrm.
R. laxa Retz.
R. beggeriana Schrenk
R. spinosissima L.
Cerasus tianschanica Pojar.
Padus avium Mill.
24. Fam. Fabaceae Lindl.
Melilotoides platycarpus (L.) Soják
M. karkarensis (Semenov ex Vassilcz.) Soják
Medicago falcata L.
M. romanica Prod.
M. schischkinii Sumnev.
M. lupulina L.
Melilotus albus Medik.
Trifolium lupinaster L.
Caragana frutex (L.) C. Koch.
Astragalus mongholicus Bunge.
A. propinquus Schischk.
A. macropterus DC.
A. sieversianus Pall.
A. trautvetteri Bunge.
A. schanginianus Pall.
A. danicus Retz.
A. dasyglottis Fisch. ex DC.
A. tibetanus Benth. ex Bunge.
A. odoratus Lam.
A. onobrychis L.
A. unilateralis Kar. et Kir.
A. testiculatus Pall.
A. hypogaeus Ledeb.
A. platyphyllus Kar. et Kir.
A. macroceras C. A. Mey ex Bong.
A. ceratoides Bieb.
A. stenoceras C. A. Mey
A. cornutus Pall.
A. melanocladus Lipsky.
A. cysticalyx Ledeb.
A. dendroides Kar. et Kir.
A. ellipsoideus Ledeb.
A. follicularis Pall.
Oxytropis avis Saposhnikow
O. recognita Bunge.
O. longibracteata Kar. et Kir.
O. ampullata Pers.
O. ochroleuca Bunge
O. pilosa DC.
O. macrocarpa Kar. et Kir.

- Hedysarum gmelinii* Ledeb.
H. ferganense Korsh.
Onobrychis arenaria DC.
Cicer songaricum Steph. ex DC.
Vicia tetrasperma (L.) Schreb.
V. unijuga A. Braun
V. cracca L.
V. tenuifolia Roth.
V. megalotropis Ledeb.
V. sepium L.
V. subvillosa Boiss.
Lathyrus tuberosus L.
L. humilis (Ser.) Fisch. ex Spreng.
L. pratensis L.
L. pisiformis L.
L. gmelinii (Fisch.) Fritsch
25. Fam. Geraniaceae Juss.
Geranium pratense L.
26. Fam. Rutaceae Juss.
Haplophyllum latifolium Kar. et Kir.
Dictamnus angustifolius Sweet
27. Fam. Euphorbiaceae Juss.
Euphorbia soongarica Boiss.
E. buchtormensis Ledeb.
E. pachyrhiza Kar. et Kir.
E. latifolia C. A. Mey
E. pilosa L.
E. humilis C. A. Mey
28. Fam. Balsaminaceae A. Rich
Impatiens parviflora DC.
29. Fam. Rhamnaceae Juss.
Rhamnus cathartica L.
30. Fam. Malvaceae Juss.
Lavatera thuringiaca L.
Alcea nudiflora (Lindl.) Boiss.
Althaea officinalis L.
31. Fam. Hypericaceae Juss.
Hypericum scabrum L.
H. elongatum C.A. Mey
H. elegans Steph. ex Willd.
H. perforatum L.
32. Fam. Tamaricaceae Link.
Myricaria bracteata Royle
33. Fam. Violaceae Batsch.
Viola rupestris F.W.Schmidt
V. persicifolia Schreb.
V. pumila Chaix.
V. canina L.
V. tarbagataica Klokov
V. disiuncta W.Becker
V. dissecta Ledeb.
34. Fam. Thymelaeaceae Juss.
Daphne altaica Pall.
35. Fam. Lythraceae J. St. – Hil.
Lythrum virgatum L.
36. Fam. Onagraceae Juss.
Chamaenerion angustifolium (L.) Scop.
37. Fam. Apiaceae Lindl.
Chaerophyllum prescottii DC.
Anthriscus sylvestris subsp. *nemorosa* (M.Bieb.)
C.Y.Wu & F.T.Pu,
Schrenkia vaginata Fisch. et C. A. Mey.
Aulacospermum anomalum Ledeb.
Cachrys herderi Regel
Bupleurum aureum Fisch. ex Hoffm.
B. krylovianum Schischk.
Trinia ramosissima Fisch. ex W.D.J.Koch
Falcaria sioides Asch.
Carum atosanguineum Kar. et Kir.
Aegopodium podagraria L.
Sium sisaroides DC.
Seseli schrenkianum (C.A. Mey. ex Schischk.)
Pimenov & Sdobnina
S. libanotis W.D.J. Koch
S. glabratum Willd. ex Schult.
S. condensatum Rchb.f.
Conioselinum tataricum Hoffm.
Archangelica decurrens Ledeb.
Ferula songarica Pall. ex Schult.
F. dissecta Ledeb.
Peucedanum morisonii Besser ex Schult.
Heracleum sibiricum L.
H. dissectum Ledeb.
38. Fam. Primulaceae Vent.
Androsace dasyphylla Bunge
A. lactiflora Fisch.
A. maxima L.
Lysimachia vulgaris L.
39. Fam. Plumbaginaceae Juss.
Acantholimon tarbagataicum Gamajun.
Goniolimon speciosum Boiss.
G. dshungaricum O.Fedtsch. & B.Fedtsch.
40. Fam. Gentianaceae Juss.
Gentiana decumbens L. f.
G. fetisowii Regel. Et Winkl.
G. riparia Kar. et Kir.
G. macrophylla Pall.
G. aquatica L.
Anagallidium dichotoma Griseb.
41. Fam. Convolvulaceae Juss.
Convolvulus ammannii Desr.
Calystegia sepium (L.) R. Br.
42. Fam. Polemoniaceae Juss.
Polemonium caeruleum L.
43. Fam. Boraginaceae Juss.
Lithospermum officinale L.
Arnebia coerulea Schipcz.
Onosma gmelinii Ledeb.

Echium vulgare L.
Myosotis suaveolens Waldst. & Kit. ex Willd.
Lappula sericata Popov
Hackelia deflexa (Wahlenb.) Opiz.
Pulmonaria mollis Wolff ex F.Heller.
44. Fam. Lamiaceae Lindl.
Scutellaria supina L.
Nepeta pannonica L.
N. cataria L.
Dracocephalum integrifolium Bunge
D. nutans L.
D. ruyschiana L.
Phlomis tuberosa L.
Leonurus turkestanicus V.I. Krecz. & Kuprian.
Salvia deserta Schangin
Ziziphora tenuior L.
Hyssopus ambiguus (Trautv.) Iljin ex Prochorov.

& Lebel.

Origanum vulgare L.
Thymus asiaticus Serg.
T. roseus Schipcz.
Lycopus exaltatus L.f.
L. europaeus L.
45. Fam. Solanaceae Juss.
Solanum depilatum Kitag.
Lycium dasystemum Pojark.
46. Fam. Scrophulariaceae Juss.
Verbascum thapsus L.
V. songaricum Schrenk
V. orientale (L.) All.
V. phoeniceum L.
Linaria vulgaris Mill.
L. hepatica Bunge
L. altaica Fisch. ex Ledeb.
Scrophularia kiriloviana Schischk.
S. incisa Weinm.
Veronica serpyllifolia L.
V. longifolia L.
V. spuria L.
V. verna L.
V. krylovii Schischk.
V. argute-serrata Regel & Schmalh.
Leptorhabdos parviflora Benth.
Euphrasia tatarica Fisch. ex Spreng
E. syreitschikovii Govor.
Pedicularis verticillata L.
P. dolichorrhiza Schrenk.
47. Fam. Rubiaceae Juss.
Galium odoratum Scop.
G. aparine L.
G. verum L.
G. ruthenicum Willd.
48. Fam. Caprifoliaceae Juss.
Lonicera tatarica L.

49. Fam. Valerianaceae Batsch.

Valeriana dubia Bunge.

50. Fam. Dipsacaceae Juss.

Dipsacus dipsacoides (Kar. & Kir.)
 V.I.Bochantsev

Scabiosa ochroleuca L.

51. Fam. Campanulaceae Juss.

Campanula sibirica L.

52. Fam. Asteraceae Dumort.

Heteropappus canescens (Nees) Novopokr. ex
 Nevski

Galatella macrosciadia Gand.

G. hauptii Lindl. ex DC.

G. fastigiiformis Novopokr.

G. tenuifolia Lindl. ex DC.

Erigeron elongatus Ledeb.

E. acris L.

E. pseudoseravschanicus Botsch.

Inula helenium L.

I. grandis Schrenk.

I. britannica L.

I. rhizocephala Schrenk.

Bidens tripartita L.

Achillea asiatica Serg.

Pyrethrum majus (Desf.) Tzvelev

Tanacetum vulgare L.

Artemisia dracunculus L.

A. glauca Pall. ex Willd.

A. sublessingiana Krasch. ex Poljakov

A. santolinifolia Turcz. ex Besser

A. glabella Kar. et Kir.

A. sericea Weber ex Stechm.

A. austriaca Jacq.

A. sieversiana Ehrh. ex Willd.

A. vulgaris L.

A. armeniaca Lamn.

A. macrantha Ledeb.

Doronicum oblongifolium DC.

Cacalia hastata L.

Senecio erucifolius L.

S. jacobaeae L.

S. octoglossus DC.

S. integrifolius Nutt.

Ligularia heterophylla Rupr.

L. robusta DC.

L. macrophylla (Ledeb.) DC.

L. glauca (L.) O. Hoffm.

L. sibirica Cass.

Echinops integrifolius Kar. et Kir.

Arctium tomentosum Mill.

Carduus crispus L.

C. nutans L.

Alfredia cernua Cass.

A. acantholepis Kar. et Kir.

Cirsium heterophyllum (L.) Hill
C. oleraceum Scop.
Saussurea salicifolia DC.
S. elata Ledeb.
S. elegans Ledeb.
Jurinea cyanoides (L.) Rchb.
J. serratuloides Iljin.
Serratula coronata L.
S. cardunculus (Pall.) Schischk.
S. marginata Tausch
Chartolepis intermedia Boiss.
Centaurea ruthenica Lam.
C. sibirica L.
C. scabiosa L.
Tragopogon songoricus S.A. Nikitin
T. orientalis L.
Scorzonera pubescens DC.
Achyrophorus maculatus Scop.
Taraxacum porphyranthum Boiss.
Chondrilla leiospemma Kar. & Kir.
Sonchus arvensis L.
Lactuca sibirica Benth. ex Maxim.
Crepis multicaulis Ledeb.
C. sibirica L.
Hieracium echioides Lumn.
H. korshinskyi Zahn
H. krylovii Nevski ex Schljakov
H. robustum Fr.
H. alatavicum (Zahn) Üksip
H. asiaticum (Nägeli & Peter) Üksip
Picris japonica Thunb.

In total, 511 accompanying species belonging to 52 families were reviewed: 1. *Polypodiaceae* (2 species), 2. *Equisetaceae* (1 species), 3. *Ephedraceae*

(1 species), 4. *Poaceae* (52 species), 5. *Liliaceae* (21 species), 6. *Amarillidaceae* (1 species), 7. *Iridaceae* (3 species), 8. *Orchidaceae* (2 species), 9. *Salicaceae* (1 species), 10. *Cannabaceae* (1 species), 11. *Urticaceae* (1 species), 12. *Santalaceae* (1 species), 13. *Polygonaceae* (12 species), 14. *Chenopodiaceae* (1 species), 15. *Caryophyllaceae* (26 species), 16. *Paeoniaceae* (2 species), 17. *Ranunculaceae* (39 species), 18. *Berberidaceae* (3 species), 19. *Papaveraceae* (6 species), 20. *Brassicaceae* (24 species), 21. *Crassulaceae* (4 species), 22. *Grossulariaceae* (7 species), 23. *Rosaceae* (44 species), 24. *Fabaceae* (56 species), 25. *Geraniaceae* (1 species), 26. *Rutaceae* (2 species), 27. *Euphorbiaceae* (6 species), 28. *Balsaminaceae* (1 species), 29. *Rhamnaceae* (1 species), 30. *Malvaceae* (3 species), 31. *Hypericaceae* (4 species), 32. *Tamaricaceae* (1 species), 33. *Violaceae* (7 species), 34. *Thymelaeaceae* (1 species), 35. *Lythraceae* (1 species), 36. *Onagraceae* (1 species), 37. *Apiaceae* (24 species), 38. *Primulaceae* (4 species), 39. *Plumbaginaceae* (3 species), 40. *Gentianaceae* (6 species), 41. *Convolvulaceae* (2 species), 42. *Polemoniaceae* (1 species), 43. *Boraginaceae* (9 species), 44. *Lamiaceae* (16 species), 45. *Solanaceae* (2 species), 46. *Scrophulariaceae* (20 species), 47. *Rubiaceae* (4 species), 48. *Caprifoliaceae* (1 species), 49. *Valerianaceae* (1 species), 50. *Dipsacaceae* (2 species), 51. *Campanulaceae* (1 species), 52. *Asteraceae* (75 species). Large families are shown in Table 2 with the numerical and percentage ratios of species growing with *Prunus ledebouriana* from the total number of species growing in the Tarbagatai State National Park.

Table 2 – The ratio of species by families growing together with *Prunus ledebouriana*

No.	Large families	The numerical ratio of species in the family	The percentage of species in the family
	<i>Asteraceae</i>	75/213	35.2
	<i>Fabaceae</i>	56/137	40.8
	<i>Poaceae</i>	52/160	32.5
	<i>Rosaceae</i>	43/97	44.3
	<i>Ranunculaceae</i>	39/78	50
	<i>Brassicaceae</i>	24/104	23
	<i>Apiaceae</i>	24/59	40.6
	<i>Scrophulariaceae</i>	20/53	37.7
	Total:	511/1637	31.2

The numerical and percentage ratios of species growing with *Prunus ledebouriana* from the total number of species growing in the Tarbagatai State National Park was 31.2% (511 species with *Prunus ledebouriana* out of 1637 total species). The accompanying species composition consists of species growing on the low-mountain shrub belt (*Asteraceae*-69 species, *Fabaceae*-47 species, *Poaceae* – 40 species, *Rosaceae* – 30 species, *Ranunculaceae* – 32 species, *Brassicaceae* – 18 species, *Apiaceae* – 24 species, *Scrophulariaceae* – 17 species), mid-mountain shrub belt (*Asteraceae* – 71 species, *Fabaceae* – 56 species, *Poaceae* – 49 species, *Rosaceae* – 43 species, *Ranunculaceae* – 39 species, *Brassicaceae* – 21 species, *Apiaceae* – 24 species, *Scrophulariaceae* – 20 species), high-mountain shrub belt (*Asteraceae* – 18 species, *Fabaceae* – 26 species, *Poaceae* – 18 species, *Rosaceae* – 21 species, *Ranunculaceae* – 14 species, *Brassicaceae* – 9 species, *Apiaceae* – 8 species, *Scrophulariaceae* – 7 species). Family *Asteraceae* – 75 species, *Fabaceae* – 56 species, *Poaceae* – 52 species, *Rosaceae* – 43 species and *Ranunculaceae* – 39 species.

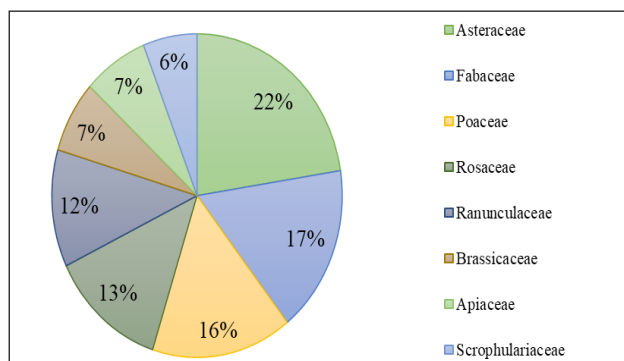


Figure 7 – The percentage of the diversity of species belonging to large families growing with *Prunus ledebouriana* in the territory of the Tarbagatai State National Park.

Figure 7 shows a diagram of the percentage ratio of species diversity from different families growing with *Prunus ledebouriana* on the territory of the Tarbagatai State National Park: *Asteraceae* 22%; *Fabaceae* 17%; *Poaceae* 16%; *Rosaceae* 13%; *Ranunculaceae* 12%; *Brassicaceae* 7%; *Apiaceae* 7% и *Scrophulariaceae* 6%.

Conclusion

Species composition analysis of *P. ledebouriana* cenopopulation on the territory of “Tarbagatai” State

national park and its surroundings showed that the leading group includes widespread species and that the species composition changes vertically. The list of plants is mainly composed of steppe, meadow, rocky and coastal water species. A map has been developed of the distribution of *P. ledebouriana* in the Tarbagatai state National Park and its surroundings.

In the lower part of the southern slope, within 700-1500 m, is occupied by thickets of bushes, mainly *P. ledebouriana*, in combination with roses (*Rosa spinosissima*), aspen lines (*Populus tremula*) and apple thickets (*Malus sieversii*) with a well-developed shrub layer of *Rosa spinosissima* and *P. ledebouriana*.

Thickets of shrubs occur on the rocky southern slopes. Here, many individuals of *Atraphaxis laetevirens*, *Calophaca howenii*, and *Spiraea hypericifolia* are found in addition to *Prunus ledebouriana*. *Poaceae* family in these shrubs is mostly represented by *Bothriochloa ischaemum* Meadowsweet and caragana thickets (*Spiraea hypericifolia*, *S. trilobata*, *Caragana camillischneideri*, *C. frutex*) prevail together with dry steppe’s wormwood-turf-grasses communities (*Stipa capillata*, *S. sareptana*, *Festuca valesiaca*, *Phleum phleoides*, *Artemisia marschalliana*, *A. sublessingiana*, *A. compacta*, and *Carex pediformis*).

Shrub thickets (*P. ledebouriana*) at the top of the hills are represented by small groups under the rocks with the dominating meadowsweet (*Spiraea trilobata*), *Cotoneaster uniflorus*, and juniper (*Juniperus sibirica*) with fescue and petrophytic grasses in the lower level (*Festuca valesiaca*, *Stipa capillata*, *Potentilla acaulis*).

On this territory, 511 species representing 52 families grow with *P. ledebouriana*. Families with largest species numbers: *Asteraceae* (75 species), *Fabaceae* (56 species), *Poaceae* (52 species), *Rosaceae* (43 species), *Ranunculaceae* (39 species). Species diversity: *Asteraceae* 22%; *Fabaceae* 17%; *Poaceae* 16%; *Rosaceae* 13%; *Ranunculaceae* 12%; *Brassicaceae* 7%; *Apiaceae* 7%; and *Scrophulariaceae* 6% from the total number of species growing with *P. ledebouriana*. Thus, a wide range of phytocenotic diversity with a high species richness has been identified in the limited territory of the Tarbagatai State National Park and its surroundings. The conservation and restoration of biological diversity is mostly ensured by the nature conservation status of the “Tarbagatai” State national park. The research results can be used for species identification and organization of conservation activities for the rare plant species *P. ledebouriana*.

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