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## Scientific and legal aspects of preservation of rare representatives of dwarf almond section of flora in East Kazakhstan

This work includes the review of materials and different sources for the presence of chronological information on representatives of *Chamaeamygdalus* (*Amygdalus ledebouriana* and *Amygdalus nana*) and its legal status. Information analysis methods in various literature sources, such as illustrations in scientific articles and etc., were used in this study. Legal aspects of preservation (laws, decrees and legal acts, that have direct or indirect connection with the research topic, object of research and its preservation at the state level) of dwarf almond representatives were studied for the first time in Kazakhstan. The uniqueness of this work is the integration of interdisciplinary researches in the field of botany and law (environmental law) into the study of an object. Samples collected on the territory of East Kazakhstan region and various literature sources were used as material for this study. The results are presented in the form of a comparative table and illustration with notes and links to competent sources. The results of the study can be used for species identification and development of preserving actions for the rare plant species *Amygdalus ledebouriana* Schlecht., as well as for the training of specialists in the field of environmental protection in East Kazakhstan and for the development of new legal standards for the conservation of rare and endangered plant species. The studied herbarium samples of *A. ledebouriana* (IPBB) were transferred to the herbarium fund in the Institute of Botany and Phytointroduction (Almaty).

**Keywords:** almond, *Chamaeamygdalus*, *Amygdalus ledebouriana*, *Amygdalus nana*, plant preservation, plant identification, taxonomy.

### Introduction

The floral composition of East Kazakhstan is rich in species diversity with various genetic and ecotypic forms of higher and lower plants that need to be studied. Two very close almond species — *Amygdalus ledebouriana* Schlecht. and *Amygdalus nana* L. grow on the territory of East Kazakhstan region. Both species belong to the section of dwarf almonds (*Chamaeamygdalus* Spach.). *A. ledebouriana* is a rare and endangered species (Figure 1), while *A. nana* is widespread on the territory of the Eurasian continent (steppe zone) [1].

In the European plant systematics, *Amygdalus* L. is not a separate genus, it is considered as the subgenus *Prunus* subgen. *Amygdalus* L. in Kazakhstan, according to the USSR's systematic of flora (1941), *Amygdalus* L. is an individual genus of the subfamily *Prunoideae*, family *Rosaceae*.

The plant called *A. ledebouriana* was identified and described for the first time by German botanist and mycologist Diederich Franz Leonhard von Schlechtendal. The first materials on that species were published in 1854: Schlecht. in Abh. Naturf. Ges. Halle 2 [2]. The species was described in the 10<sup>th</sup> volume of USSR Flora [3], in the 4<sup>th</sup> volume of Flora of Kazakhstan [4] and in the first part of the illustrated identifier of plants in Kazakhstan (Fig. 2). *A. ledebouriana* is included in the Red Book of Kazakhstan as rare and endangered plant species [5]. In all abovementioned sources, *A. ledebouriana* is positioned as a separate plant species with the narrow endemic characteristics.

The second species (*A. nana*) was firstly described by Carl Linnaeus in 1753. The first mentions of this species were in Sp. pl. [6]. There is a full description of *A. nana* in the 10<sup>th</sup> volume of USSR Flora published in 1941 [7]. For the book Flora of Kazakhstan, this species was described 1961 in the 4<sup>th</sup> volume [8]. The major differences between two species are ecological area of growing and the shape of seed (seeds of *A. ledebouriana* are aslant-elongated).

Similarity of two species and different approaches in systematic of the genus create the problems for identification of plant samples. Ambiguity of systematic also inhibits processes of its preservation and rational

use. In the current study, we consider the scientific aspects of the identification of studied plants, as well as questions on their legal status.

*Methods and materials*

The list of methods used in this work included analysis of different literature sources, scientific publications, laws, decree and legal acts directly or indirectly connected with the topic of research, studied object and its preservation on the state level. Samples collected on the territory of East Kazakhstan were used as the materials of the study.



Figure 1. Herbarium samples of *Amygdalus ledebouriana* Schlecht. (IPBB) transferred to the herbarium fund in the Institute of Botany and Phytointroduction (Almaty)

After the survey of Naryn ridge (South Altai), geographical locations of *A. ledebouriana* populations were determined. The largest population was found in Katon-Karagai region near Kokterek village. Plants of *A. ledebouriana* were detected in northeastern bush slope of Sary-Shoky Mountain, Naryn ridge, South Altai, close to Kokterek village. GPS coordinates: N: 49°05', E: 84°29', 724 m above sea level. Almond plants were relatively large, 150–170 cm height with branched shoots. Samples were transferred in 2019 to the Institute of Botany and Phytointroduction for the verification of species, digitization and further storage in herbarium fund [9].

*Results and discussion*

Analysis of literature sources and herbarium samples had showed the presence of contradictions in the identification of two species, which had interfered species determination. Short comparative analysis of literature sources is presented in Table 1.

Table 1

**Mentions of two representatives of dwarf almond section in historical sources**

№	Sources	<i>A. ledebouriana</i> (rus. Mindal ledebura)	<i>A. nana</i> (rus. Mindal nizkiy)	Notes
1	2	3	4	5
1	<i>Lat.</i> Species plantarum. Carl Linnaeus, 1753.	Absent	<i>Amygdalus indica nana</i>	The <i>Amygdalus</i> genus and some of its representatives were described for the first time
2	<i>Ger.</i> Abhandlungen der naturforschenden gesellschaft zu Halle 2. Schlecht., 1854	<i>Amygdalus Ledebouriana</i>	<i>Amygdalus nana</i> L.	The species <i>Amygdalus Ledebouriana</i> was firstly described on Irtysh and Bukhtarma rivers. Close species: <i>Amygdalus nana</i> , <i>Altaica</i> Ledeb. From Altai flora. Differences in seeds shape. No illustrations

Continuation of Table 1

1	2	3	4	5
3	USSR Flora. Eds. Komarov V.A., Vol. 10, 1941	<i>A. ledebouriana</i> Schlecht. (rus. M. ledebura)	<i>A. nana</i> L. (rus. M. nizkiy)	<i>A. ledebouriana</i> have aslant-elongated on the base seed (Altai, Tarbagatai). No illustrations of <i>A. ledebouriana</i> . <i>A. nana</i> and <i>A. petunnikowii</i> L. are presented (Fig. 2).
4	Flora of Kazakhstan. Eds. Pavlov N.V., Vol. 4, 1961	<i>A. ledebouriana</i> Schlecht. (rus. M. Lebeburovskiy)	<i>A. nana</i> L. (rus. bobovnik; kaz. ishik-sabak)	<i>A. ledebouriana</i> have 7–9 mm calyx tube; higher, up to 2 m height bush. The base of seed is aslant-elongated. Distribution (endemic): 22 Altai, 23 Tarbagatai, 24 Dzungarian Alatau. Illustrations of close species (Fig. 2)
5	Illustrated identified of plant in Kazakhstan. Eds. Goloskokov V.P. Part 1, 1969	<i>A. ledebouriana</i> Schlecht. (rus. M. Lebeburovskiy)	<i>A. nana</i> L. (rus. bobovnik; kaz. ishik-sabak)	<i>A. ledebouriana</i> have 7–9 mm calyx tube; the base of seed is aslant elongated. Bush 1.5–2 m height. Flowering V–VI, ripening VI–VII. Grow on meadow and steppe mountain slopes in river valleys of Altai, Tarbagatai, Soongari Alatau. Endemic, ornamental plant. Illustrations of close species in Figure 2
6	Flora of China. Gu Kyingi and co-authors. Vol. 9, 1974, 1985 and 1986	Mentioned as synonym for <i>Amygdalus nana</i> L.	<i>Amygdalus nana</i> L., <i>Amygdalus ledebouriana</i> Schlechtendal; <i>Prunus nana</i> (Linnaeus) Stokes (1812), not Du Roi (1772); <i>P. tenella</i> Batsch.	Seed has oval or spherical shape, 1–2 (–2.5) × 1.2–1.8 (–2) cm, thick straw-yellow hairs; mesocarp is dry, split after ripening; endocarp is oval-spherical 0.8–1.8 (–2.2) × 1–1.5 (–1.7) cm. Thick curved ventral and dorsal area. Surface with irregular net-like shallow furrows. The base of seed is aslant with blunt apex. Illustrations of close species in Figure 2
7	Illustrated identified of plant in Russia. Gubanov I.A. with co-authors. Vol. 2, 2003	Absent in the list, but characteristic trait of <i>A. ledebouriana</i> “stone-fruit aslant-elongated” is used for <i>A. nana</i>	<i>Amygdalus nana</i> L.	Fruits are thick covered with yellow-gray hairs, round, slightly flattened. Seeds have irregular net-like shallow furrows with aslant-elongated base. Illustrations of close species in Figure 2
8	Plants of Kazakhstan. Traditional and scientific names. Arystangaliyev S.A. and Ramazanov E.R., 1977	<i>Amygdalus ledebouriana</i> L.	<i>Amygdalus nana</i> (rus. Mindal nizkiy, or bobovnik; kaz. Alasa badam)	The first published Kazakh names of two species. Contradiction in traditional names of <i>A. nana</i> (kaz. Alasa badam) with Flora of Kazakhstan (kaz. ishik-sabak) and Illustrated identified of plant in Kazakhstan (kaz. ishiksabak)
9	The list of vascular plants of Kazakhstan. Abdulina S.A., 1999	<i>A. ledebouriana</i> Schlecht.	<i>A. nana</i> L.	<i>A. nana</i> L. is marked with “?”. Probably doubtful species
10	Decree of the Government of the Republic of Kazakhstan from 31.10.06 N 1034 “On Approving the Lists of Rare and Endangered Plant Species”	<i>Amygdalus ledebouriana</i>	Absent	Abstract name of the species without author’s name and its synonymous
11	www.theplantlist.org	<i>Amygdalus ledebouriana</i> Schltld. — synonym to <i>Prunus ledebouriana</i> (Schltld.) YY Yao	<i>Amygdalus nana</i> L. — synonym to <i>Prunus tenella</i> Batsch.	<i>Amygdalus</i> is synonym to <i>Prunus</i> . In other words, <i>Prunus</i> subgen. <i>Amygdalus</i> (L.) Focke, 1894

Illustrations of dwarf almonds representatives in various competent sources also have contradictions. Illustrations of almond seeds and fruits in various sources are highlighted in red. For example, in USSR Flora,

the shape of seed in the fruit of *A. nana* does not match with *A. nana* in Flora of Kazakhstan. In Flora of China (1986) this trait was ignored, and *A. ledebouriana* was named as *A. nana* (Fig. 2).

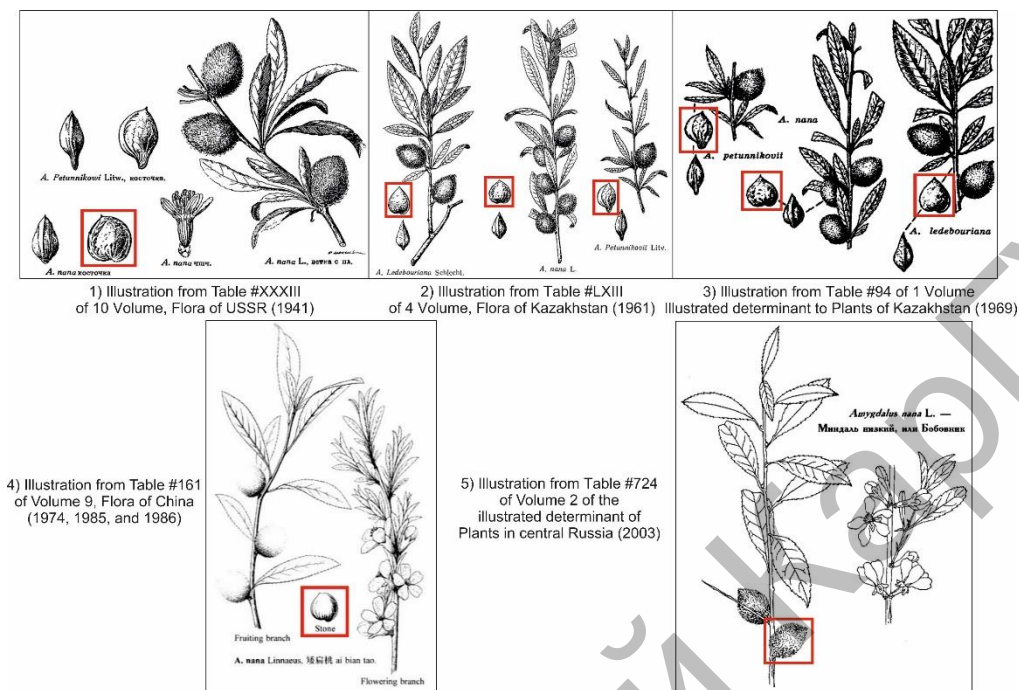


Figure 2. Illustration of dwarf almonds section representatives in various competent sources

Abovementioned contradictions between two species cast doubt on the presence of *A. nana* among the flora of East Kazakhstan, as well as jeopardize *A. ledebouriana*. According to the Law of the Republic of Kazakhstan dated July 7, 2006 No. 175 “On Specially Protected Natural Territories”, *A. ledebouriana*, if present on specially protected natural territories, is an object of the state nature reserve fund of the Republic of Kazakhstan [10]. Species and subspecies mentioned in the list of objects in the state nature reserve fund are also listed in the Red Book of the Republic of Kazakhstan of different publication years. Abovementioned almond species can be considered within its distribution population or may be unique individual objects of the plant world with the unique scientific significance. According to the decree of the Government of the Republic of Kazakhstan from October 31, 2006 No. 1034 “On approval of the lists of rare and endangered plant and animal species”, *A. ledebouriana* has a special status [11]. The extraction procedure is allowed only for propagation under specially created conditions, for scientific research and for breeding. Separate organisms (a whole plant), its various organs or derivatives (a substance that occurs in the process of biochemical reactions from another substance and, thus, is called derivative) can serve as an object for the extraction procedure.

According to the decision of the Council of the Eurasian Economic Commission from January 26, 2018 No. 15 “On approval of the rules of good practice for the cultivation, collection, processing and storage of raw plant originated materials”, it is not allowed to collect and harvest raw materials from endangered medicinal plant species (*A. ledebouriana*) without the permission of the authorized bodies of member-countries in accordance with the provisions of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) [12].

According to Article No. 339 of the Criminal Code of the Republic of Kazakhstan from July 3, 2014 No. 226-V ZRK, illegal treatment of rare and endangered species, as well as species of plants or animals prohibited for usage, their parts or derivatives, provides various penalties depending on severity of the crime: from a fine of three thousand monthly calculation indices to imprisonment for 7–12 years with deprivation of the right to occupy certain positions or engage in certain activities up to five years with confiscation of property [13].

The development of criminal penalties or organization of events and measures to protect these plants are based on accurate species identification (according to the approved list of plants) of the plant biological objects (*A. ledebouriana*). During the classification, plant biological objects are assigned to the officially accepted taxonomic group of the current rank with accepted synonymic names in the state (Kazakh) and Russian

languages with the binary Latin nomenclature of the family, subfamily, genus, subgenus, section, species and subspecies of rare and endangered plants. Vegetative (leaves, stems, organs of the root system, etc.) and generative (inflorescences, sporangia, fruits, seeds, spores, etc.) organs, tissues, and cells serve as a biological object of plant origin. Also, this term includes various synthesized chemical and organic compounds, primary and secondary metabolites, etc.

The traditional procedure for identification of the sample under study is based on different apparent anatomical and morphological characteristics of species forming the keys for determination (described or implemented algorithm for the work with theses and antitheses). Usually, Flora of Kazakhstan [14], illustrated identifier of plants [15] and other scientific and methodological works are used as the main tool for determination.

These scientific and methodological works are unique multi-volume instruments for the study and identification of all plants growing on the territory of the Republic of Kazakhstan. Unfortunately, these works were published in Russian under the auspices of the Academy of Sciences of Kazakh SSR and are outdated at the moment. The information is not relevant for an accurate identification of species, which casts doubt on the procedure of traditional identification of rare and endangered plants growing on the territory of the Republic of Kazakhstan. Names of taxonomic groups and their systematic structure do not correspond to international information databases of plants, such as World Flora Online [16], The Plant List [17], International Plant Names Index (IPNI), Royal Botanic Gardens Kew [18], and etc.

Official confirmation of the presence of a certain plant species is regulated by legal acts and its official and scientific public recognition without rebuttal. The main legal acts governing the recognition of a species and its scientific justification are listed in International Code of Nomenclature of algae, fungi, and plants. This code is a set of rules and recommendations governing the formation and use of the scientific names of plants, fungi and some other groups of organisms. The purpose of the code is to ensure that each taxonomic group has only one correct legal name that is used throughout the world. The remaining names are recognized as illegitimate and can be equated with synonyms or an erroneous definition (erroneous concept or outdated interpretation). Changes or additions to these taxonomic names is the main function of International Botanical Congress, which issues decisions of the plenary session on the basis of the resolution of the Congress' nomenclature section.

The absence of a constantly updated international system of taxonomic names for various groups of binary nomenclature in Kazakhstan complicates the international integration in the protection of rare and endangered plant species of Kazakhstan. A substantial and structural update of the approved list of rare and endangered plants taking into account the above-mentioned problems is required. It is also necessary to develop an updated electronic system (like Denali Flora and others) for identification of rare and endangered plants with different variations of anatomical and morphological characters depending on growing conditions. This system becomes popular in foreign countries, but, unfortunately, there is no analogue for identification of rare and endangered plants growing on the territory of the Republic of Kazakhstan.

Identification of biological plant objects, belonging to rare and endangered plants, is also based on the determination of its geographical distribution area. The distribution area of certain plant populations provides additional information for decision making. The geographical relief with various environmental factors and the availability of the necessary resources to support the vital functions of an organism serve to identify a limited distribution area. This information on the limited range is relevant for endemic plant species with a narrow ecological niche. Also, a large distribution area with the low density generates the presence of different ecotypes of one plant species with various anatomical and morphological characters in ontogenesis or vice versa. Unfortunately, in Kazakhstan, there are no information systems with specialized maps and updated information on the distribution of rare and endangered plants of national flora.

Another unique method for the identification of plant species' correspondence to the section of dwarf almonds in East Kazakhstan is barcoding based on the nucleotide sequence of certain sections of the plant genome. The use of DNA barcoding based on the identification of intra specific and inter specific polymorphism via DNA markers is a necessary tool for solving problems of identification and classification plant objects. Similar and different positions in nucleotide sequences are revealed in certain sections of the chloroplast and other plant genomes.

During the identification of samples, this method compares the obtained nucleotide sequences with an international database of various genomic parts of the plant. To improve this procedure, it is necessary to create a national database of complete genomes of rare and endangered plants based on all known markers. This scientific field actively develops on the basis of "Laboratory of molecular genetics" in Institute of Plant

Biology and Biotechnology belonging to the Committee of Sciences of the Ministry of Education and Science of the Republic of Kazakhstan (Almaty).

Exact classification and identification of the plant species is carried out by the competent authorities of the Center for Forensic Expertise under the Ministry of Justice of the Republic of Kazakhstan and its branches in various regions of our country. The type of accredited examination is No. 16.1 “Forensic Biological Expertise: Forensic Biological Investigation of Plant-Based Objects”. However, the official list of this organization does not include a forensic botanical examination. As a separate type of this examination, biological research of plant objects is used in the Russian Federation and the countries of the European Union, only in specially accredited laboratories. Works on the study of the systematic and classification of rare and endangered plants is carried out by various methods on the basis of scientific centers, universities and institutes of the Ministry of Education and Science, the Ministry of Agriculture, the Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan.

### Conclusion

It is necessary to develop new legal norms and special training programs for training specialists-researchers not only for the organization of environmental protection of natural resources and environmental management, the organization of specially protected natural territories of various significances, but also for supervisory bodies and internal affairs bodies in the field of environmental protection. Specialists of this group should be competent in the field of botany, geobotany, geography, ecology, and molecular genetics of rare, agricultural and medicinal plants. They also need to know the basics of forensic science and forensic examination of wild flora objects. The presence of these specialists with natural-scientific and legal competencies in the field of environmental protection in various organizations will increase the level of preservation of rare and endangered plants of the flora in East Kazakhstan.

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## Шығыс Қазақстан флорасының ергежейлі бадамдар секциясының сирек кездесетін өкілдерін қорғаудың ғылыми және құқықтық аспектілері

Мақалада *Chamaeamygdalus* өкілдерінің (*Amygdalus ledebouriana* және *Amygdalus nana*) құқықтық мәртебесін анықтайтын және хронологиялық мәліметтері бар деректер көздері зерттелген. Мақалада әртүрлі әдебиет көздерінен және ғылыми мақалалардың иллюстрацияларынан алынған мәліметтерді талдау әдістері қолданылған. Қазақстанның ергежейлі бадамдар өкілдерін қорғаудың құқықтық аспектілері (мемлекеттік деңгейдегі қорғалуы үшін тікелей немесе жанама байланысы бар заңдар, жарлықтар және құқықтық актілері) алғаш рет зерттелген. Зерттеу нысаны үшін ботаника және құқық (экологиялық) саласындағы пәнаралық зерттеулердің бірігуі бұл жұмыстың өзіндік ерекшелігі болып табылады. Шығыс Қазақстан облысының аумағында жиналған биологиялық үлгілер және әртүрлі әдебиет көздерінен алынған деректер зерттелген. Зерттеу нәтижелері құзыретті әдебиеттер көздеріне сілтемелері бар салыстырмалы кесте және әртүрлі иллюстрацияларға ескертулері бар суреттер түрінде ұсынылған. Зерттеу нәтижелерін сирек кездесетін және жойылып бара жатқан *Amygdalus ledebouriana* Schlecht. және басқада осындай сирек өсімдіктер түрлерін сақтау бойынша шараларды ұйымдастыру барысында қолдануға болады. Зерттелген (ӨББИ) *A. ledebouriana* кеппешөп үлгілері Ботаника және фитожерсіндіру институтының кеппешөп қорына жіберілген (Алматы қ.).

*Кілт сөздер:* бадам, *Chamaeamygdalus*, *Amygdalus ledebouriana*, *Amygdalus nana*, өсімдіктерді қорғау, өсімдіктерді анықтау, сәйкестендіру, таксономия.

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## Научные и правовые аспекты охраны редких представителей секции карликовых миндалей флоры Восточного Казахстана

В статье изучены материалы и различные источники на наличие хронологической информации представителей *Chamaeamygdalus* (*Amygdalus ledebouriana* и *Amygdalus nana*) и его правового статуса. Применены такие методы анализа информации в различных литературных источниках, как иллюстрации в научных статьях и др. Впервые изучены правовые аспекты охраны (законы, постановления и правовые акты, имеющие прямую или косвенную связь с темой исследования на предмет связи с объектом исследования и его защищенности на государственном уровне) представителей карликовых миндалей Казахстана. Оригинальностью данной работы является интеграция междисциплинарных исследований в сфере ботаники и права (экологического права) для изучения исследуемого объекта. В качестве материала для изучения были использованы образцы, собранные на территории ВКО, и различные источники. Результаты приведены в форме сравнительной таблицы и иллюстрации с примечаниями и ссылками на различные компетентные источники, которые могут быть использованы для видовой идентификации и организации мер по сохранению редкого вида растения *Amygdalus ledebouriana* Schlecht., а также для подготовки специалистов в сфере охраны окружающей среды Восточного Казахстана и для разработки новых правовых норм по сохранению редких и исчезающих видов растений. Исследуемые гербарные образцы *A. ledebouriana* (ИББР) были переданы в Гербарный фонд Института ботаники и фитоинтродукции (г. Алматы).

*Ключевые слова:* миндаль, *Chamaeamygdalus*, *Amygdalus ledebouriana*, *Amygdalus nana*, охрана растений, определение растений, идентификация, таксономия.

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