1. Introduction

The problem of thorough study, mobilization and effective use of the species of cultivated plants, which are the most important for agricultural production, had been formulated by Vavilov in the late 1920s. Nowadays effective use of genetic resources of the planet is considered as one of the factors of sustainable development of the world, the process of biodiversity reduction being observed everywhere in the last decades, including a reduction of varieties of crop wild relatives (CWR) caused by the anthropogenic factor which represents a serious threat for the world community (FAO, 2010).

In treaties of the Food and Agriculture Organization of the United Nations (FAO), it is said that genetic resources of plants are the most important terrestrial resources. Conserving biodiversity is of major importance for food and agriculture and promoting its use in global food security and sustainable development, for present and future generations (FAO, 1996, 1998, 2001, 2014). At the same time, about 75% of the world genetic variety of crops was lost between 1900 and 2000 (FAO, 2010).

The Global Plan of Action for preservation and steady use of Genetic Resources of Plants for Food and Agriculture was officially approved by the representatives of 150 countries, including Kazakhstan (http://www.un.org/ru/documents/decl_conv/conventions/agenda21_ch14g.shtml).

In 1994, Kazakhstan ratified the convention on biodiversity according to that for preservation and the balanced use of biological diversity. It is necessary to solve the following strategic problems: the preservation of ex situ wild relatives of cultivated plants in regions of their origin; the preservation of a gene pool of local ancient cultivars of crops; the creation of a germplasm bank for rare and endangered plant species. The Global Strategy for Plant Conservation 2011–2020 addresses the challenges posed by threats to plant diversity (CBD, 2010).

This paper presents the results of the field study on species composition, geographical distribution, phytocoenotic diversity and resources of crop wild relatives (CWR) in Kazakhstan’s ranges of the Tien Shan Mountains. Taxa of not only cultivated genera of crops are taken into account, but also a wider range of species of high socio-economic importance, including medicinal, fodder, essential oil and other species. List of CWR includes 289 species belonging to 39 families and 145 genera. Among them, 9 species listed in the Red Data book of Kazakhstan: Pistacia vera, Rheum wittrockii, Armeniaca vulgaris, Malus sieversii, Allium pskemense, Allochrusa gypsophilloides, Sorbus sibirica, Vitis vinifera and Artemisia cina. The highest plant diversity is recorded in intermountain plains and river valleys where meadow vegetation forms a high abundance of forage and resource plants. The diversity of wild fruit plants is concentrated in gallery forests. CWR of cereals are concentrated in dry steppe slopes in low piedmont belt. The populations of almond, pistachio, plum and cherry were recorded at dry slopes of low mountain belt.

The estimation of the raw material base for 13 resource plants is given. Only Rumex tianschanicus, Berberis sphaerocarpa are recommended for industrial harvesting; for local pharmacy chain — Mentha longifolia, Origanum vulgare, O. vulgare subsp. gracile, Zizipora clinopodioides, Hypericum scabrum, Hypericum perforatum, and five Rosa species.
In November 2001 the UN International Treaty of Plant Genetic Resources for Food and Agriculture was adopted (FAO, 2001). This Treaty was directed to the preservation of plant genetic resources, their steady use for food and agriculture; fair distribution of the profits derived from the commercial use of genetic resources as well as of traditional knowledge.

Eight historic-geographic centers of development of cultural flora were allocated by Vavilov (1926), including the Central Asian center. The essential value in its composing belongs to Kazakhstan playing an important role in global biodiversity conservation, including the CWR gene pool. Smyskaya (1986) allocated 5 main geographical areas of historical development of cultural flora, Kazakhstan is situated within the Middle South-West-Asian sub-region of the Ancient Mediterranean region (that completely corresponds to Vavilov’s Central Asian center). According to Wulf (1987), it is necessary to allocate 16 floristic areas of the globe to include the largest part of Kazakhstan in the East Mediterranean sub-region of the Mediterranean region at the same time. So, Kazakhstan is one of the world centers of speciation of live organisms and plays an important role in the conservation of global biodiversity. In Kazakhstan genetic resources of plant agrobiodiversity of world value are concentrated. They include 194 species of vegetable and 25 species of fruit plants determining the genetic potential of 24 crops. In Kazakhstan there are natural genetic resources of 10 genera of wild fruit plants (Malus Mill., Armeniaca Scop., Pyrus L., Ribes L., Amygdalus L., Vitis L., Pistacia L., Elaeagnus L., Juglans L. and Grossularia Mill.), 7 cereal and technical genera (Linum L., Brassica L., Eruca Adams., Carthamus L., Medicago L., Avena L. and Cannabis L.), and 4 genera of vegetables (Daucus L., Portulaca L., Asparagus L. and Allium L.).

In Kazakhstan among CWR the main attention was paid to studying an apricot and Sivers apple-tree. The most powerful contribution of research was that of academician Dzhangaliyev studying an apricot and Sivers apple-tree. The most powerful Allium and 4 genera of vegetables (Daucus L., Portulaca L., Asparagus L. and Allium L.).

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pattern of distribution, the reserve of raw materials, as well as the CWR seed collection, for their deposit into the seed bank.

2. Material and methods

In the performance of the study classical botanical research methods were used. The main method, used during the field research was route-reconnaissance. The laboratory processing of initial material was performed in strict accordance with all requirements, and the herbarium samples were stored in the Herbarium. Herbarium collection of the Institute of Botany & Phytointroduction (AA) were studied in order to identify the spread of CWR in the research area. For the identification of the collected materials fundamental floristic summaries were used, covering the territory of Kazakhstan: “Flora of Kazakhstan” (1956–1966), “Illustrated Guide for Identification of the Plants of Kazakhstan” (1969–1972), “Manual for Identification of Plants of Central Asia and Kazakhstan” (1968–1987).

The names of plant species, genera, and families were quoted in accordance with summaries by the APG IV system (2016) and Internet resources of Plantarium (http://www.plantarium.ru) and The Plant List (http://www.theplantlist.org/). In classifying eco-biomorphs, the methodological guidance and terminology by Serebryakov (1964) and Bykov (1980, 1983) were used.

The vegetation was studied using traditional methods of geobotanic field research, including the geobotanical description of the main vegetation communities and the landscape and ecological profiling with the use of topographic maps and space imagery (Lavrenko and Korchagin, 1959–1976; Bykov, 1978; Berlant, 1997). At some points, position was registered by GPS device, and the detailed geobotanical description was compiled of the main plant communities representative of the area.

The research of plant resources was performed by a route method with the use of topographic maps of different scale. The density of the reserve of raw materials was determined by establishing the test plots with the further extrapolation of the obtained data to the entire area and the projective cover. For recording of the raw material reserves of thickets, the test plots were laid out ranging in size from 1 to 10 sq. m. The number of test plots varied from 15 to 25 depending on the area and the evenness of distribution of the species within the plant community.

In each test plot the number of generative stems (primary output) was counted, they were cut, weighed and, in this way the density was determined of the reserve of raw materials. Then the magnitude of operational reserve, the volume of possible annual stocks, subject to the period of restoration of the studied species, were estimated. The data obtained during the field work were processed statistically (Methodology for the assessment of medicinal plant reserves, 1986). All the obtained data were statistically processed and summarized in the inventory spreadsheet. The operational stock of raw material on key sites was documented in a similar way.

Survey to identify the distribution and the raw material reserves that formed commercial thickets was conducted in South Kazakhstan within the limits of the Karatau and the West Tien Shan mountains in July and August 2013. For herbal species of medicinal plants in which the aboveground part serves as raw material, the assessment of the resources of raw materials was carried out during the flowering period (July); for Rosa species fruits, the resources of raw material were calculated in August. Survey of the resources in the ranges of the North Tien Shan Mountains were carried out a month later in August–September 2014.

3. Results

3.1. Flora

Identification of CWR and the precise locations of their growth were the main objectives of this study. On the basis of the seeds collected for the Seed bank of the Institute of Botany & Phytointroduction, the regional lists of CWR were formed (Table 1).
| Families/Species | Floristic district |
|------------------|--------------------|
| **Amaranthaceae Juss.** | |
| Amaranthus retroflexus L. | + - - - - |
| Ceratocarpus arenarius L. | - - - + - |
| Kochia prostrata (L.) Schrad. | - - + + + |
| Krascheninnikovia eversmanniana (Stschegl. ex Losinsk.) Grubov | + - - - - |
| **Amaryllidaceae J.St.-Hil.** | |
| Allium altissimum Regel | + - - - - |
| A. angulosum L. | - - - - - |
| A. caesium Schrenk | - - - - - |
| A. caeruleum Pall. | - - - - - |
| A. dolichostylum Vved. | - - - - - |
| A. galanthum Kar. & Kir. | - - - - - |
| A. obliquum L. | - - - - - |
| A. pskemense B. Fedtsch | - - - - - |
| A. sativum L. | - - - - - |
| A. turkestanicum Regel | - - - - - |
| **Anacardiaceae Lindl.** | |
| Pistacia vera L. | - - - - + |
| **Apiaceae Lindl.** | |
| Anthriscus sylvestris (L.) Hoffm. | - - - - - |
| Carum carvi L. | - - - - - |
| Daucus carota L. | - - - - - |
| Eremodaucus lehmannii Bunge | + - - - + |
| **Asparagaceae Juss.** | |
| Asparagus officinalis L. | - - - - - |
| A. persicus Baker | - - - - - |
| **Asteraceae Dumort.** | |
| Achillea asiatica Serg. | - - - - + |
| A. millefolium L. | + + + + + |
| Arctium tomentosum Mill. | - - - - - |
| Artemisia absinthium L. | - - - - - |
| A. cina Berg ex Poljak | - - - - + |
| A. dracunculus L. | - - - - + |
| A. semiranda (Krasch. & Lavrenko) Filatova | - - - - - |
| A. serotina Bunge | - - - - - |
| A. terra-albae Krasch. | - - - - - |
| A. vulgaris L. | - - - - - |
| Carduus mutans L. | + - - - - |
| Carthamus lanatus L. | - - - - - |
| Cichorium intybus L. | - - - - - |
| Helichrysum maracandicum Popov | + - - - - |
| Inula helenium L. | - - - - - |
| Lactuca serriola L. | + + - + + |
| Ligularia heterophylla Ruhr. | + - - - - |
| Tanacetum vulgare L. | + - - - - |
| **Berberidaceae Juss.** | |
| Berberis integerrima Bunge | - - - - - |
| Berberis interjehmpra (Regel) C.K. Scheid | - - - - - |
| B. sphaerocarpa Kar. & Kir. | + + - - - |
| B. heteropoda Schrenk | - - - - - |
| **Boraginaceae Endl.** | |
| Betula pendula Roth | - - - - - |
| B. tianschanica Ruhr. | - - - - - |
| **Boraginaceae Juss.** | |
| Borago officinalis L. | - - - - - |
| **Brassicaceae Burnett.** | |
| Brassica elongata Ehrh. | - - - - - |
| B. juncea (L.) Czern. | - - - - - |
| Crambe cordifolia subsp. kotschyanu (Boiss.) Jafri | + - + - - |
| Isatis tinctoria L. | + - - - - |
| Lepidium draba L. | + - - - - |
| L. latifolium L. | - - - - - |
| **Cannabaceae Endl.** | |
| Cannabis sativa L. | - - - - - |
| Humulus lupulus L. | - + - - - |
| **Capparaceae Juss.** | |
| Capparis sicula subsp. herbacea (Willd.) Inocencio, D.Rivera, Obón & Alcaraz | - - - - - |
| **Caprifoliaceae Juss.** | |
| Lonicera hispida Pall. ex Schult. | + + - - - |
| L. humilis Kar. & Kir. | + + - - - |
| L. microphylla Willd. ex Schult. | + - - - - |
| L. nummularifolia Jaub. & Spach | - - - - - |
| L. stenantha Pojaik. | + + - - - |
| Families/Species | Floristic district |
|------------------|------------------|
|                  | 25   | 25a  | 26   | 27   | 28, 29 |
| L. tatarica L.   | +    |      |      |      |        |
| L. tianschanica Pojark. | -    |      |      |      |        |
| L. webbiana Wall. ex DC. | +    |      |      |      |        |
| Patrinia intermedia (Hornem.) Roem. & Schult. | +    |      |      |      |        |
| Scabiosa ochroleuca L. | +    |      |      |      |        |
| Valeriana officinalis L. | -    |      |      |      |        |
| Caryophyllaceae Juss. |      |      |      |      |        |
| Allochrosa gypsophiloides (Regel) Schischk | -    |      |      |      |        |
| Crassulaceae DC. |      |      |      |      |        |
| Rhodiola kirilowii (Regel) Maxim. | -    |      |      |      |        |
| Cyperaceae Juss. |      |      |      |      |        |
| Carex pachystylis J.Gay |      |      |      |      |        |
| E. rhamnoides (L.) A.Nelson | -    |      |      |      |        |
| Ephedraceae Dumort. |      |      |      |      |        |
| Ephedra equisetina Bunge | +    |      |      |      |        |
| E. intermedia Schrenk & C.A.Mey. | -    |      |      |      |        |
| Euphorbiaceae Juss. |      |      |      |      |        |
| Euphorbia macrocarpa Boiss. & Buhse | +    |      |      |      |        |
| Fabaceae Lindl. |      |      |      |      |        |
| Alhagi kirghisorum Schrenk | -    |      |      |      |        |
| A. pseudalhagi (M. Bieb.) Desv. ex B. Keller & Shap. | +    |      |      |      |        |
| Astragalus severzovii Bunge | -    |      |      |      |        |
| Caragana jubata (Pall.) Poir. | -    |      |      |      |        |
| C. pleiophylla (Regel) Pojark. | -    |      |      |      |        |
| Halimodendron halodendron (Pall.) Voss | -    |      |      |      |        |
| Hedysarum austrosibiricum B.Fedtsch. | -    |      |      |      |        |
| H. songoricum Bong. | -    |      |      |      |        |
| Lathyrus tuberosus L. | -    |      |      |      |        |
| L. pratensis L. | -    |      |      |      |        |
| Medicago falcata L. | -    |      |      |      |        |
| M. lupulina L. | -    |      |      |      |        |
| M. sativa L. | -    |      |      |      |        |
| Melilotus albus Medik. | -    |      |      |      |        |
| M. officinalis (L.) Pall. | -    |      |      |      |        |
| Onobrichis pulchella Schrenk | +    |      |      |      |        |
| Sophora alopecuroides L. | -    |      |      |      |        |
| Thermopsis alpina (Pall.) Ledeb. | +    |      |      |      |        |
| Trifolium arvense L. | +    |      |      |      |        |
| T. hybridum L. | +    |      |      |      |        |
| T. lupinaster L. | -    |      |      |      |        |
| T. pratense L. | +    |      |      |      |        |
| Vicia cracca L. | +    |      |      |      |        |
| V. tenuifolia Roth | -    |      |      |      |        |
| Grossulariaceae DC. |      |      |      |      |        |
| Ribes aureum Pursh | -    |      |      |      |        |
| R. meyert Maxim. | +    |      |      |      |        |
| Hypericaceae Juss. |      |      |      |      |        |
| Hypericum elongatum Ledeb. ex Rchb. | +    |      |      |      |        |
| H. perforatum L. | -    |      |      |      |        |
| H. scarutum L. | -    |      |      |      |        |
| Juglandaceae A. Rich. | -    |      |      |      |        |
| Juglans regia L. | -    |      |      |      |        |
| Iridaceae Juss. |      |      |      |      |        |
| Iris halophila var. sogdiana (Bunge) Grubov | -    |      |      |      |        |
| Lamiaceae Martonov |      |      |      |      |        |
| Leonurus turkestanicus V.I.Krecz. & Kuprian. | -    |      |      |      |        |
| Marrubium vulgare L. | -    |      |      |      |        |
| Mentha arvensis L. | -    |      |      |      |        |
| M. longifolia (L.) L. | -    |      |      |      |        |
| M. longifolia var. asiatica (Boriss.) Rech.f. | -    |      |      |      |        |
| M. rotundifolia (L.) Huds. | -    |      |      |      |        |
| Nepeta nuda L. | -    |      |      |      |        |
| Oreganum vulgare L. | -    |      |      |      |        |
| O. vulgare subsp. gracile (K.Koch) letsw. | -    |      |      |      |        |
| Phlomoides oreophila (Kar. & Kir.) Adylov, Kamelin & Makhm. | -    |      |      |      |        |
| Phlomoides oreophila (Kar. & Kir.) Adylov, Kamelin & Makhm. | -    |      |      |      |        |
| Prunella vulgaris L. | -    |      |      |      |        |

(continued on next page)
Table 1 (continued)

| Families/Species Floristic district | 25 | 25a | 26 | 27 | 28, 29 |
|------------------------------------|----|-----|----|----|--------|
| Salvia aethiopis L.                | –  | –   | –  | –  | –      |
| S. desert Schangin                  | –  | +   | –  | –  | –      |
| S. sclarea L.                      | –  | –   | +  | –  | +      |
| Thymus pulegioides subsp. pannonicus (All.) Kerguelen | + | + | – | – | – |
| Zizipora clonopodiodes Lam.        | +  | +   | –  | –  | +      |
| Linaceae DC. ex S.F. Gray           |    |     |    |    |        |
| Linum macrorhizum Juz.             | +  | –   | –  | –  | –      |
| L. perenne                         | +  | –   | –  | –  | –      |
| Malvaceae Juss.                     |    |     |    |    |        |
| Alcea nudi flora (Lindl.) Boiss.    | –  | +   | –  | –  | +      |
| Althaea of ficinalis L.             | +  | –   | –  | –  | –      |
| Lavatera thuringiaca L.             | –  | +   | –  | –  | –      |
| Moraceae Link                       |    |     |    |    |        |
| Morus nigre L.                     | –  | –   | –  | –  | +      |
| Nitriaceae Bercht. & J. Presl.      |    |     |    |    |        |
| Peganum harmula L.                 | –  | +   | –  | –  | +      |
| Plantaginaceae Juss.                |    |     |    |    |        |
| Plantago lanceolata L.              | +  | +   | –  | –  | –      |
| P. major L.                        | +  | +   | –  | –  | –      |
| Poaceae Barnhart                    |    |     |    |    |        |
| Achnatherum splendens (Trin.) Nevski| –  | +   | –  | –  | –      |
| Aegilops cylindrica Host            | +  | –   | –  | –  | +      |
| A. triuncialis L.                  | –  | –   | +  | –  | –      |
| Aeluropus littoralis (Gouan) Parl.  | –  | –   | +  | –  | –      |
| Agropyron cristatum (L.) Gaertn.    | –  | –   | +  | –  | –      |
| A. pratensis L.                    | –  | –   | –  | –  | +      |
| Avena fatua L.                     | +  | –   | –  | –  | +      |
| Bothriochloa ischaemum (L.) Keng    | +  | –   | –  | –  | +      |
| Brachypodium pinnatum (L.) P.Beauv. | +  | +   | –  | –  | +      |
| Bromus danthoniae Trin.             | –  | –   | –  | –  | +      |
| B. inermis L.                      | –  | –   | –  | –  | +      |
| B. japonicus Thunb.                | +  | –   | –  | –  | +      |
| B. lanceolatius Roth               | –  | –   | –  | –  | +      |
| B. racemosus L.                    | –  | –   | –  | –  | +      |
| B. scoparius L.                    | –  | –   | –  | –  | –      |
| B. secalinus L.                    | –  | –   | –  | –  | –      |
| B. squarrosus L.                   | –  | –   | –  | –  | –      |
| B. tectorum L.                     | –  | –   | –  | –  | –      |
| Calamagrostis epigeios (L.) Roth    | –  | –   | –  | –  | +      |
| C. pseudophragmites (Haller f.) Koeler | –  | +   | –  | –  | +      |
| Cynodon dactylon (L.) Pers.         | –  | +   | –  | –  | +      |
| Dactylis glomerata L.               | –  | +   | –  | –  | +      |
| Deschampsia cespitosa (L.) Keng     | +  | –   | –  | –  | +      |
| Elymus gmelinii (Ledeb.) Tzvelev    | –  | +   | –  | –  | –      |
| E. hispidus (Opiz) Melderis         | +  | –   | –  | –  | +      |
| E. repens (L.) Gould.               | +  | –   | –  | –  | +      |
| E. sibiricus L.                    | –  | +   | –  | –  | –      |
| Eragrostis cilianensis (All.) Janch.| +  | +   | –  | –  | +      |
| E. collina Trin.                   | –  | –   | –  | –  | –      |
| E. minor Host                      | –  | –   | –  | –  | –      |
| Eremopyrum bonaepartis (Spreng.) Nevski | –  | –   | –  | –  | +      |
| E. orientale (L.) Jabo. & Spach     | –  | –   | –  | –  | +      |
| E. triticeum (Gaertn.) Nevski      | –  | +   | –  | –  | +      |
| Festucia krolyoviana Reverd.       | –  | +   | –  | –  | –      |
| F. orientalis (Boiss.) B.Fedtsch.   | –  | –   | –  | –  | +      |
| F. pratensis Huds.                  | –  | –   | –  | –  | +      |
| F. valesia Schleich. ex Gaudin      | –  | –   | –  | –  | +      |
| Helictotrichon desertorum (Less.) Pilg. | –  | +   | –  | –  | –      |
| H. hookeri (Scribn.) Henriard      | –  | +   | –  | –  | –      |
| Hordeum bogdani Wilensky           | –  | +   | –  | –  | –      |
| H. brevisubulatum (Trin.) Link      | –  | +   | –  | –  | –      |
| H. bulbosum L.                     | –  | –   | –  | –  | +      |
| H. muralum subsp. lopinum (Link) Arcang. | +  | –   | +  | –  | +      |
| Koeleria altaica (Domin) Krylov    | –  | +   | –  | –  | –      |
| K. pyramidalata (Lam.) P.Beauv.     | +  | +   | –  | –  | +      |
| Leymus angustus (Trin.) Pilg.       | –  | –   | –  | –  | +      |
| L. multiannual (Kar. & Kir.) Tzvelev| –  | +   | –  | –  | +      |
| L. racemosus (Lam.) Tzvelev         | –  | +   | –  | –  | +      |
| L. ramosus (C.Richt.) Tzvelev       | –  | +   | –  | –  | –      |
| Melica alissimis L.                | –  | –   | –  | –  | +      |
| Families/Species | Floristic district |
|-----------------|-------------------|
|                | 25    | 25a  | 26 | 27 | 28, 29 |
| *M. transilvanica* Schur | +     |     | +  |  | +     |
| *Milium effusum* L. | +     |     | +  |  | +     |
| *Panicum miliaceum* L. | +     |     | +  |  | +     |
| *Phalaris arundinacea* L. | +     |     | +  |  | +     |
| *P. tuberosa* L. | +     |     | +  |  | +     |
| *Phragmites australis* (Cav.) Trin. ex Steud. | +     |     | +  |  | +     |
| *Piptatherum songaricum* (Trin. & Rupr.) Roshev. | +     |     | +  |  | +     |
| *Porangia* L. | +     |     | +  |  | +     |
| *P. bulbosa* L. | +     |     | +  |  | +     |
| *P. nemoralis* L. | +     |     | +  |  | +     |
| *P. pratensis* L. | +     |     | +  |  | +     |
| *P. sibirica* Roshev. | +     |     | +  |  | +     |
| *P. trivialis* L. | +     |     | +  |  | +     |
| *Setaria anguliflora* (L.) Beauv. | +     |     | +  |  | +     |
| *S. viridis* (L.) P.Beauv. | +     |     | +  |  | +     |
| *S. capillata* L. | +     |     | +  |  | +     |
| *S. caucasicus* Schmalz. | +     |     | +  |  | +     |
| *S. hohenackeriana* Trin. & Rupr. | +     |     | +  |  | +     |
| *S. korschinskii* P.A.Smurn. | +     |     | +  |  | +     |
| *S. lessingiana* Trin. & Rupr. | +     |     | +  |  | +     |
| *S. richteri* Karav. & K Pr. | +     |     | +  |  | +     |
| *S. serepana* Beck | +     |     | +  |  | +     |
| *Stipa capensis* (Trin.) De Winte | +     |     | +  |  | +     |
| *Taeniatherum caput-medusae* (L.) Nevski | +     |     | +  |  | +     |

**Polygonaceae** Juss.

- *Aconogonon alpinum* (All.) Schur
- *Atraphaxis pyrifolia* Bunge
- *Polygonum aviculare* L.
- *P. parviflorae* C.A. Mey.
- *Rheum cordatum* Losinsk.
- *R. wittrockii* C.E. Lundstr.
- *Rumex acetosa* L.
- *R. confertus* Willd.
- *R. crispus* L.
- *R. tianschanicus* Losinsk.

**Ranunculaceae** Takht.

- *Aconitum leucostomum* Vorosch.
- *Clematis glauca* Willd.

**Rhamnaceae** Juss.

- *Frangula alnus* Mill.
- *Rhamnus cathartica* L.

**Rosaceae** Juss.

- *Atriplex hortensis* (Franch.) Vass.
- *Amygdalus communis* L.
- *A. petroselinifolia* Litv.
- *A. spinosissima* Bunge
- *Armeniaca vulgaris* Lam.
- *Cerasus erythrocarpa* Litv.
- *C. karabastaviensis* Vass.
- *C. sibirica* Pojark.
- *C. verrucosa* (Franch.) Nevski
- *Cotoneaster melanocarpus* Fisch. ex A.Blytt
- *C. multiflorus* Bunge
- *C. oigenthus* Pojark.
- *C. pojarjovae* Zakrz.
- *C. suavis* Pojark.
- *Crataegus almatensis* Pojark.
- *C. azarolus* var. pontice (K.Koch) K.J.Chr.
- *C. chlorocharpa* Lenz & K.Koch
- *C. chlorocharpa* Maxim.
- *C. orientalis* Pall. ex M.Bieb.
- *C. pseudoheterophylla* subsp. turkestanica (Pojark.) K.J.Chr.
- *C. songoricus* K. Koch
- *C. submollis* Sarg.
- *C. watsonii* Hemsdl. & Lace
- *Fragaria viridis* Weston
- *Geum urbanum* L.
- *Malus sieversii* (Ledeb.) M. Roem.
- *Potentilla crantzii* (Crantz) Beck ex Fritsch
- *Prunus domestica* L.
- *P. sogdiana* Vass.

(continued on next page)
The list of CWR includes 289 species belonging to 39 families and 145 genera. The leading 8 families are as follows: Poaceae (81 species), Rosaceae (50), Fabaceae (27), Lamiales (18), Asteraceae (18), Caprifoliaceae (11), Polygonaceae (10), Amaryllidaceae (10). Thus, 225 species are accumulated in these families, which is 77.8% of the total number of the Tien Shan CWR.

The taxonomical structure of CWR flora of the West Tien Shan and the Karatau range is represented by 191 species from 29 families and 96 genera. The greatest species diversity was found among the following families: Poaceae (59 species); Rosaceae (40); Fabaceae (19); Asteraceae (13); Lamiales (11); Amaryllidaceae (7); Polygonaceae (5); Caprifoliaceae (5). Thus, the composition of the leading 8 families unites 159 species.

In spite of the fact that the quantitative distribution of species among the families is extremely uneven, it should be noted that many of the listed families take the leading positions as a part of regional flora (Asteraceae, Poaceae, Rosaceae, Fabaceae). The other 21 families possessed only 32 species of CWR. The quantitative structure of families is insignificant: from 3 species (Berberidaceae, Hypericaceae) and 2 species (Apiaceae, Asparagaceae, Brassicaceae, Elaeagnaceae, Ephedraceae, Grossulariaceae, Solanaceae) up to 1 family (12 families). The distribution of the CWR of the West Tien Shan and the Karatau by genera were also uneven. Genera Rosa L. (9 species), Bromus L. (9) Crataegus L. (8) and Allium L. (7) contained the greatest number of species (33). Genera Poa L. and Artemisia L. were each represented by five species: genera Festuca L., Cerasus Hill, Trifolium L., Lonicera L. and Mentha L. were each represented by four species each one. In general, the listed genera unite 63 species. The greatest cumulative number of the CWR was noted at the genera containing 2--3 species (31 genera – 75 species that makes up 39.3% of the total number of species). The number of the genera only containing one species was 53 (27.7%).

The studied ridges of the North Tien Shan possess a rather high degree of botanical diversity that allows them to be considered as the important objects of concentration of CWR in Kazakhstan.

The taxonomical structure of CWR flora of the North Tien Shan is presented by 32 families belonging to 124 genera and 215 species. The species structure of the leading 8 families of the CWR unites 167 taxa. The quantitative distribution between families was found to be uneven. The greatest species variety of CWR was represented in the following families: Poaceae (64 species); Rosaceae (31); Fabaceae (19); Lamiales (16); Asteraceae (13); Caprifoliaceae (9); Amaranthaceae (8); and Polygonaceae (7).

The remaining 24 families are represented by 1--4 species uniting 48 CWR. The greatest number of species (14) was concentrated in 11 families each having 2 representatives.

The distribution of the CWR by genera was also uneven. The greatest number appeared in the following genera: Allium L. (8 species), Lonicera L. (7), Rosa L. (6), Stipa L. (6), Artemisia L. Bromus L., Crataegus L., Poa L. (5 species in each one); Leymus Hochst., Elymus L., Rubus L., Trifolium L. (4). In total, in these genera there were 63 species (29.3%). Other genera containing from 1 to 3 species were presented by 152 species, and one—species genera dominated 81.

The quantitative content of the families of the CWR of the North Tien Shan ridges was distributed as follows: 24 families were found in the Ile and Kungey Alatau and also in Ketmen; 21 families were found in the Kyrgyz Alatau. Only 14 families were found in the Shu-Ile mountains. The sequence of arrangement of the families in the Ile, the Kungey Alatau, the Ketmen ridge and also the Kyrgyz Alatau was characterized by similarity of 4 leading families: Poaceae,
Rosaceae, Fabaceae, and Lamiaceae. The structure of the leading families of the CWR of the Shu-Ile mountains was also headed by the Poaceae family as well, as in the above listed regions. However, subsequent places were taken by other families: Lamiaceae and Asteraceae. The low-mountain type of the landscape of the Shu-Ile range, in comparison with the other ridges of the North Tien Shan, explained the insignificant content and features of the composition of the CWR.

The quantitative representation of the genera of the CWR in regions demonstrated the picture which was similar to families' distribution: the greatest number of genera were in the Ile and the Kunget Alatau (81 genera), in the Ketmen ridge (73), in the Kyrgyz Alatau (64). In the Shu-Ile mountains the number of genera was 37.

The analysis of distribution of species among the floristic areas also reflected the representation of the greatest number of the CWR in the large mountain territories. In the Ile, the Kunget Alatau and in the Ketmen ridge 105 species were found; in the Kyrgyz Alatau 103 species were found, and in the Shu-Ile mountains only 48 species were found.

Comparison of the family structure of the CWR of the ridges of the North (32 families with 215 species) and the West Tien Shan (29 families with 191 species) testifies to a similar hierarchical order of the distribution of 3 leading families (Poaceae, Rosaceae and Fabaceae) (Fig. 2). The sequence of the arrangement of the following 4 families (Lamiaceae, Asteracae, Caprifoliaceae, Polygononaceae) may change; however, they keep the leading positions among the first 10 families (Fig. 3). The domination of the Poaceae family (20 species) was usual for the Shu-Ile mountains and the subsequent families such as Lamiaceae (6 species), Asteracae (5), Amayllidaceae (4), and Fabaceae (4) were characterized by low species saturation.

Among the identified CWR, are the species included in the Red Data Book of Kazakhstan (2014): Pistacia vera L., Rheum wittrockii C. E Lundstr., Armeniaca vulgaris Lam., Malus sieversii (Ledeb.) M. Roem., Allium psakemence B. Fedsch., Allochrusa gypsophiloides (Regel) Schischk., Sorbus persica Hedl., Vitis vinifera L., Artemisia cina Berg ex Poljak. According to the IUCN Red List, M. sieversii is listed as a vulnerable species: P. vera, A. psakemence, A. cina are categorized as “Possibly Threatened” species (http://www.bgci.org/threat_search.php?).

3.2. Vegetation

The diversity of habitats causes the forming of vegetation communities with the participation and sometimes the domination of CWR.

With respect to the ranges of the West Tien Shan, Kyrgyz Alatau and Karatay, the greatest floristic and phytocoenetic diversity was noted in the intermountain valleys and in river floodplains, where the meadow vegetation provides the high abundance of forage (Elymus repens, Elymus hirsutus, Bromus inermis, Lathyrus pratensis, Vicia cracca, Dactylis glomerata, Trifolium repens), and resource plants (Mentha longifolia, Hypericum perforatum, Allium spp.). In the gallery forest the diversity of wild fruit plants such as Sievers apple, Regel pear, the species of hawthorn, apricot, rowan (M. sieversii, Pyrus regelii Rehder, Crataegus spp., A. vulgaris, Sorbus spp.) is high; mulberry and mahaleb cherry (Morus nigra, M. alba L., Cerasus karabastaviensis) are found as single plants. The shrub thickets are formed by buckthorn, blackberry and dogrose (Elaeagnus racnoideae, Rubus caesius, Rosa spp.) (Sitpaeva et al., 2014a,b).

In the West Tien Shan ranges the CWR of grain cultured plants (Taeniatherum caput-medusae, Aegilops cylindrica, Bromus spp., Hordeum murinum subsp. leporinum) are confined to dry steppe slopes in the low mountainous belt.

In the steppe communities the following forage plants are dominant: Festuca valesiaca, Stipa spp., Helictotrichon hookeri, Phleum phleioides, Poa angustifolia. In the Karatay ridge are found highly abundant populations of A. cylindrica, A. triuncialis, Hordeum bulbosum in the composition of sagebrush (Artemisia karatavica Kracsh. et Abolin ex Poljakov) communities, and in the grass layer of the maple and ash tree (Prunus sogdiana Bunge, Acer tataricum subsp. semenovii (Regel & Herder) A.E.Murray) woodlands. Along the banks of streams in the gorges the species of onion were noted (Allium altissimum, A. sativum). In the interstitial hollow, there are hawthorns (Crataegus spp.), woodlands with the participation of shrubs (Rosa spp., Cerasus erythrocarpa, Cerasus tianschanica) and grasses (E. hirsutus, B. inermis, H. bulbosum).

The populations of almond (Amygdalus spp.) and plum (Prunus sogdiana) commonly occur in the shrub communities of the West Tien Shan. Ephedra equisetina is dominant on the patches of rock deposits. The woodlands of pistachio (P. vera) are encountered along the dry slopes of the south-eastern and the south-western expositions in the low mountainous areas of the West Tien Shan; the most north locations are discovered in the west of the Kyrgyz Alatau range.

The geobotanic research of the North Tien Shan ranges revealed the high phytocoenetic diversity and the domination of many species of CWR. The typical steppes are only preserved within the limits of the Ketmen, Terskey, Kunget Alatau ranges. The dominants of steppes are the valuable rangeland grasses: Stipa capillata, F. valesiaca, Helictotrichon desertorum, Koeleria pyramidata, Agropyrone cristatum with the participation of motley grass (Salvia

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**Fig. 2.** Taxonomy content of CWR. (A) West Tien Shan. (B) North Tien Shan.
dumetorum Andrz. ex Besser, Achillea millefolium, Medicago falcata). In the Terskey Alatau range there are steppe grasses: Stipa kirsghisorum, F. valesiaca, H. hookeri.

Big bluestem (Bothriochloa ischaemum) and fescue are dominants of meadow steppes. In the middle mountain belt, the role of shrubs of the genera Rosa L., Cotonaster Medik. is important. On the north slopes of the Terskey Alatau range, the shrub belt (Rosa spp., Cotonaster melanocarpus, Berberis sphaerocarpa) is prominent; in the river valleys there are E. rhamnoides thickets and meadows (P. phleoides, Melica transsilvanica, Fragaria viridis, Origanum vulgare, Ziziphora clinopodioides, etc.) (Dimeyeva et al., 2016).

In the Ile Alatau range apple forests (M. sieversii) are encountered with hawthorn (Crataegus almaetensis) and maple trees. In the underbrush layer there are Rosa beggeriana, B. sphaerocarpa, Lonicera humilis. In the grass layer there are meadow species (Achillea millefolium, Trifolium pratense, Tanacetum vulgare). The apricot forests (A. vulgaris) grow on southern, eastern and western stony slopes. In the grass layer M. transsilvanica, Dactylis glomerata, O. vulgare, H. perforatum, etc. are distributed. The shrub communities (Rosa spp., Rubus idaeus) are common in the mid-mountainous belt.

The underbrush of fir tree (Picea schrenkiana Fisch. & C.A. Mey.) and mixed forests form shrubs: (Lonicera spp., Rosa albertii, Cotonaster alghanzus, Sorbus tianshanica, Ribes meyeri); forage and medicinal species are in the grass layer (Poa pratensis, Lathyrus gmelinii Fritsch, Z. clinopodioides, Thymus pulegioides subsp. pannonicus).

In the gallery forests the shrub layer is formed by B. sphaerocarpa and E. rhamnoides. In the floodplain meadows various species of CWR were identified: Salvia deserta, Mellilotus officinalis, Trifolium hybridum, Agrostis gigantea, A. millefolium, O. vulgare, Medicago falcata, Rumex confertus, Dactylis glomerata, Poa trivialis, etc.

Fescue, bunch-grass-forb steppes and meadows prevail in the high mountainous belt. The alpine meadows are kobresia-forb (Alchemilla retropilosa Juz., A. sauri Juz., Allium atrosanguineum Schrenk., Deschampsia koelerioides Regel., Kobresia capillifolia (Decne.) C.B.Clarke, K. humilis (C.A. Mey. ex Trautv.) Serg.). In the sub-alpine belt there are steppe species (F. valesiaca, Helichotrichon tianschanicum (Roshev.) Henrard, H. desertorum (Less.) Pilg., Poa versicolor Besser) and grass-forb meadows (Alchemilla sibirica Zamelis, Geranium collinus Stephan ex Willd., G. albiflorum Ledeb., Aloepecurus pratensis, P. pratensis).

In the Shu-Ili low mountain range the dominant and subdominant plants of the vegetation cover are the forage species: steppe grains (Agropyron cristatum, K. pyramidalata, Stipa saturetana, S. capillata, F. valesiaca, P. phleoides), meadow grasses and forbs (Agrostis gigantea, B. inermis, Calamagrostis epigeios, E. repens, Leymus multicaulus, Achnatherum splendens, M. falcata, M. officinalis, Mentha arvensis, Glyceria uralesis). Onion species are encountered in communities with low abundance (Alium angulosum, A. caesium, A. galanthum, A. turkestanicum), as well as C. tianschanica, Ephedra intermedia, A. cylindrica.

### 3.3. Resources

As a result of resource research in the West Tien Shan ranges, it was established that the thickets of production importance are formed only by some of the identified species. In doing so, certain species, with a characteristic of a high crop rate do not form thickets, but grow in small groups or, sporadically, with single plants.

In the Karatau and the West Tien Shan ranges reserves of the air-dry raw material were identified and recorded of 9 species of CWR from the families of Hypericaceae Juss. (2 species), Lamiaceae (3), Rosaceae (4): M. longifolia, O. vulgare subsp. gracile, Z. clinopodioides, Hypericum scabrum L. (Karatau range); Rosa albertii, R. beggeriana, R. kokanica (Regel) Juz., Rosa platycantha (Karatau and Karzhantau); H. perforatum (Karzhantau) (Table 1). For local pharmacy chain, it is possible to recommend species of Rosa L., Hypericum L., M. longifolia, O. vulgare subsp. gracile, Z. clinopodioides (Karatau and Karzhantau ranges).

As a result of our resource research in the North Tien Shan ranges, the reserves of the air-dry and fresh raw materials were recorded of 10 species from the families of Rosaceae (5 species), Lamiaceae (3), Polygonaceae (1), Berberidaceae (1): Rosa spp., B. sphaerocarpa, A. vulgaris, Cotonaster multiflorus Bunge, M. sieversii, Z. clinopodioides, O. vulgare, M. longifolia, Rumex tianschanicus (Tables 2 and 3).

Among the resource species of CWR identified in the North and West Tien Shan A. vulgaris which grows outside Kazakhstan (in China), considered a rare species with a decreasing habitat (Red Data Book of Kazakhstan, 2014). The species is valuable because of the rich genetic pool. The fruit is rich in vitamins C, B, P, carotene, microelements, tanning substances, mineral salts, and starches. They are edible in fresh, dry and processed form; the seeds are the
surrogate of almond. The nectar bearing plant is suitable as a soil stabilizer and is valuable for the selection of the late-blooming, frost and drought resistant species (Plant resources of the USSR, 1987). In our research area *A. vulgaris* was found in the composition of the arborous and shrub communities of the Ketmen mountains in the gorges of the Big and Small Kyrgyzsai, the gorge of the Sumbe River at the altitude from 1419 to 1525 m a.s.l., with the participation of *Malus* Mill., *Berberis* L., *Rosa* L., *Cotoneaster* Medik., etc.

The operational reserve of *A. vulgaris* in the gorge of the Big Kyrgyzsai comprised 5.9 metric tons of fresh fruit.

The species with greatly decreasing quantity include *M. sieversii* (Red Data Book of Kazakhstan, 2014); the valuable rootstock and parent plant of the numerous cultured kinds, characteristic with form diversity, especially in terms of size, colour and taste of fruit, growing outside Kazakhstan—in the mountains of Central Asia and West China (Dzhangaliyev, 1977; Ponomarenko, 1977). *M. sieversii* was identified in all gorges of the Ketmen mountains at the altitudes from 1438 m to 1591 m a.s.l. The operational stock of fresh fruit *M. sieversii* in the gorge of Tereksay comprised 6.4 metric tons.

The natural populations of *A. vulgaris* and *M. sieversii* can be recommended as reserve plots for the collection of seed and growth materials.

### 4. Discussion

Research of the CWR in the Tien Shan and other territories of Kazakhstan were carried out for the first time. During the implementation of the Program, all floristic districts of Kazakhstan were

| Plant species, processed part | Location of production plants | Area, ha | Crop yield, kg/ha | Operational stock of raw material, metric tons | Volume of possible annual processed raw material, metric tons |
|------------------------------|-------------------------------|----------|------------------|-----------------------------------------------|-------------------------------------------------------------|
| *Rosa alberti* fruit         | The Karatau mountains, the Ulken Karakuz river valley, 12 km to the south-west of Syzgan village (Turkestan province) | 100.0    | 21.5 ± 2.4       | 0.22                                          | 0.1                                                         |
| *Species of Rosa L.* (*R. alberti, R. kokanica, R. beggeriana*) fruit | The Karzhantau range, the Saryaigyr river valley, 20–22 km from the Kaskasu village (Turkestan province) | 180.0    | 25.5 ± 3.3       | 0.69                                          | 0.3                                                         |
| *Origanum vulgare* subsp. gracile overground | The Karatau mountains, the Ulken Karakul river valley, 12 km to the south-west of Syzgan village (Turkestan province) | 100.0    | 45.3 ± 6.3       | 1.13                                          | 0.3                                                         |
| *Origanum vulgare* overground | The Kungey Alatau range, the gorge of Great Zhalanash, 0.5 km higher than ranger station, sub-alpine meadow (Almaty province) | 45.0     | 283.2 ± 36.8     | 1.27                                          | 0.3                                                         |
| *Hypericum perforatum* overground | The Karzhantau range, the gorge of the river Saryaigyr, 20–33 km from Kaskasu village (Turkestan province) | 180.0    | 109.0 ± 14.2     | 0.98                                          | 0.3                                                         |
| *Hypericum scabrum* overground | The Karatau mountains, the Khantagy river valley, 4–5 km to the north-east of Khantagy village (Turkestan province) | 200.0    | 58.4 ± 7.6       | 1.75                                          | 0.4                                                         |
| *Mentha longifolia* overground | The Karatau mountains, the Ulken Karakuz river valley, 12 km to the south-west of Syzgan village (Turkestan province) | 100.0    | 314.0 ± 37.7     | 1.57                                          | 0.4                                                         |
| The Ketmen range, the Small Kyrgyzzai gorge, 4 km to the south-east of Kyrgyzzai village (Almaty province) | 20.0    | 320.0 ± 44.8     | 0.6                                           | 0.2                                                         |
| *Ziziphora clinopodioides* overground | The Karatau mountains, the gorge of the Khantagy river, 4–5 km to the north-east of Khantagy village (Turkestan province) | 200.0    | 71.5 ± 8.6       | 1.43                                          | 0.3                                                         |
| The Karzhantau range, the Saryaigyr river gorge, 20–22 km from Kaskasu village (Turkestan province) | 180.0    | 56.0 ± 7.3       | 1.01                                          | 0.2                                                         |
| The Kungey Alatau range, the mountain pass Kayky (Almaty province) | 10.0     | 73.5 ± 8.8       | 0.1                                           | –                                                            |
| *Rumex tianschanicus* overground | The Kungey Alatau range, the Great Zhalanash gorge, 0.5 km higher than ranger station (Almaty province) | 45.0     | 1768.0 ± 247.5  | 26.5                                          | 3.8                                                         |
examined (29 in total). The article discusses the region of Kazakhstan’s Tien Shan, within 6 districts. During the survey period, 289 species of seeds were collected in these areas (Table 1). This is not the whole list. Previous field research based on the screening of the Herbarium (AA) and floristic lists of separate ranges of the Tien Shan revealed 389 species. The collection of seeds is a long careful process, which continues to the present. We produced distribution maps for each collected species (Fig. 4).

Field studies of floristic diversity of the crop wild relatives (CWR) of the North Tien Shan at the species and genus level is higher compared with the ranges of the West Tien Shan (Fig. 5). As shown by our field research, the greatest floristic and phytocoenotic diversity was noted in the intermountain valleys and in the floodplains, where the meadow vegetation forms high abundance of forage, and medicinal plants. In the gallery forests the diversity is high of wild fruit plants such as Sievers apple, Regel pear, the species of hawthorn, apricot, cherry and mulberry. The shrub thickets are formed with sea-buckthorn, raspberry, and species of wild rose.

In the ranges of the Tien Shan Mountains, the CWR of the grain crops are usually confined to dry steppe slopes in the low mountainous belt. The populations of almond and plum distributed in the arborous and shrub thickets of the West Tien Shan occupy small areas; the woodlands of pistachio inhabit dry slopes in the lower mountainous areas of the West Tien Shan and in the west part of the Kyrgyz Alatau range.

In the researched territory of the Karatau and the West Tien Shan mountains we recorded operational reserves of the air-dry

| Plant species, processed part | Location of production plants | Area, hectares | Crop yield of raw materials kg/ha | Operational stock of raw material, metric tons | Volume of possible annual processed raw material, metric tons |
|------------------------------|---------------------------------|---------------|----------------------------------|-----------------------------------------------|-------------------------------------------------------------|
| **Armeniaca vulgaris fruit** | The Ketmen range, the Great Kyrgyzsa gorge, 5 km from the Kyrgyzsa village (Almaty province) | 100.0 | 119.1 ± 15.5 | 5.9 | 4.5 |
| **Malus sieversii fruit** | The Ketmen range, the Tereksai gorge, 5.2 km to the south-east of the Sumbe village (Almaty province) | 40.0 | 319.0 ± 41.5 | 6.4 | 4.8 |
| **Rosa laxa fruit** | The Ketmen range, the Great Kyrgyzsa gorge, 5 km from the Kyrgyzsa village (Almaty province) | 100.0 | 250.0 ± 32.5 | 2.5 | 1.9 |
| **Rosa platyacantha fruit** | The Ketmen range, the Great Kyrgyzsa gorge, 5 km from Kyrgyzsa village (Almaty province) | 100.0 | 301.0 ± 42.1 | 1.5 | 1.1 |
| **Cotoneaster multiflorus fruit** | The Ketmen range, the Great Kyrgyzsa gorge, 5 km from Kyrgyzsa village (Almaty province) | 100.0 | 128.0 ± 16.6 | 0.6 | 0.5 |
| **Berberis sphaerocarpa fruit** | The Ketmen range, the Great Kyrgyzsa gorge, 5 km from Kyrgyzsa village (Almaty province) | 100.0 | 120.0 ± 15.6 | 6.0 | 4.5 |

Fig. 4. Geographic distribution of some Red Data Book species in the Tien Shan Mountains. (A) Pistacia vera. (B) Armeniaca vulgaris. The legends include seed collection points and the presence of species in floristic districts (numbers on the map).
raw materials of 9 species (M. longifolia, O. vulgare subsp. gracile, Z. clinopodioides, H. scabrum, H. perforatum, R. alberti, R. beggeriana, R. kokanica, R. platyantha). For local pharmacy network needs the species of Rosa L., M. longifolia, O. vulgare subsp. gracile, Z. clinopodioides, H. scabrum can be recommend.

In the researched area of the North Tien Shan we recorded reserves of air-dry and raw materials of 10 species such as B. sphaerocarpa, A. vulgaris, C. multiflorus, M. sieversii, Z. clinopodioides, O. vulgare, M. longifolia, R. tianschanicus, Rosa laxa, R. platyantha. For the local pharmacy network needs we recommend the species of Rosa L., C. multiflorus, Z. clinopodioides, O. vulgare, M. longifolia. The production plants of R. tianschanicus, B. sphaerocarpa are promising for industrial harvesting.

The recorded reserves of raw materials and the natural populations of the Red Book species of A. vulgaris and M. sieversii should be used as reserve plots for the collection of seed and planting material. For the preservation of populations of identified resource species, it will be necessary to observe the recommended volume of possible annual processing and recommendations for the rational use of productive areas subject to the restoration period of each species. The rest of the CWR species, for which even the limited raw material stocks for a small territory are recorded, represent the unique genetic material of biological diversity formed in the studied regions of Kazakhstan.

5. Conclusions

Analysis of the distribution of CWR by mountain ranges of the Kazakhstani part of the Tien Shan demonstrated the greatest number of plant species concentrated there. The identified variety of a valuable gene pool of CWR confirms Vavilov’s points of view about the existence of the Central Asian historic and geographic center of development of cultural flora.

Three State National Nature Parks (Sairam-Ugam, Ile-Alatau, Kolsay Kolderi), three State Nature reserves (Karatau, Aksu-Zhabagly, Almaty), and the Museum-reserve Tanbaly-Tas cover a part of the Kazakhstan’s Tien Shan Mountains where undisturbed natural ecosystems with valuable CWR are preserved.

The program on CWR ended in 2015. Since then, the seed bank in our Institute has been replenished after each field season. Currently it holds 3082 samples of 820 species of wild flora of Kazakhstan, including CWR, rare and endemic plants.

Declaration of Competing Interest

No conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pld.2019.10.003.

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