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**ESSENTIAL OIL PLANTS OF THE
KARAGANDA REGION**

Monograph

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The monograph presents the results of the study of essential oil plants in the natural flora of the Karaganda region and after introduction into the culture. The complete species composition has been determined, which included 275 species from 130 genera and 35 families. The leading families are *Asteraceae*, *Lamiaceae*, *Apiaceae*, the largest genera *Artemisia*, *Achillea* and *Thymus*. A conspectus of flora has been compiled; an environmental characteristic of species, an analysis of life forms and the degree of prevalence has been given. Plant resources of essential oil plants in nature have been determined. The success of the introduction of essential oil plants in the culture conditions was evaluated; objects promising for industrial cultivation were identified. For some essential oil plants; recommendations for their cultivation have been proposed.

Results of study were published in frame of grant ‘The Best High School Teacher – 2019’.

The monograph is intended for specialists in the field of botany, plant introduction, workers in botanical gardens, forestry, environmentalists, pharmacists, teachers and students of colleges and universities of biological, pharmaceutical and agricultural profiles.

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CONTENT

INTRODUCTION	4
1 THE GENERAL CHARACTERISTICS OF ESSENTIAL OILS AND THEIR ECONOMIC SIGNIFICANCE	6
2 CLIMATES AND VEGETATION OF THE KARAGANDA REGION .	17
3 WILD ESSENTIAL OIL PLANTS OF THE KARAGANDA REGION .	21
3.1 The analysis of essential oil plants of the Karaganda region and their ranking	21
3.2 Conspectus of flora of essential oil plants	30
3.3 Study of raw material resources of some essential oil plants of the Karaganda region	49
3.4 Study of dynamics of quantitative accumulation of essential oils in some species	60
4 ASSESSMENT OF INTRODUCTION INTO CULTURE ESSENTIAL OIL PLANTS IN THE CONDITIONS OF THE CENTRAL KAZAKHSTAN	63
4.1 Evaluation of the introduction potential of essential oil plants in the conditions of the cities of Karaganda and Zhezkazgan	63
CONCLUSION	74
BIBLIOGRAPHY	76
APPENDIX A. POINT MAPS OF AREAS OF ESSENTIAL OIL PLANTS OF THE KARAGANDA REGION	86
APPENDIX B. PHOTOGRAPHS OF ESSENTIAL OIL PLANTS OF NATURAL FLORA OF THE KARAGANDA REGION	97
APPENDIX C. QUANTITATIVE ACCUMULATIO OF ESSENTIAL OILS IN SOME ESSENTIAL OIL PLANTS OF THE CENTRAL KAZAKHSTAN'S FLORA	103

INTRODUCTION

The flora of Republic of Kazakhstan is more than 5500 species [1], contains all practical-valued groups of plants [2-5], including essential oil plants [6].

For the conservation and systematic use of Kazakhstan's biological potential, in addition to introduced objects, wild plant species are also promising. However, in order to achieve the objectives set out in the UN Convention on Biological Diversity [7], a complete inventory of floristic diversity is first and foremost necessary in order to identify its main components, which could be further balanced used and preserved.

The development of modern industries' branches and the rapid growth of the human population in the next 50 years present to scientists the task of finding renewable resources, as food sources, bio fuels, medicinal preparations, cosmetics and hygiene products, which leads to increased interest in national plant resources.

The World Health Organization (WHO) noted in recent decades an increase in the use of herbal preparations and an increase in the proportion of medicinal and essential oil plants by the population of the world [8]. In many countries, the use of phytopreparations is recommended; their inclusion in national health programmes. So, herbal medicines have low toxicity, act more comprehensively, have no practical side effects, are quite cheap and easily accessible [9, 10].

An important source of practically useful compounds are essential oil plants, the components of which are used in the food, liquor, perfume and cosmetic industry; essential oils possess antimicrobial, anti-inflammatory, fungicidal, wound-healing, antiviral and other types of biological activity [6, 11-16].

Essential oils, extracted from aromatic plants, as well as their individual components, from ancient times, have been used by humans as medicinal, antiseptic, perfume and protective agents (repellents, attractants and others). Currently, the essential oil industry is widely developed in many countries of the world. World production of essential oil exceeds 150 thousand tons [17-19]. Among the countries, the world's producers of essential oil dominate Brazil (40%), USA (20%), India (15%) [20]. Many developing countries have significant potential for the production of essential oils. Thus, 65% of the total production of aromatics comes from developing countries, 35% from industrialized states. The main importers of essential oils are the countries of the European Union, USA, Japan, Canada, Pakistan, China and Switzerland [19]. In the presence of rich raw material potential of ether carriers in Kazakhstan, their industrial production has not been carried out to date.

Currently, the need for essential oils and raw materials is satisfied in Kazakhstan only through imports, although there is a potential for own production.

The relevance of the study is due to the need of the food, aromatic, healthcare and pharmaceutical industry of the Republic of Kazakhstan for new and effective medicines and supplements of plant origin. The study of the species composition of wild-growing and cultivated essential oil plants is relevant, since Kazakhstan has huge reserves of essential plant resources, and only a small part of them is used

in practical medicine. The creation and development of such industries meets the requirements of economic management in the modern conditions of a market economy.

The aim of the present study was to identify the species composition and raw stock of essential oil plants in the territory of the Karaganda region (Central Kazakhstan) and their introduction tests with the identification of promising taxa for cultivation.

1 THE GENERAL CHARACTERISTICS OF ESSENTIAL OILS AND THEIR ECONOMIC SIGNIFICANCE

Essential oil plants are a group of plants that contain odorous essential oils in specialized (less often not specialized) cells or structures. Essential oils usually consist of light fractions of different chemical compositions, have volatility, are oily, are usually lighter than water and do not dissolve in it [21]. Almost all oils dissolve well in alcohol and are mixed in all proportions with chloroform, petroleum ether, and other organic solvents.

These plants began to be called essential oils in the 19th century, when industrial quantities of odorous substances began to be obtained from them - primarily essential oils. The ability to produce essential oils is noted in more than 3,000 plant species belonging to the families *Apiaceae*, *Lamiaceae*, *Rutaceae*, *Asteraceae*, *Cupressaceae*, *Pinaceae*, *Annonaceae*, *Zingiberaceae*, *Myrtaceae*, *Lauraceae*, *Geraniaceae*, *Rosaceae*, etc., but about 200 species are of industrial importance in the world.

Most essential oil plants grow in the tropics and subtropics, where many woody species grow (citrus, ginger, cinnamon tree, clove tree, laurel, etc.). In the temperate zone, the main amount of essential oil plants are herbaceous plants from the genera *Salvia*, *Artemisia*, *Achillea*, *Mentha*, *Anisum*, *Acorus*, *Tanacetum*, *Thymus*, *Dracocephalum*, *Hyssopus*, etc. [11, 12, 15]. It is noted that mainly essential oils are produced in dicotyledonous plants; then in monocotyledons many families (such as *Poaceae*, *Cyperaceae*, *Palmaceae*) do not form these substances.

The total number of essential oil plants is estimated at 3,000 species from 77 families.

Essential oils are complex natural mixtures of aromatic substances belonging to various classes of organic compounds, mainly terpenoids (monoterpenes, diterpenes, sesquiterpenes), less often aromatic or aliphatic compounds. They are called "oils" for external similarities with fatty oils. The name "essential" is associated with physical properties - high volatility.

The classification is based on the main components of essential oil, which are carriers of the smell of current oil and determine biological activity. Essential oils can be conditionally divided into the following groups (Fig. 1):

- i) acyclic monoterpenes (linalool, geraniol, citral);
- ii) monocyclic monoterpenes (menthol, cineol);
- iii) bicyclic monoterpenes (camphor, pinene);
- iv) sesquiterpenes (azulene, santonin);
- v) aromatic compounds (thymol).

Currently, the chemical composition of more than 2000 essential oils has been studied; among them accordingly 500 individual compounds have been isolated.

Essential oils are formed in various organs of plants, both above-ground and underground [22-24], accumulating in special receptacles (schisogenic or lysigenic origin), glandular hairs, essential-oil glands, inside specialized cells or in the form of drops in non-specialized cells (Fig. 2, 3).

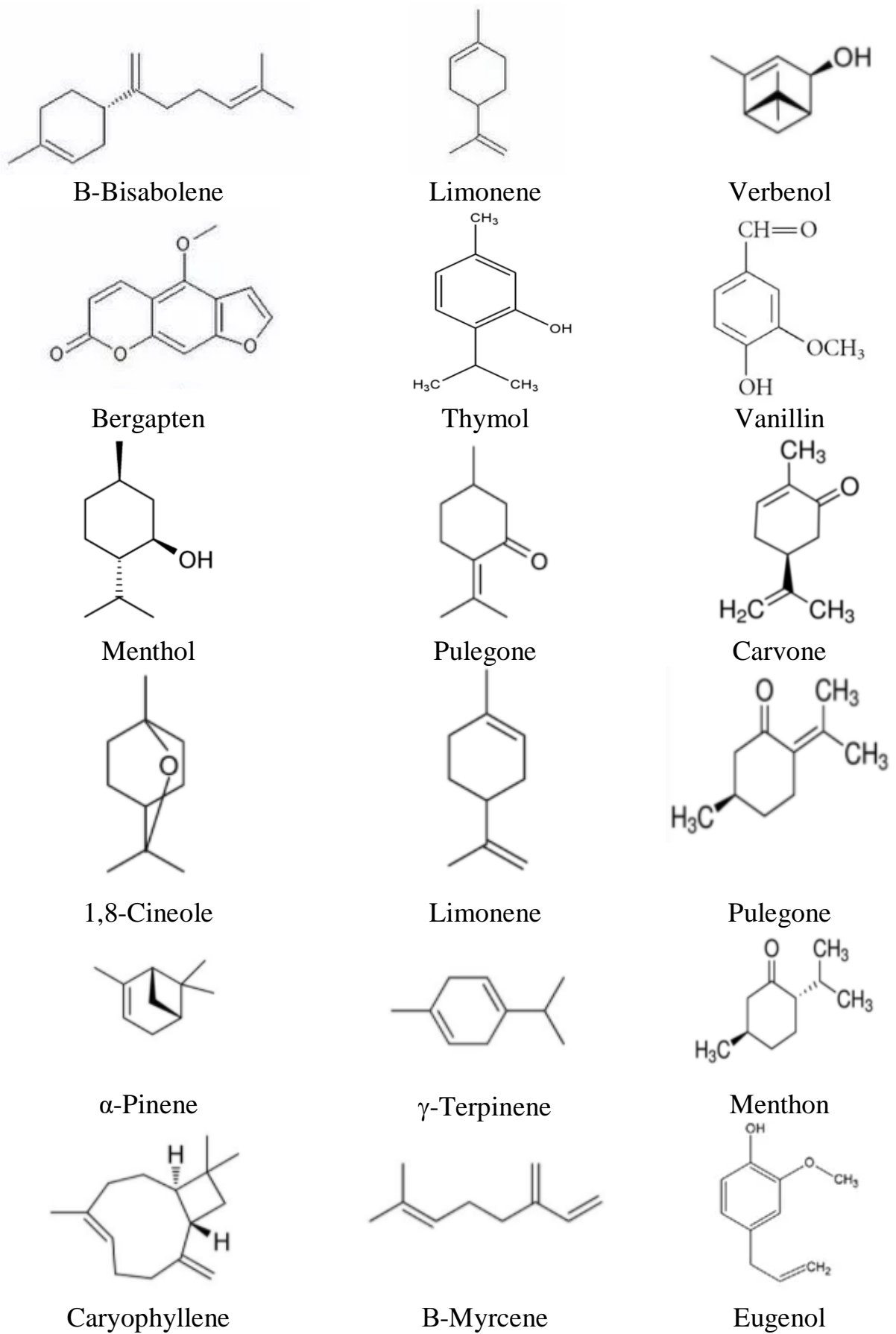
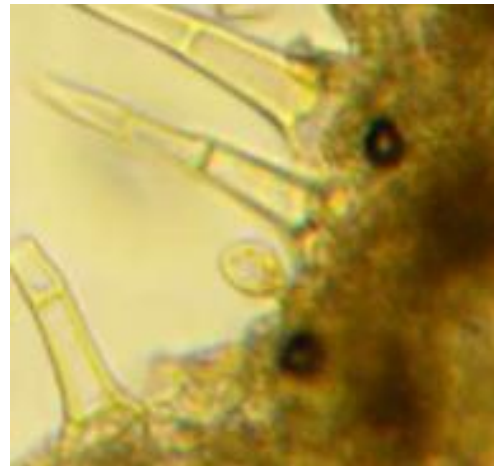


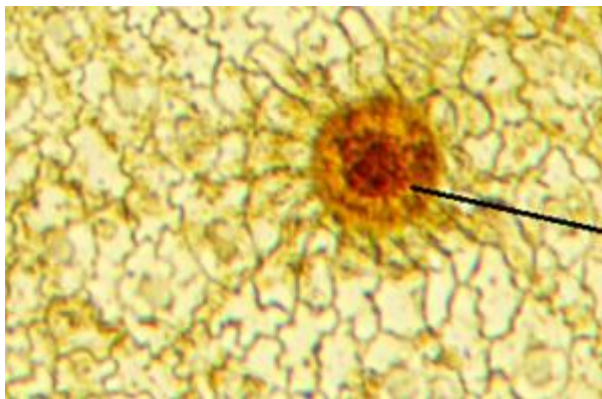
Figure 1. Examples of the most using components of essential oils



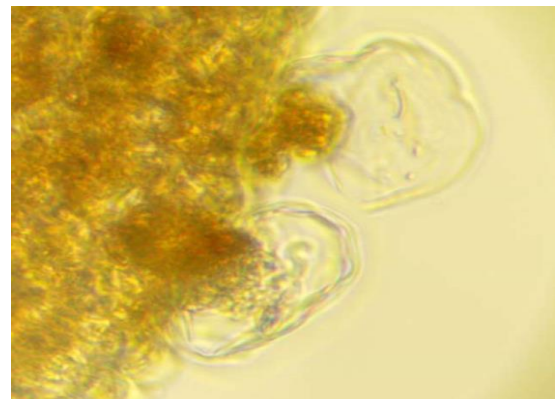
Specialized receptacles of *Ferula foetida*'s leaf



Gland of *Nepeta densifolia*'s leaf



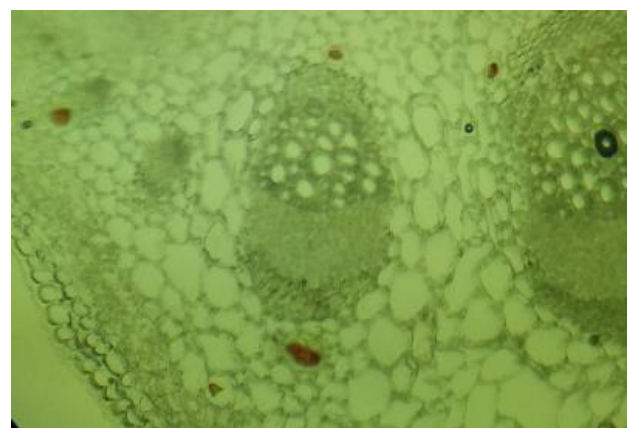
Essential oil gland of *Thymus lavrenkoanus*'s leaf



Essential oil glands of *Nepera sibirica*'s shoot



Essential oil receptacles of *Centaurea ruthenica*'s leaf

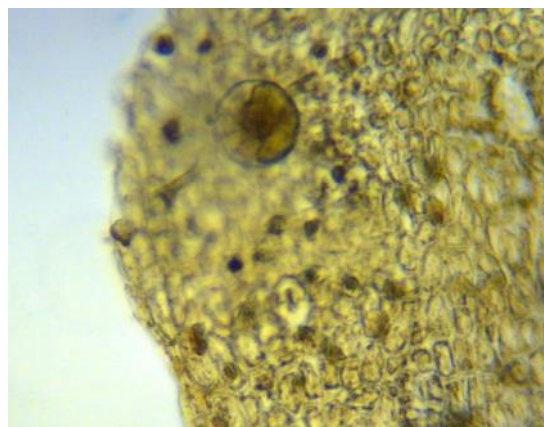


Receptacles of *Centaurea bipinnatifida*'s petiole

Figure 2. Localization of essential oils in different plant organs and tissue



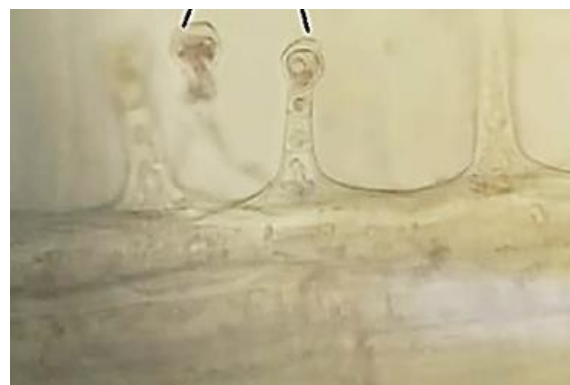
Essential oil gland of *Salvia deserta*'s leaf



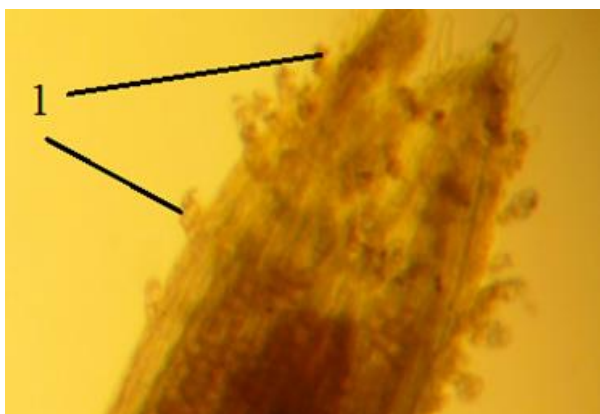
Essential oil gland and drops of essential oil in non-specialized cells of *Salvia deserta*'s leaf



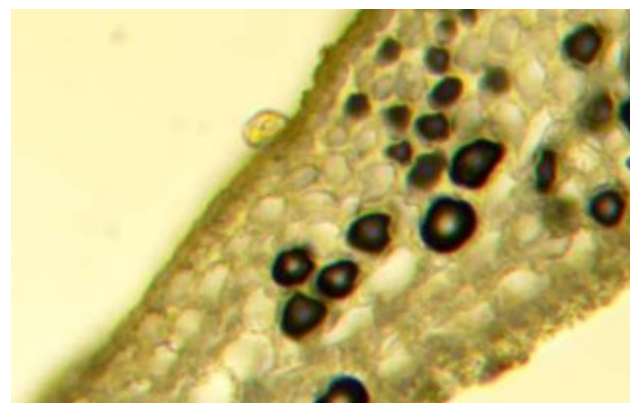
Essential oil receptacles of *Ferula tatarica*'s seed



Glandular hairs of *Salvia stepposa*'s leaf



Essential oil glands of *Pulicaria prostrata*'s flower



Gland of *Dragocephalum grandiflorum*'s petiole

Figure 3. Localization of essential oils in different plant organs and tissue

In plants, essential oils perform a number of important functions:

- i) they are secondary metabolites, take part in metabolism;
- ii) evaporation of essential oils during high temperatures helps to reduce the level of water transpiration;
- iii) attract insects - pollinators;
- iv) serves as an agent for protection of plants against pathogenic microorganisms (viruses, bacteria, fungi);
- v) frighten herbivores due to bitter taste of essential oil;
- vi) inter-plants signaling.

Accumulation of essential oils depends on a number of factors, among them illumination, temperature, presence of moisture, content of micro- and macro-elements in soil, height above sea level, age, vegetation phase [25-30]. Thus, high solar activity and moisture deficiency lead to an increase in the accumulation of essential oils in plants. The direct dependence of essential oil accumulation on the sum of positive temperatures is noted. In flowers of *Chamomilla reticulata* the maximum accumulation of essential oil is in phase of beginning of flowering; in root of *Valeriana officinalis* – the end of fruitening; for raw material of *Coriandrum sativum* – in phase of mature seeds. Young plants usually accumulate more essential oils, than old plants.

More essential oils accumulate on rich soils in plants than on poor soils. Thus, agricultural measures and fertilizers have a significant impact on plant yields and the accumulation of valuable components.

XX century is a period of active development of essential oil production in the countries of the former Soviet Union. The main production was concentrated in the territories of Crimea, Moldova, the Caucasus (Armenia, Azerbaijan and Georgia) and the Central Asia (Uzbekistan, Tajikistan and Turkmenistan; to a lesser extent Kyrgyzstan and Kazakhstan). Until the beginning of the 90s of the last century, about 25 species of crops were cultivated. Among them are: *Coriandrum sativum* (90% of all areas occupied by essential oil crops), *Carum carvi*, *Anethum graveolens*, *Foeniculum officinalis*, *Mentha piperita*, *Salvia sclarea*, *Salvia officinalis*, *Rosa x damascene*, *Rosa alba*, *Lavandula*, *Artemisia*, etc [31, 32].

The interest of many researchers in the world in recent decades has been aimed at finding new promising species of essential oil plants in the families: *Apiaceae*, *Asteraceae*, *Cupressaceae*, *Geraniaceae*, *Lamiaceae*, *Lauraceae*, *Myrtaceae*, *Pinaceae*, *Rutaceae* and *Taxaceae*. Great attention is paid to the study of the component composition of essential oils. The increasing number of publications on this group of plants, their component composition, assessment of biological activity, features of accumulation in plants, introduction of essential-oil plants shows the relevance of work with this group of useful plants.

Modern centers for the study of essential oils and essential oil plants are India, Turkey, China, Egypt, USA and Brazil, which account for the bulk of publications in this area. Currently, there is a specialization in the production of certain varieties of essential oil [15] and vegetable raw materials (Tab. 1).

Table 1. Production of essential oils and essential oil plants in different countries of world

Country	Name of production essential oil / essential oil plant
1	2
Austria	Spruce, pine
Australia	Kayeput, tea tree, eucalyptus
Argentina	Lemongrass, citronella, lavender, eucalyptus, fennel
Bulgaria	Rose oil, mint, anise, lavender, chamomile
Brasilia	Eucalyptus, sassafras, citrus, basil, mint
Vietnam	Citronella, badyan, cubebs, citrus fruits
Haiti	American sandalwood, neroli, vetiver
Guatemala	Citronella, lemongrass, cardamom
Guinea	Nerole, petitgrain
Greece	Cypress
Zanzibar	Clove oil
India	Aghon, vetiver, jasmine, ginger, palmarose, rose oil, patchouli, Indian sandalwood, black pepper, eucalyptus
Indonesia	Citronella, patchouli, cananga, cayeput
Spain and Portuguese	Anise, rosemary, mint, thyme, fennel, eucalyptus
Italy	Orange, bitter orange, grapefruit, bergamot, lemon, tangerine, mint, neroli, rose oil, geraniac, basil
Canada	Cedar oil
China	Citronella, mint, lemongrass, lyceum, eucalyptus
Congo	Eucalyptus, vetiver, lemongrass
Madagascar	Ylang-ylang, clove oil
Macedonia	Valerian, issope, sage
Morocco, Tunisia, Algeria	Geraniac, neroli, rosemary, myrtle, eucalyptus, rose oil, wormwood
Mexico, Honduras	Citronella, lemongrass
Nepal	Palmrose
Pakistan	Orange, vanilla,
Poland	Angelic, mint, coriander, anise, cumin, medicinal sage, spruce, juniper
Puerto-Rico	Vetiver
Russian Federation	Spruce, fir, coriander, mint, rose oil
Serbia	Lavender, mint, fennel, sage
Singapore	Patchouli
Somali	Myrrh
Swiss	Mint
Ukraine	Sage, lavender, lavandiner, mint

1	2
USA	Mint, citrus, anise, cedar, wormwood, conifers (pine, spruce)
Thailand	Orange, bergamot, jasmine, rosemary, eucalypt
Turkish	Laurel, origanum, rose oil, thyme, conifer
Finland	Caraway
France	verbena, origanum, jasmine, lavender, lavandine, marjoram, fennel
Croatia	Hyssop, juniper, sage
Ceylon	Citronella, cardamom, cinnamon, ginger, cinnamon, litsea, melissa
Java	Nutmeg, citronella
Jamaica	Orange and limettes, litsea, melissa
Japan	Mint

The best companies for essential oil production are “Young living essential oils”, “doTERRA”, “Plant Therapy”, “Reviver Essential oils”, “Rocky Mountain Oils”, “Edens Garden”, “Mountain roe herbs”, “Jade Bloom”, “Now Essential oils”, “Aura Cacia”, “Lagunamoon”, “Plant Guru”, “Radha”, etc.

In most cases essential oils are produced from fresh raw materials (green mass of geranium, lavender flowers). But some oils are obtained from partially fermented (mint), dried (thyme, salvia, acorus roots) or pre-fermented (rose flowers, iris roots, oak moss) raw materials. Depending on the nature of the raw materials and the basic properties of the oils, for their extraction, another method is used, which allows to obtain the highest yield and the best quality of essential oil [33-37].

In production practice are used the following methods:

A) Steam distillation. It is used if the essential oil raw materials contain a relatively large amount of essential oil; its components are not destroyed after treatment of high temperature (about 100 °C). Distillation is carried out in special apparatuses (for example, Clevenger apparatus). The raw material is either charged into water (hydro-distillation) or treated directly with steam (steam distillation) (Fig. 4).

B) Enfleurage is a method of absorbing essential oil with solid fats. It was mainly used to extract oil from plant petals. The method is expensive and rarely used (Fig. 5).

C) Pressing is used to extract essential oil from the peel of citrus fruits.

D) Maceration is extraction of flower raw materials with fatty oils when heated.

E) Extraction by organic solvents (petroleum ether, ethyl alcohol, acetone, etc.). This method is not convenient, since other organic substances are released with it. Recently, the method of carbon dioxide extraction – CO₂-extraction. (cryogenic method) has gained popularity (Fig. 6).

F) Microwave extraction is a method of extracting valuable substances from plant raw materials using microwave energy, characterized in that extraction is

carried out by steam of water included in the raw material and heated by microwave energy.

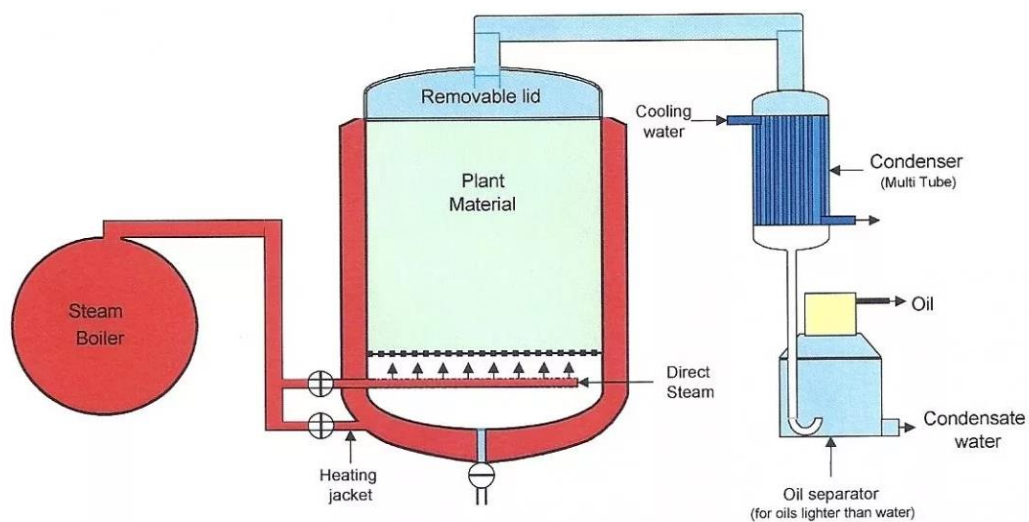


Figure 4. Steam distillation of essential oil plants. Scheme



Figure 5. Extraction of essential oils by enfleurage method

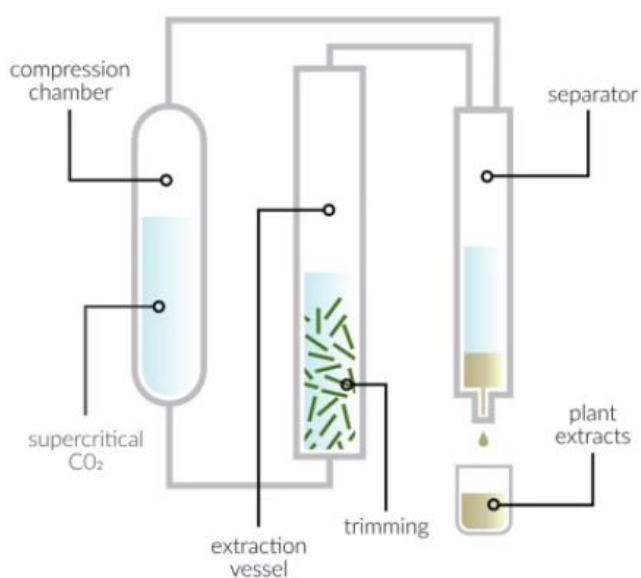


Figure 6. CO₂-extraction of essential oil raw material

Essential oils have different types of biological activities (Tab. 2).

Table 2. Biological activity of some essential oil plants

Biological activity	Essential oil plants or individual compound of essential oil	Bibliography
1	2	3
Anti-cancer	<i>Nigella damascene</i> , <i>Zornia brasiliensis</i> , <i>Tarchonanthus camphorates</i> , <i>Abies balsamea</i> , <i>Zanthoxylum schinifolium</i> , <i>Aniba rosaeodora</i> , <i>Pinus densiflora</i> , <i>Boswellia sacra</i> , <i>Litsea cubeba</i> , <i>Curcuma zedoaria</i> , <i>Monarda citriodora</i> , <i>Pinus koraiensis</i> , <i>Artemisia capillaries</i> , <i>Thymus vulgaris</i> , <i>Cymbopogon flexuosus</i> , <i>Pogostemon cablin</i> , <i>Curcuma wenyujin</i> , <i>Cinnamomum cassia</i> , <i>Cryptomeria japonica</i> , <i>Artemisia vulgaris</i>	38, 39, 40, 44
Anti-inflammatory	<i>Citrus limon</i> , <i>Populus balsamifera</i> , <i>Chamomilla reticulata</i>	41
Anti-bacterial	Carvacrol, citral, limonene	13
Anti-parasitic	<i>Coriandrum sativum</i> , <i>Solidago canadensis</i> , <i>Lavandula intermedia</i> , <i>Piper cubeba</i> , <i>Cymbopogon species</i> , <i>C. citratus</i> , <i>C. giganteus.</i> , <i>C. nardus</i> , <i>C. schoenanthus</i> , <i>Ocimum gratissima</i> , <i>Artemisia indica</i> , <i>Artemisia ansinthium</i> , <i>Foeniculum vulgare</i> , <i>Artemisia annua</i> , <i>Thymus capitellatus</i> , <i>Artemisia cina</i> , <i>Artemisia taurica</i>	42, 45
Allochemical	<i>Xanthium strumarium</i>	43
Anti-fungal	<i>Origanum syriacum</i> , <i>Thymbra spicata</i> , <i>Lavandula stoechas</i> , <i>Rosmarinus officinalis</i> , <i>Foeniculum vulgare</i> , <i>Laurus nobilis</i> , <i>Lavandula multifida</i> , <i>Thymus eryocalyx</i> , <i>Matricaria chamomilla</i> , <i>Cinnamomum jensenianum</i> , <i>Mentha piperita</i> , <i>Anethum graveolens</i> , <i>Piper betle</i> , <i>Zataria multiflora</i>	13, 45, 46
Hepatoprotective	<i>Artemisia capillaries</i>	13, 45, 46
Wound-healing	<i>Hypericum perforatum</i> , <i>Artemisia vulgaris</i> , <i>Artemisia leucoides</i>	21
Insecticide	<i>Eucalyptus</i> , <i>Acorus calamnus</i>	21
Necrotic	<i>Juniperus Sabina</i>	21
Photosensitizative	<i>Angelica</i> , <i>Heracleum mantegazzianum</i>	21
Expectorant	<i>Thymus serpyllum</i> , <i>Thymus vulgare</i> , <i>Mentha arvensis</i> , <i>Salvia officinalis</i>	21, 44, 45

1	2	3
Stimulation of digestion	<i>Anethum, Angelica, Mentha piperita, Calamus, Curcuma xanthorrhiza, Chamomilla reticulata, Foeniculum, Citrus sinensis</i>	44-47
Spasmolytic	<i>Citrus sinensis, Chamomilla reticulata, Carum carvi, Foeniculum anisum, Mentha piperita, Melissa officinalis</i>	45-47
Diuretic	<i>Origanum vulgare, Melaleuca viridiflora</i>	45, 46
Stimulation of blood circulation	<i>Rosemarinum, Lavandula, Mentha piperita, camphor</i>	44-47
Narcotic	<i>Artemisia absinthium, Tanacetum vulgare, Thuja</i>	21
Abortive	<i>Juniperus sabina, Thuja occidentatus, Chenopodium ambrosioides</i>	21
Cancerogenic	<i>Acorus calamnus</i>	21

The use of essential oil plants in Kazakhstan requires their comprehensive study by regions of the republic. Earlier studies (works of M.I. Goryaev, S.N. Kudryashov, N.V. Pavlov, L.K. Klyshev, M.K. Kukenov, L.F. Demidovskaya, V.Yu. Averina, A.D. Dembitsky, Y. Suleimen, G. Atazhanova, D.T. Sadyrbekov, R.A. Egeubaeva, A.B. Myrzagaliev and others) gave extensive material on raw materials [6, 11, 12, 48-54].

The study of the resource potential of essential oil plants in Kazakhstan is carried out by employees of the plant resources laboratory of the Institute of Botany and Phyto-Introduction (Almaty), the Department of Botany of East Kazakhstan State University (Ust-Kamenogorsk), whose research covered the territories of Southern, Southeast and partially Eastern Kazakhstan [6, 11, 50]. The species composition of essential-oil flora is described, raw materials for certain species are identified; dynamics of accumulation of active substances is studied. A row of investigation were conducted on the base of JSC “International Scientific – Production Holding “Phytochemistry”, E.A. Buketov Karaganda University (Karaganda, the Central Kazakhstan) and Zhezkazgan Botanical Garden (Zhezkazgan) with such species, as *Ziziphora clinopodioides, Thymus marschallianus, Thymus vulgaris, Thymus rasiatus, Hyssopus ambiguus, Achillea millefolium, Ajania fruticulosa, Hypericum perforatum, Chamomilla reticulata, Artemisia glabella, Artemisia annua, Artemisia pontica*, etc. [12, 16, 52-61].

In neighboring countries, significant comprehensive studies on the introduction, resources and chemical study of essential oil plants are presented at the All-Russian Institute of Medicinal and Aromatic Plants, the Main Botanical Garden (Moscow); Komarov Botanical Institute (St. Petersburg); Tomsk State Medical Institute and Tomsk State University (Tomsk); the Central Siberian Botanical Garden, Institute of Forest Chemistry, Institute of Organic Chemistry (Novosibirsk). Significant developments in the cultivation of essential oil plants were made on the basis of the laboratory of aromatic plants of the scientific research station of medicinal plants (Berezochota, Ukraine) [60, 62-65].

Chemical research on the composition of essential oils and individual components in Kazakhstan is carried out at JSC “International Scientific – Production Holding “Phytochemistry” (Karaganda), the Institute of Chemical Sciences, the Faculty of Chemistry of Al-Fabari Kazakh National University, Institute of Plant Biology and Biotechnology (Almaty), Institute of Applied Chemistry of the L.N. Gumilyev Eurasian National University (Nur-Sultan).

In the Central Kazakhstan plants of the natural flora were ranked in various areas of practical application: feed, technical, medicinal, honey, ornamental, food, essential-oil, vitamin, etc. Their species composition was determined, promising groups for further research were identified. Based on the analysis of literary data and the results of research studies, a preliminary list of essential oil plants of the Karaganda region was compiled.

The chemical composition of 66 species of wild-growing essential oil plants of the Central Kazakhstan belonging to the families *Asteraceae*, *Lamiaceae*, *Apiaceae*, *Cupressaceae*, *Pinaceae* was studied; the component composition and physicochemical characteristics were described; for 26 species, the composition is characterized for the first time [12, 14, 16, 52-54]. From a number of essential substances of wild raw material of the Central Kazakhstan are identified, individual compounds, which were interested for medicine. Among them: pulegone from essential oil of *Ziziphora clinopodioides*, menthol from essential oil of *Mentha arvensis* and *M. piperita*, limonene from essential oil of *Erigeron canadensis*, dillapiol from essential oil of *Galeopsis bifida*, buddledin C from essential oil of *Pulicaria prostrate*, 3-carene and pinene from essential oil of *Pinus sylvestris*, thymol from essential oil of *Thymus marschallianus*, artemisia-ketone from *Artemisia annua*, sabinene and sabinyl acetate from essential oil of *Juniperus sabina*. The expressed anti-microbial activity of the essential oil of *Artemisia tomentella* and *Pinus sylvestris*; anti-inflammatory and wound healing activity of essential oil of *Ajania fruticulosa*; tuberculosis activity of essential oil of *Artemisia sieversiana* and *Artemisia filatovae* were found [12, 14].

Thus, the Central Kazakhstan is a promising region for the botanical study of essential oil plants. However, these works were not carried out at a sufficient level in the Central Kazakhstan, which makes our planned studies relevant and practically significant.

2 CLIMATES AND VEGETATION OF THE KARAGANDA REGION

The territory of the Central Kazakhstan (the Karaganda region) is located within the continental Western Siberian steppe zone and occupied the middle position in the republic (Fig. 7), bordering in the north with Akmola and Pavlodar regions, in the north-west – with Kostanai region, in the east – with Eastern Kazakhstan region, in the south – with Zhambyl and Southern Kazakhstan region [66]. The total area of the Karaganda region is 428 thousand square km.



Figure 7. Location of the Karaganda region in Kazakhstan

The following floristic districts are located on the territory of the Central Kazakhstan: Western lowland, Eastern lowland, Betpakdala, Karkaraly and Ulytau [67].

The negative aspects of the geographical position of the Karaganda region are expressed in the aridity of the climate, low rainfall. Common and typical for the climate of the Republic and, in particular, of the Karaganda region, is the mainland air temperature regime, which is characterized by great contrast, sharp seasonal and annual fluctuations [68].

The main part of the region is located in the central-kazakhstani lowland. It is a heavily destroyed ancient mountain system that has become a hilly country with heights from 300 to 900 meters. The shallow ridge is characterized by alternating randomly scattered elevations with wavy plains, wide valleys and closed basins [69, 70]. In the southwest, the central-kazakhstani lowland passes into the sandy massifs of Karakum, Mynbulak, Aryskum, Moyinkum; in the south is the northern outskirts of the Betpakdala upland.

Hills are composed of shale, sandstone, limestone, which are easily weathered and have small heights. A significant feature of the relief is the development of meso- and micro-relief.

Typical plains are associated with river valleys: Nura, Sherubai Nura, Jarly, Taldy, Sarysu, Tersakkan. The eastern part of the region is covered by the Karkaralinsky mountain junction, represented by the Kyzylrai Mountains (absolute height 1559 m), Karkaraly (absolute height 1403 m), Kent (absolute height 1369 m), Genghiztau (absolute height 1300 m). In the south of the region, the Bectauata Mountains (absolute height 1214 m) and Ulytau Mountains (absolute height 1133 m) are the unique mountain ranges in the semi-desert zone.

In the Karaganda region there are about 2200 rivers and temporary watercourses with a total length of about 15 thousand km [70]. More than 1800 watercourses have a length of less than 10 km; and only 11 - more than 100 km. All rivers are typical Kazakhstani lowland, snow or snow-and-ground nutrition, as the level of groundwater decreases, quickly melts and dries.

The largest watershed is the Karkaralinsky mountain junction [5, 6], from which the Nura, Sherubay Nura, Sarysu, Jamshy, Mointy, Tokrau, Taldy, Karkaralinka, Zharly rivers originate. Rivers belong to inland dryless basins. There are a large number of lakes (both fresh and saline), the largest of which is Lake Balkhash. Groundwater is fractured-formation; the degree of mineralization is insignificant.

The territory is characterized by mottled soil cover, which is due to the heterogeneity of soil formation conditions: relief, soil-forming rocks and the degree of moisture [71]. From the North to the South the gradual change of zonal types of soils is noted: ordinary black earth, southern black earth, dark-chestnut, chestnut, light brown. The power of the humus horizon ranges from 18 to 50 cm, and the content of humus is 4.5-6%. Mountain black earth and mountain chestnut soils are confined to the massifs of low mountains, which occupy insignificant areas, the humus content is 5-9%. Half of the region's territory is occupied by chestnut soils, a feature of which is the occurrence of dense rocks at a shallow depth (40-80 cm).

Among the zonal types of soils, the following main groups can be distinguished: normal, carbonate, salinity, salt marsh, underdeveloped (soil thickness no more than 40 cm) and underdeveloped (profile thickness less than 30 cm). Carbonate soils are confined to watershed territories composed of cover carbonate loams and heavy clays. Large areas are occupied by saline soils, which formed on saline rocks or under the influence of mineralized groundwater. Intra-zonal soils include meadow-steppe, malt, forest dark-colored and forest low developed.

The climate of the Central Kazakhstan is sharply continental [68-70]. The duration of sunshine, the main climatic factor, is 2300-2400 hours/year. Its maximum falls in July. The duration of the growing season in the Karaganda region reaches from 180 (on north and north-east) till 210 days (on south and south-west).

The average annual air temperature in the region increases from north to south from + 2 to + 6. The average temperature of the coldest month January is -16-17 °C. The absolute minimum temperature in some years reaches -42-45 °C. In

spring, the average daily air temperature passes through point 0 °C on April, 7-8; and after + 5 °C - on April, 21-23.

The warmest month is July with the average temperature +20-25 °C. The absolute maximum temperature in July is +37-40 °C. Summer is usually hot and dry [68], often accompanied by dry winds.

In autumn, the transition of average daily temperatures through 0 °C is observed on October, 22-25. Already at the end of September there are the first autumn frosts, in late October - early November frosts are established and snow cover forms. Autumn is more dry than summer.

The amplitude of fluctuations in average monthly temperatures reaches 34-39 °C; the absolute annual amplitude reaches 80-90 °C.

The average annual precipitation in the region is 300-400 mm in the north, north-east and 180-200 mm in the south - southwest. The largest precipitation occurs in the summer months (June-July) - 41-57 mm. The smallest amount of precipitation is usually in February - March and November-December. In general, during the winter, 35-37% of the annual amount of precipitation in the form of snow falls. Precipitation amounts fluctuate from one year to another within large limits. In wet years, up to 400-450 mm of precipitation falls; in dry years is not more than 90-170 mm. Climate dryness is also manifested in a long period without precipitation. In some years, precipitation does not occur for 50-60 days.

Period without precipitation is most often in August – September, rare in July. Snow accumulation is gradual, reaching a maximum in the first decade of March. Water reserves in the snow during this period are highest (40-60 mm); then they begin to decline due to evaporation and freezing. The average of the snow cover is 25-30 cm. In low-snow winters, the height of snow cover before snowmelt does not exceed 10 cm. In multi-snow winters, the maximum height of snow cover reaches 45-55 cm. Melting snow cover in spring begins at the end of March. Full melting of snow cover is noted on April, 5-10.

The vulnerability of the territory from the penetration of air masses of various origins into its borders favors intensive wind activity. The average annual wind speed is 3.5-5.5 meters/second. Days with silence are rare. In winter, the region is dominated by south-western winds with a repeatability of 20-25%. Northerly winds prevail. The highest wind speeds are usually observed in the second half of winter and spring, reaching 25-30 meters/second.

Thus, the sharply continental climate of the Karaganda region is characterized by temperature differences both in the seasons of the year and during the day, low rainfall, and an active wind regime.

Flora of the Central Kazakhstan has more than 1000 species of vascular plants from 80-82 families [70, 72-76].

In the Karaganda region it is observed the following types of vegetation: steppe; forest, semi-desert, desert, shrub and swamp [70, 72].

The steppe type of vegetation includes communities dominated by micro-thermal turf cereals (*Stipa lessingiana*, *S. sareptana*, *S. capillata*, *S. kirghizorum*, *S. pennata*, *S. orientalis*, *Festuca valesiaca*, *Agropyron*, *Silene parviflora*, *Poa*

stepposa, *P. bulbosa*), with shrubs (*Caragana frutex*, *C. balchaschensis*, *Spiraea trilobata*, *S. hypericifolia*) and semi-shrubs from genus *Artemisia* (*Artemisia gracilescens*, *A. sublessingiana*, *A. frigida*, *A. marschalliana*, *A. radicans*, *A. pontica*, *A. sericea*). At elevated areas, petrophytic plants *Patrinia intermedia*, *Valeriana tuberosa* are included in the outcrops of granite. Communities of the steppe type of vegetation occupy the predominant areas on watershed, interstitial plains and plumes of hills and low mountains.

The desert type of vegetation includes communities formed by xerophilic and halo-xerophilic representatives of *Chenopodiaceae* family and some wormwood: *Atriplex cana*, *A. verucifera*, *Nanophyton erinaceum*, *Salsola arbusculiformis*, *Anabasis salsa*, *A. aphylla*, *Artemisia nitrosa*, *A. schrenkiana*, *A. pauciflora*, *A. terrae-albae*.

Forests occupy areas along the slopes of hills and mountains (Karkaraly, Buguli, Kent and others). In the rest of the region there are island deciduous forests. Among the most interesting forest formations are pine forests (*Pinus sylvestris* L.), confined to the outcrops of granites and which are the guardian of rare boreal flora elements. Island aspen-birch forests (*Betula pendula*, less often *B. kirghisorum*, *Populus tremula*) are usually with the participation of *Brachypodium pinnatum*, *Poa angustifolia*, *Ribes saxatilis*, *Lupinaster triphyllum*, *Artemisia sericea*.

Significant areas of the forest are occupied by interstitial valleys, around springs, less often by the westerns of sandy massifs (Karaagash valey). Very rare are black-alder forests (*Alnus glutinosa*) in the Buyratau Mountains with an abundance of mesophilic elements (*Ribes nigrum*, *Padus racemosa*, *Urtica dioica*, *Serratula coronata*, *Crataegus sanguinea*, *Rubus saxatile*, *Fragaria vesca*, etc.).

Shrub thickets are diverse in ecology, which allows them to be divided into 3 classes:

i) thickets, which formed by xerophilic steppe shrubs *Spiraea crenata*, *S. hypericifolia*, *S. trilobata*, *Caragana frutex*, *C. balchaschensis*, *C. bongardiana*;

ii) thickets, which formed by mesophilic species of forest shrubs: *Rosa spinosissima*, *R. aciculata*, *Ceracus fruticosus*, *Cotoneaster melanocarpa*. A special position is occupied by willows composed of *Salix pentandra*, *S. caspica*, *S. bebbiana*, *S. triandra*, *S. viminalis*;

iii) petrophytic thickets which formed by *Juniperus sabina*.

Swamp vegetation is extremely rare in the Karaganda region, one sphagnum swamp was found in the Karkarly Mountains.

Meadow vegetation is also confined to moistened territories. Meadows can be divided into:

i) real meadow with the dominance of *Agropyron repens*, *Zerna inermis*, *Agrostis gigantea*, *Hordeum bogdanii*, *Puccinellia tenuissima*, *P. dolicholepis*;

ii) marshy meadow with formations from *Phragmites communis*, *Scolochloa festucaceae*, *Carex melanostachya*, *C. acutiformis*, *C. songorica*; of *Leymus angustus*, *Poa angustifolia*, *Medicago falcata*, *Calamagrostis epigeios*.

3 WILD ESSENTIAL OIL PLANTS OF THE KARAGANDA REGION

3.1 The analysis of essential oil plants of the Karaganda region and their ranking

Essential oil plants are one of the largest groups of useful plants [2, 6, 11-21, 77-81]. Thus, the results of the analysis of the flora of Kazakhstan showed the growth on the territory of the republic of 1025 species of essential oilseeds belonging to 47 families and 240 genera [82]. The total number of species of essential oil plants is 17.9% of the total species composition of the flora of Kazakhstan; for the proportion of births, this figure is 22.5%, for the proportion of the family - 29.6% (Tab. 3).

Table 3. The taxonomic composition of essential oil plants of Kazakhstan

Family	Number of genera		Number of species	
	Total	% from total number of genera	Total	% from total number of species
1	2	3	4	5
<i>Adiantaceae</i>	1	0.4	1	0.09
<i>Alliaceae</i>	1	0.4	99	9.6
<i>Apiaceae</i>	75	31.3	222	21.7
<i>Araceae</i>	1	0.4	1	0.09
<i>Aristolochiaceae</i>	1	0.4	1	0.09
<i>Aspidiaceae</i>	1	0.4	7	0.7
<i>Asteraceae</i>	29	12.1	150	14.6
<i>Betulaceae</i>	2	0.8	15	1.5
<i>Biebersteniaceae</i>	1	0.4	2	0.2
<i>Brassicaceae</i>	13	5.4	41	4.0
<i>Caprifoliaceae</i>	2	0.8	9	0.9
<i>Caryophyllaceae</i>	2	0.8	28	2.7
<i>Chenopodiaceae</i>	2	0.8	4	0.4
<i>Cupressaceae</i>	1	0.4	7	0.7
<i>Cyperaceae</i>	1	0.4	7	0.7
<i>Elaeagnaceae</i>	1	0.4	2	0.2
<i>Euphorbiaceae</i>	2	0.8	8	0.8
<i>Fabaceae</i>	7	2.9	15	1.5
<i>Gentiniaceae</i>	1	0.4	1	0.09
<i>Geraniaceae</i>	1	0.4	6	0.6
<i>Hypericaceae</i>	1	0.4	7	0.7
<i>Iridaceae</i>	2	0.8	23	2.2
<i>Lamiaceae</i>	30	12.5	170	16.6

1	2	3	4	5
<i>Liliaceae</i>	3	1.3	3	0.3
<i>Malvaceae</i>	2	0.8	4	0.4
<i>Moraceae</i>	3	1.3	3	0.3
<i>Oleaceae</i>	1	0.4	2	0.2
<i>Papaveraceae</i>	1	0.4	1	0.09
<i>Pinaceae</i>	4	1.7	6	0.6
<i>Poaceae</i>	3	1.3	4	0.4
<i>Polygalaceae</i>	1	0.4	2	0.2
<i>Polygonaceae</i>	2	0.8	8	0.8
<i>Primulaceae</i>	1	0.4	2	0.2
<i>Ranunculaceae</i>	8	3.3	14	1.4
<i>Resedaceae</i>	1	0.4	2	0.2
<i>Rosaceae</i>	15	6.3	45	4.4
<i>Rubiaceae</i>	2	0.8	15	1.5
<i>Rutaceae</i>	2	0.8	5	0.5
<i>Salicaceae</i>	2	0.8	54	5.3
<i>Saxifragaceae</i>	1	0.4	2	0.2
<i>Scrophulariaceae</i>	1	0.4	6	0.6
<i>Solanaceae</i>	2	0.8	3	0.3
<i>Thymelaeaceae</i>	1	0.4	2	0.2
<i>Valerianaceae</i>	2	0.8	1	0.09
<i>Verbenaceae</i>	1	0.4	2	0.2
<i>Violaceae</i>	1	0.4	2	0.2
Total: 47	240	100.0	1025	100.0

The leading families among essential oil plants are *Apiaceae* (31.3% of the total species number of essential oil plants), *Lamiaceae* (16.6% of the total species composition), *Asteraceae* (14.6% of the total species composition), *Alliaceae* (9.6% of the total species composition), *Salicaceae* (5.3% of the total species composition), *Rosaceae* (4.4% of the total species composition) and *Brassicaceae* (4.0% of the total species composition). The combined share of these 7 families is 85.8% of species composition, while the remaining 40 families account for 14.2% of plant species, respectively.

In terms of the number of species, the *Apiaceae* family (222 species) comes in first place; on the second place is *Lamiaceae* family (170 species); on the third – *Asteraceae* family (150 species), on the fourth – *Alliaceae* family (99 species), in fifth place - *Salicaceae* family (54 species).

In terms of the number of genera the leading position have tree families (*Apiaceae*, *Lamiaceae*, *Asteraceae*), and in fourth position is *Rosaceae* family; on the fifth position is *Brassicaceae* family.

The distribution of essential oil plants in the territory of Kazakhstan does not occur evenly (Tab. 4). So, the smallest number of essential oil plants grows in the

Western Kazakhstan (225 species), slightly more in the Northern Kazakhstan (241 species). The third place in the number of species is occupied by the Southern Kazakhstan (387 species), the fourth place is occupied by the Central Kazakhstan (275 species).

Table 4. Distribution of essential oil plants by region of Kazakhstan

Region of Kazakhstan	Number of families, piece	Number of genera, piece	Number of species, piece
The Western Kazakhstan	31	125	225
The Northern Kazakhstan	35	126	241
The Eastern Kazakhstan	41	198	461
The South-Eastern Kazakhstan	45	215	582
The Southern Kazakhstan	37	148	387
The Central Kazakhstan	35	130	275

The dominant positions are held by the South-Eastern Kazakhstan (582 species) and the Eastern Kazakhstan (461 species). The current distribution system of essential oil plants can be explained by the complexity of geographical and relief factors, which, in turn, leads to a variety of soil, ecological and microclimatic factors and, as a result, to a wider species diversity.

On the territory of the Western, Central and Northern Kazakhstan, the relief is smoothed; climatic conditions are more or less leveled throughout the territory, which impoverishes the species composition of flora, including essential oil plants.

It is noted the different degree of study of essential oil plants in Kazakhstan. Thus, the most studied regions are the Southern and South-Eastern Kazakhstan [80-82], slightly less studied – the Eastern and the Central Kazakhstan, practically not studied are the Northern and the Western Kazakhstan.

The variety of natural reliefs of the Central Kazakhstan, significant amplitude of temperatures, precipitation and humidity determined the variety of vegetation. As a result of the analysis of herbarium materials, literary data and own herbarium collections, it was determined that 1256 species of vascular plants belonging to 434 genera and 99 families grow in the Central Kazakhstan [72].

A significant part of these plant species is the practical importance. As presented in Table 4, 275 essential oil species from 130 genera and 35 families grow in the Central Kazakhstan. The largest number of species includes tree families: *Asteraceae* (66 species), *Lamiaceae* (60 species) and *Apiaceae* (44 species) (Tab. 5).

Table 5. A list of essential oil plants of the Central Kazakhstan's flora

Family	Genus	Species
1	2	3
<i>Apiaceae</i> (<i>Umbellifera</i>)	<i>Eryngium</i>	<i>E.planum</i>
	<i>Chaerophyllum</i>	<i>Ch.prescottii</i>
	<i>Anthriscus</i>	<i>A.aemula</i>
	<i>Cachrys</i>	<i>C.macrocarpa</i>
	<i>Prangos</i>	<i>P.ledebouri</i>
	<i>Bupleurum</i>	<i>B.aureum</i>
	<i>Cnidium</i>	<i>C.dubium</i>
	<i>Silaum</i>	<i>S.besseri</i>
	<i>Carum</i>	<i>C.carvi</i>
	<i>Bunium</i>	<i>B.setosum</i>
	<i>Falcaria</i>	<i>F.vulgaris</i>
	<i>Trinia</i>	<i>T.hispida, T.polyclada</i>
	<i>Cicuta</i>	<i>C.virosa</i>
	<i>Sium</i>	<i>S.sisaroides, S.latifolium, S.medium</i>
	<i>Oenanthe</i>	<i>O.aquatica</i>
	<i>Seseli</i>	<i>S.buchtormensis, S.eriocarpa, S.eriocephalum, S.ledebourii, S.strictum, S.sesiliflorum, S.glabratum</i>
	<i>Cenolophium</i>	<i>C.fischeri</i>
	<i>Conium</i>	<i>C.maculatum</i>
	<i>Peucedanum</i>	<i>P.morisonii, P.lubimenkoanum</i>
	<i>Oedibasis</i>	<i>O.apiculata</i>
	<i>Palimbia</i>	<i>P.turgaica, P.salsa</i>
	<i>Ferula</i>	<i>F.canescens, F.schair, F.soongarica, F.ferulaeoides, F.caspica, F.tatarica</i>
	<i>Pastinaca</i>	<i>P.graveolens</i>
	<i>Heracleum</i>	<i>H.sibiricum</i>
<i>Turgenia</i>	<i>T.latifolia</i>	
<i>Hymenolyma</i>	<i>H.bupleuroides</i>	
<i>Scaligeria</i>	<i>S.setacea</i>	
<i>Araceae</i>	<i>Acorus</i>	<i>A.calamus</i>
<i>Asphodelaceae</i>	<i>Eremurus</i>	<i>E.altaicus</i>
<i>Asteraceae</i> (<i>Compositae</i>)	<i>Galatella</i>	<i>G.villosa, G.tatarica, G.divaricata, G.punctata, G.angustissima</i>
	<i>Conyza</i>	<i>C.canadensis</i>
	<i>Tripolium</i>	<i>T.vulgare</i>
	<i>Helichrysum</i>	<i>H.arenarium</i>
	<i>Inula</i>	<i>I.helenium</i>

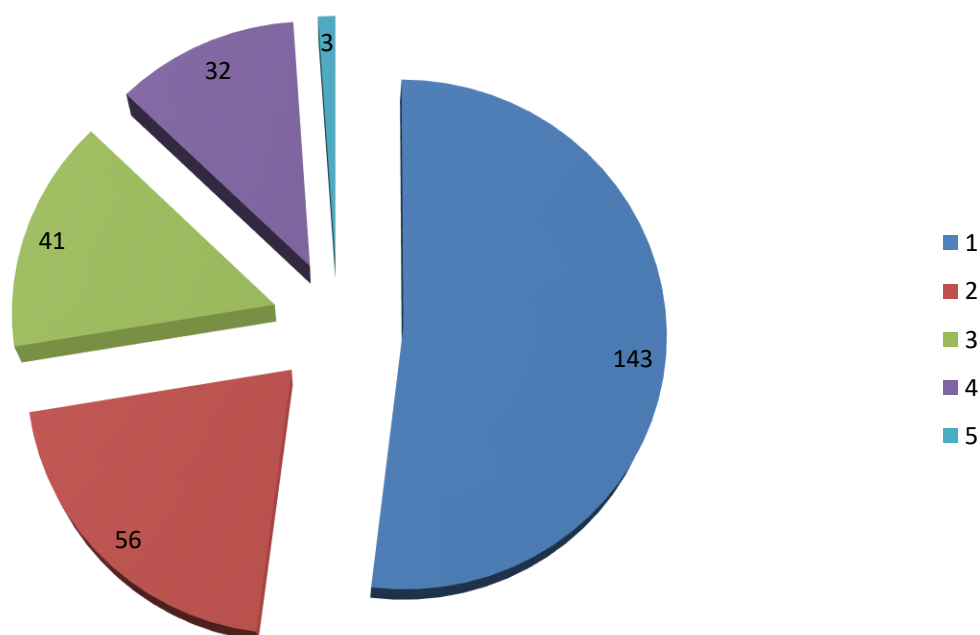
1	2	3
	<i>Pulicaria</i>	<i>P.prostrata</i>
	<i>Bidens</i>	<i>B.tripartita</i>
	<i>Achillea</i>	<i>A.nobilis, A.millefolium, A.setacea, A.micrantha, A.salicifolia, A.cartilaginea</i>
	<i>Tripleurospermum</i>	<i>T.inodorum</i>
	<i>Cancrinia</i>	<i>C.discoidea</i>
	<i>Tanacetum</i>	<i>T.vulgare, T.scopulorum, T.santolina, T.millefolium, T.ulutavicum, T.achilleifolium</i>
	<i>Ajania</i>	<i>A.fruticulosa</i>
	<i>Cancriniella</i>	<i>C.krascheninnikovii</i>
	<i>Artemisia</i>	<i>A.armeniaca, A.latifolia, A.laciniata, A.santolinifolia, A.pontica, A.macrantha, A.obtusiloba, A.proceraeformis, A.tournefortiana, A.glabella, A.rupestris, A.frigida, A.austriaca, A.sericea, A.absinthium, A.sieversiana, A.subchrisolepis, A.radicans, A.dracunculus, A.marschalliana, A.tomentella, A.scoparia, A.juncea, A.scopaeformis, A.lercheana, A.terrae-albae, A.semiarida, A.gracilescens, A.pauciflora, A.aralensis, A.camelorum, A.nitrosa, A.schrenkiana, A.sublessingiana, A.serotina, A.albida, A.kasakorum, A.vulgaris</i>
	<i>Arctium</i>	<i>A.tomentosum</i>
<i>Betulaceae</i>	<i>Betula</i>	<i>B.pendula, B.pubescens, B.microphylla, B.kirghisorum</i>
	<i>Alnus</i>	<i>A.glutinosa</i>
<i>Biebersteniaceae</i>	<i>Bieberstenia</i>	<i>B.multifida</i>
<i>Brassicaceae</i> (<i>Cruciferae</i>)	<i>Cardamine</i>	<i>C.impatiens</i>
	<i>Isatis</i>	<i>I.emarginata, I.costata, I.tinctoria</i>
	<i>Herperis</i>	<i>H.sibirica</i>
	<i>Mattiola</i>	<i>M.robusta, M.superba</i>
	<i>Brassica</i>	<i>B.campestris, B.juncea</i>
	<i>Sinaps</i>	<i>S.arvensis</i>
	<i>Eruca</i>	<i>E.sativa</i>
	<i>Thlaspi</i>	<i>Th.arvense</i>

1	2	3
	<i>Camelina</i>	<i>C.glabrata, C.microcarpa</i>
	<i>Capsella</i>	<i>C.bursa-pastoris</i>
<i>Boraginaceae</i>	<i>Arnebia</i>	<i>A.decumbens</i>
<i>Cannabaceae</i>	<i>Cannabis</i>	<i>C.ruderalis</i>
	<i>Humulus</i>	<i>H.lupulus</i>
<i>Caryophyllaceae</i>	<i>Herniaria</i>	<i>H.polygama, H.glabra</i>
	<i>Dianthus</i>	<i>D. leptopetalum, D.campestris, D.rigidus</i>
<i>Chenopodiaceae</i>	<i>Chenopodium</i>	<i>C.hybridum, C.botris</i>
	<i>Camphorosma</i>	<i>C.soongorica, C. monspeliaca</i>
<i>Cupressaceae</i>	<i>Juniperus</i>	<i>J.sabina</i>
<i>Cyperaceae</i>	<i>Cyperus</i>	<i>C.longus, C.fuscus</i>
<i>Elaeagnaceae</i>	<i>Elaeagnus</i>	<i>E.oxycarpa</i>
<i>Fabaceae</i>	<i>Ononis</i>	<i>O.arvensis</i>
	<i>Melilotus</i>	<i>M.dentatus, M.suaveolens</i>
<i>Gentianaceae</i>	<i>Gentiana</i>	<i>G.cruciata</i>
<i>Geraniaceae</i>	<i>Geranium</i>	<i>G.sibiricum, G.pratense, G.collinum, G.transversale</i>
<i>Hypericaceae</i>	<i>Hypericum</i>	<i>H.perforatum, H.scabrum, H.hirsutum</i>
<i>Iridaceae</i>	<i>Iris</i>	<i>I.tenuifolia, I.songarica, I.halophila, I.haematophylla, I.scariosa</i>
<i>Lamiaceae</i> (<i>Labiatae</i>)	<i>Scutellaria</i>	<i>S.galericata, S.scordiifolia, S.dubia, S.grandiflora, S.krylovii, S.supina</i>
	<i>Schizonepeta</i>	<i>S.annua</i>
	<i>Siderites</i>	<i>S.montana</i>
	<i>Lophanthus</i>	<i>L.schrenkii</i>
	<i>Nepeta</i>	<i>N.cataria, N.micrantha, N.annonica, N.ucranica, N.pungens, N.micrantha</i>
	<i>Glechoma</i>	<i>G.hederacea</i>
	<i>Dracocephalum</i>	<i>D.nutans, D.thymiformis, D.peregrinum, D.ruyschiana</i>
	<i>Lallemantia</i>	<i>L.royleana</i>
	<i>Prunella</i>	<i>P.vulgaris</i>
	<i>Phlomoides</i>	<i>Ph.tuberosa</i>
	<i>Phlomis</i>	<i>Ph. puberula, Ph.agraria</i>
	<i>Galeopsis</i>	<i>G.ladanum, G.bifida</i>
	<i>Lamium</i>	<i>L.amplexicaule</i>
	<i>Leonurus</i>	<i>L.glaucescens</i>
	<i>Lagochillus</i>	<i>L.acutilobus, L.pungens</i>
	<i>Betonica</i>	<i>B.officinalis</i>
<i>Stachys</i>	<i>S.palustris</i>	
<i>Salvia</i>	<i>S.stepposa, S.deserta</i>	

1	2	3
	<i>Ziziphora</i>	<i>Z.clinopodioides, Z.bungeana</i>
	<i>Hyssopus</i>	<i>H.ambiguus, H.macranthus</i>
	<i>Thymus</i>	<i>T.marschallianus, T.stepposus, T.lavrenkoanus, T.minussinesis, T.crebriifolius, T.asiaticus, T.rasitatus, T.guberbinensis, T.roseus, T.kirgisorum, T.kasakstanicus, T.eremita</i>
	<i>Lycopus</i>	<i>L.exaltatus, L.europaeus</i>
	<i>Mentha</i>	<i>M.arvensis, M.longifolia, M.micrantha, M.aquatica</i>
	<i>Teucrium</i>	<i>T.scordium</i>
	<i>Eremostachys</i>	<i>E.molucelloides</i>
<i>Liliaceae</i>	<i>Asparagus</i>	<i>A.officinalis</i>
<i>Malvaceae</i>	<i>Althaea</i>	<i>H.officinalis</i>
	<i>Lavatera</i>	<i>L.thuringiaca</i>
<i>Papaveraceae</i>	<i>Chelidonium</i>	<i>C.majus</i>
<i>Pinaceae</i>	<i>Pinus</i>	<i>P.sylvestris</i>
<i>Poaceae</i> (<i>Graminea</i>)	<i>Elytrigia</i>	<i>E.repens</i>
<i>Polygalaceae</i>	<i>Polygala</i>	<i>P.comosa</i>
<i>Polygonaceae</i>	<i>Rheum</i>	<i>Rh.nanum</i>
	<i>Polygonum</i>	<i>P.thymifolium, P.undulatum</i>
<i>Ranunculaceae</i>	<i>Thalictrum</i>	<i>Th.foetidum</i>
	<i>Pulsatilla</i>	<i>P.multifida, P.patens</i>
	<i>Clematis</i>	<i>C.orientalis</i>
	<i>Ranunculus</i>	<i>R.sceleratus</i>
<i>Rosaceae</i>	<i>Filipendula</i>	<i>F.ulmaria</i>
	<i>Amygdalus</i>	<i>A.nana</i>
	<i>Spiraea</i>	<i>S.trilobata, S.hypericifolia, S.crenata</i>
	<i>Crataegus</i>	<i>C.sangiunea</i>
	<i>Rubus</i>	<i>R.saxatilis, R. idaeus</i>
	<i>Geum</i>	<i>G.rivale, G.urbanicum</i>
	<i>Agrimonia</i>	<i>A.asiatica</i>
	<i>Rosa</i>	<i>R.laxa, R.canina</i>
	<i>Hulthemia</i>	<i>H.berberifolia</i>
	<i>Cerasus</i>	<i>C.fruticosa</i>
	<i>Padus</i>	<i>P.racemosa</i>
<i>Rubiaceae</i>	<i>Gallium</i>	<i>G. aparine, G.spurium, G.uliginosum, G.boreale, G.verum</i>
<i>Rutaceae</i>	<i>Dictamnus</i>	<i>D. angustifolius</i>
<i>Salicaceae</i>	<i>Populus</i>	<i>P.nigra, P.canescens, P.tremula</i>

1	2	3
	<i>Salix</i>	<i>S.alba, S.bebbiana, S.rosmarinifolia, S.cinerea, S.caprea, S.viminalis, S.caspica, S.tenujulis</i>
<i>Glossulariaceae</i>	<i>Ribes</i>	<i>R.nigrum</i>
<i>Solanaceae</i>	<i>Datura</i>	<i>D.stramonium</i>
<i>Valerianaceae</i>	<i>Patrinia</i>	<i>P.intermedia</i>

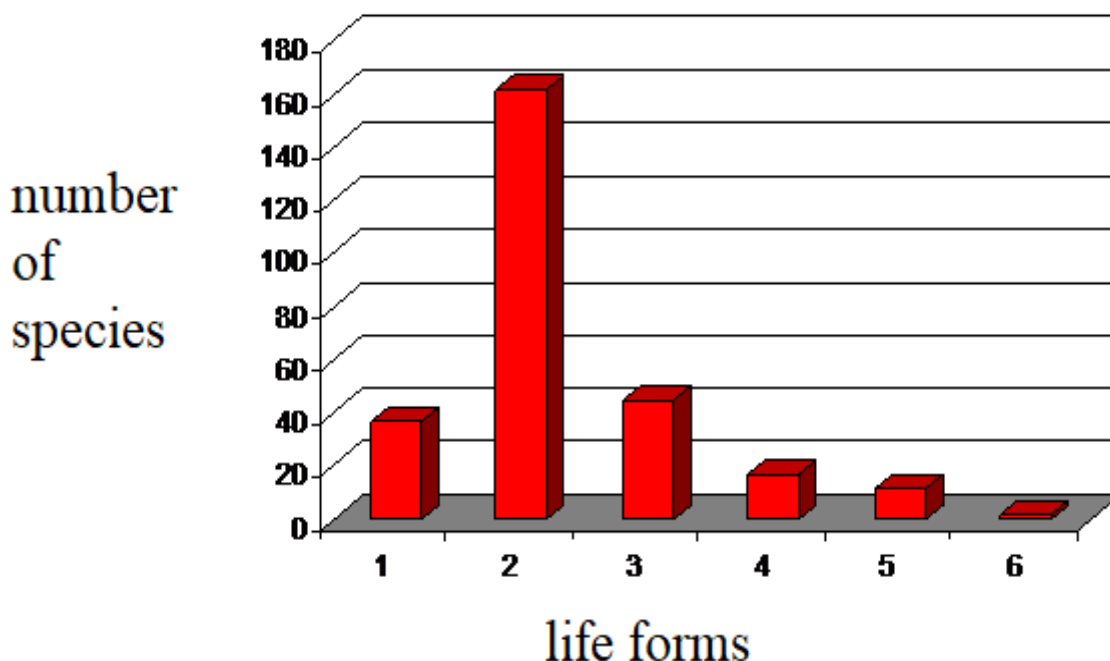
Ecological analysis of wild-growing essential oil plants of the Central Kazakhstan was carried out. So, among essential oil plants, the following ecological groups relative to humidification conditions [83, 84] were identified: mesophytes, meso-xerophytes, xerophytes, xero-mesophytes and hydrophytes (Fig. 8). The largest number of species includes a group of xerophytes - 143 species. In second place are mesophytes. The lowest quantitative content is in the hydrophyte group (3 species). This distribution corresponds to the climatic conditions and vegetation of the Central Kazakhstan with an arid climate, the predominance of steppe and desert zones, in which forests occupy only 3% of the total territory.



1 – xerophytes, 2 – mesophytes, 3 – meso-xerophytes, 4 – xero-mesophytes, 5 – hydrophytes

Figure 8. Ratio of ecological groups among essential-oil plants of the Karaganda region flora

From vital forms we distinguished the following groups of plants: annual and biannual herbaceous plants, herbaceous perennial plants, semi-low shrubs, bushes, trees and lianas [85, 86]. The largest number of species was included in the group of herbaceous perennials - 162 species (Fig. 9).



1 – annual and biennial herbaceous plants, 2 – herbaceous perennial plants, 3 – semi-low shrubs, 4 – bushes, 5 – trees, 6 – lianas

Figure 9. Ranking of essential oil plants of the Central Kazakhstan's flora by life forms

At the final stage, essential oil plants were ranked according to the degree of prevalence, commercial thickets and the possibility of practical use. There are four groups:

i) rare and endangered species, which are not subjects to collection (*Thymus minussinensis*, *Th.guberlinensis*, *Tanacetum ulutavicum*, *T.scopulorum*, *Prunella vulgaris*, *Juniperus sabina*, *Pulsatilla patens*, and others);

ii) species that are widespread, but do not form commercial thickets (*Iris halophyla*, *Geranium collinum*, *Tripolium vulgare*, *Galatella divaricata*, *Melilotus suaveolens*, *Ferula tatarica*, *Tripleurospermum inodorum* and others);

iii) widespread species forming thickets suitable for collecting raw materials in small volumes (*Tanacetum vulgare*, *Achillea millefolium*, *Achillea nobilis*, *Hypericum perforatum*, *Artemisia austriaca*, *Nepeta cataria*, *Salvia stepposa*, *Ajania fruticulosa*, *Thymus crebrifolius*, *Ziziphora bungeana*, *Filipendula ulmaria*);

iv) widespread species forming thickets suitable for industrial collection of raw materials (*Thymus marschallianus*, *Ziziphora clinopodioides*, *Artemisia*

terrae-albae, *Hyssopus ambiguus*, *Thymus rasilatus*, *Patrinia intermedia* and others).

For further investigation for assessment of resources of raw materials, essential oil plants belonging to the 3rd and 4th groups were selected.

3.2 Conspectus of flora of essential oil plants

Based on the obtained data on the species composition, a conspectus of essential oil plants of the Central Kazakhstan's flora was compiled (Appendix A and B).

Family Apiaceae Lindl. (Umbelliferae Moris.)

Anthriscus aemula (Woron.) Schischk. Annual plant. Rare. It lives in shady gorges, under the canopy of pine forests and the banks of springs. It was marked only in the Karkaraly Mountains.

Bunium setosum (Schrenk) H. Wolff. Herbaceous perennial plant. It lives on the slopes of rocky hills. It was marked in the Altai Mountains, in the valley of the Sarysu river.

Bupleurum aureum Fisch. Herbaceous perennial plant. It grows in the low mountains of the Central Kazakhstan (Mountains Karkaraly, Kent, Shynghiztau). It lives in thickets of shrubs, along the edges of forests, along river banks and on forest glades. It is rare.

Cachrys macrocarpa Ledeb. Perennial plant. It grows on rocky soils, in deserted steppes, shrub thickets, slopes of low mountains. Found in the Ulytau Mountains, on upland Betpakdala.

Carum carvi L. Herbaceous biennial plant. It is found scattered on the territory of the Karkaraly Mountains. It lives in pines, along streams, in meadows, in shrub thickets.

Cenolophium fischeri (Spreng.) Koch. ex DC. Perennial herbaceous plant. It grows throughout the steppe part of the Central Kazakhstan. It lives in wet meadows, in river valleys, in swampy places, around springs, in willow thickets.

Chaerophyllum prescottii DC. Herbaceous perennial plant. It is widely distributed throughout the steppe part of the Central Kazakhstan. It lives in steppe communities, in raw meadows (around springs, in river valleys, on the edges of birch-aspen teal forests), in thickets of steppe shrubs, less often in chievniki and in salt-marsh meadows. It is plentiful.

Cicuta virosa L. Perennial herbaceous plant. It grows in marshy places, near lakes, rivers, along streams, often under the canopy of small-leaved forests. It grows in the mountains of Karkaraly and Kent.

Cnidium dubium (Schkuhr.) Thell. Annual plant. It is found throughout the territory of the Central Kazakhstan, abundantly in low mountains. It lives in raw meadows, at the edges of deciduous forests, in birch peaks, in glades among pine forests, less often in shrub thickets.

Conium maculatum L. Biennial plant. The weed species, it meets sporadically along roads, in gardens, in kitchen gardens.

Eryngium planum L. Herbaceous perennial plant. It grows in grain steppes, in steeped meadows, along the slopes of hills and interstitial depressions, along roads, on deposits and in river floodplains. It is widely distributed throughout the Central Kazakhstan.

Falcaria vulgaris Bernh. Biennial plant. It grows in the steppes, among shrub thickets, along the slopes of hills, in logs. It is revealed the only place of growth in the Karkaraly Mountains.

Ferula canescens Ledeb. Perennial plant. It grows on crushed stone and heavy clay soils, along the slopes of hills, on flat areas. It is found in the Betpakdala upland.

Ferula caspica M. Bieb. Perennial plant. It grows in the steppe and semi-desert zone of the Central Kazakhstan, on salinity and, clay-salinity soils, along the plains and gentle slopes of hills. It grows in the Betpakdala upland, in Ulytau Mountains.

Ferula ferulaeoides (Steud.) Korov. Perennial plant. It grows in dry steppe communities, less often in the desert zone, along the slopes of gentle hills, on clay-rubble outcrops. It is identified populations in the Betpakdala upland, Northern Balkhash.

Ferula schair Borszcz. Perennial plant. It grows in the desert zone of the Central Kazakhstan, settling in flat places, on gentle hills, in shrub thickets. It forms dense thickets. Habitats - Betpakdala upland.

Ferula soongarica Pall. ex Spreng. Perennial plant. It is widely distributed in most part of the Central Kazakhstan, covering the slopes of hills and interstitial depressions, valleys of rivers, streams and temporary watercourses, shrub thickets, edges of island birch-aspen forests.

Ferula tatarica Fisch. Perennial plant. It grows on brackish soils in the steppe and desert parts of the Central Kazakhstan, often in shrub thickets, along the gentle slopes of hills, in river valleys, withstands salinization. It is marked in the Betpakdala upland, the Ulytau mountains, steppe zone.

Heracleum sibiricum L. Perennial plant. It grows in raw meadows, along the banks of rivers and streams, in bush thickets, in swampy places. It is found in the low mountains of the Central Kazakhstan.

Hymenolyma bupleuroides (Schrenk.) Korov. Perennial plant. It grows in wormwood-type steppes, less often in salty meadows, in the vicinity of low mountains, in flat areas. It occurs scattered in the Betpakdala upland, around Zhezkazgan city.

Seseli buchtormensis (Fisch.) DC. Perennial plant, petrophyte. It grows along the slopes of granite hills, in the cracks of rocks, in a strip of dry and deserted steppes. It is found in the low mountains of the southern and southwestern parts of the Central Kazakhstan.

Seseli eriocarpa Schrenk. Perennial plant. It grows on stony slopes of hills of upland, in dry steppes. It is found scattered throughout the territory of the Central Kazakhstan.

Oedibasis apiculata (Kar.et Kir.) K.-Pol. Perennial plant. It grows on crushed plains, along the slopes of low mountains. It is found in the Northern Balkhash region.

Oenanthe aquatica (L.) Poir. Perennial plant. It lives on the banks of rivers, lakes, reservoirs, in swampy places. It is found in the Karkaraly Mountains, in the valley of the rivers Nura and Sherubay Nura.

Palimbia salsa (L.) Besser. Perennial plant. It is found throughout the territory of the Central Kazakhstan in a strip of variegated-feathered steppes, south on carbonate clay soils, along steppe and meadow declines, around springs.

Palimbia turgaica Lipsky. Perennial plant. It is found throughout the territory of the Central Kazakhstan in a strip of variegated-feathered steppes, south on carbonate clay soils, along steppe and meadow declines, around springs.

Pastinaca graveolens M. Bieb. Perennial plant. It grows in feathered, feathered-different steppes, among communities with the participation of *Artemisia terrae-albae*. It is often in the steppe part of the Central Kazakhstan, the Ulytau Mountains.

Peucedanum morisonii Besser. Perennial plant. The species is widespread in the steppe and low-hill parts of the Central Kazakhstan. It grows in steppe communities, along the slopes of hills, in depressions, among shrubby thickets, along the edges of pine and small-leaved forests, in steppe meadows.

P.lubimenkoanum Kotov. (*P. alsaticum* L.). Perennial plant. It is common in most parts of the Central Kazakhstan; grows in dry steppes, is abundant in logs, steppe depressions, slopes of hills, in salty meadows, at the edges of island forests.

Prangos ledebouri Herrnst. et Heyn. Herbaceous perennial plant. It lives in meadow thickets, under the canopy of forests, on the slopes of low mountains. It is found scattered throughout the territory of the Central Kazakhstan, mainly in the semi-desert part.

Scaligeria setacea (Schrenk) Korov. Perennial plant. It grows along the grassy slopes of low mountains, in logs, along shrub thickets, dry river beds. It is marked in the Ortau, Kyzyltau, Aktau Mountains.

Seseli eriocephalum (Pall. ex Spreng.) Schischk. Perennial plant. Habitation is confined to the desert zone of the Central Kazakhstan. It grows on clay soil, salt marshes, along the shores of salt lakes, less often on takyrs.

Seseli ledebourii G. Don. Perennial plant. It is widespread throughout the Central Kazakhstan, often being a dominant or component in petrophytic communities. It grows in shallow seedlings along crushed or rocky slopes, on flat steppe areas, less often on sandy or saline soils.

Seseli glabratum Willd. ex Schult. Perennial plant. It grows on the rocky slopes of hills, in the low mountains of the steppe and desert parts of the Central Kazakhstan.

Seseli strictum Ledeb. Perennial plant. It grows in salty meadows, in shrubby thickets of the steppe and desert zones of the Central Kazakhstan.

Seseli sesiliflorum Schrenk. Perennial plant. It grows along the dry slopes of hills, on rocky showers, less often flat areas. Found in Betpakdala upland, in the Ulytau Mountains.

Silaum besseri DC. Herbaceous perennial plant. It is found scattered throughout the territory of the Central Kazakhstan. It lives in river floodplains, among shrub thickets, in steeped meadows, in logs, withstands minor salinization.

Sium sisaroides DC. Perennial plant. The species is widespread in the Central Kazakhstan. It grows in wet places, along streams, springs, along the banks of rivers, lakes, through meadow communities, under the canopy of birch-aspen and black-alder forests.

Sium latifolium L. Perennial plant. It is common in the Central Kazakhstan, grows in swampy places, in water, along the banks of lakes and rivers.

Sium medium Fisch. Perennial plant. It grows in wet meadows in river valleys, in swampy places, along the banks of reservoirs. It is noted populations in the Ortau, Ulytau Mountains, the valleys of the Ulken-Kundyzdy and Sopaly rivers.

Trinia hispida Hoffm. Perennial plant. It grows in steppe communities, in deposits. It is identified populations in surrounding of Karaganda city.

Trinia polyclada Schischk. Perennial plant. It grows in feathered-wormwood, tipchak and stepped meadow communities, less often among shrub thickets. The only habitat in the Karkaraly Mountains is noted.

Turgenia latifolia (L.) Hoffm. Annual plant. It is apparently an arrogant species. It grows on crushed stone soils, along clones of hills, in low mountains, sometimes, like a weed species, in crops, in weeds. It is marked in surrounding of Karaganda city. It is rare.

Family Araceae Juss.

Acorus calamus L. Perennial plant. It grows in steppe rivers, less often in lakes. The only place is noted in surrounding of Centralnoe settlement.

Family Asphodelaceae Juss.

Eremurus altaicus (Pall.) Stev. Perennial plant. It grows in typically steppe communities, along the slopes of hills, among shrub thickets. It is found scattered in most parts of the Central Kazakhstan.

Family Asteraceae Dumort.

Achillea cartilaginea Ledeb. Perennial plant. It is found scattered throughout the territory of the Central Kazakhstan. It grows in wet meadows, in swampy places, in willow thickets, in river valleys and temporary watercourses.

Achillea millefolium L. Perennial plant. It is also found in the form of commercial thickets throughout the territory of the Central Kazakhstan. It grows in real and steppe meadows, in steppe communities, among thickets of shrubs, along roads, in logs and interstitial depressions.

Achillea micrantha Willd. Perennial plant. It grows on sandy soils as part of psammophyte communities. It is found in the valley of Sarysu river, Kyzyl-Rai and Ulytau Mountains, surrounding of Zhezkazgan city.

Achillea nobilis L. Perennial plant. It grows throughout the Central Kazakhstan. It grows in steppe communities, less often in petrophytic, in river valleys, along the shores of lakes, along the slopes of hills, in shrub thickets. It is abundance, forms commercial thickets.

Achillea salicifolia Besser. It is found scattered throughout the territory of the Central Kazakhstan. It grows in moist meadows, near springs, on edges and under the canopy of birch-aspen and black-alder forests, in willow thickets.

Achillea setacea Waldst. et Kit. Perennial plant. It grows in meadows, in variegated-feathered steppes, along the slopes of low mountains, in interstitial depressions. It is found mainly in the low mountains of the Central Kazakhstan - Karkaraly, Kent, Ku, Ulytau, Kyzyltau Mountains, Spassky hills.

Ajania fruticulosa (Ledeb.) Poljak. Semi-low shrub. It grows along the slopes of hills, crushed showers, in feathery-diverse steppe communities. On the territory of the Central Kazakhstan it is found in surrounding of the Karkaraly Mountains, Temirshi Mountains, surrounding of settlement Balykty.

Arctium tomentosum Mill. Biennial plant. Weed species. It is found in deposits, in weeds, along roads, in the vicinity of settlements.

Artemisia absinthium L. Perennial plant. It lives on the edges of forests, in shrub thickets, as part of steppe meadows, less often in steppe communities. It is rare in the low mountains of the Central Kazakhstan.

Artemisia albida Willd.ex Spreng. (*A.compacta* Fisch.ex DC.). Perennial plant, petrophyte. It grows in steppe communities, along the rocky slopes of hills. It is found in the eastern part of the Central Kazakhstan.

Artemisia aralensis Krasch. Semi-low shrub. It grows in typical desert communities. The only place of location in the Shetskiy district of the Karaganda region was noted.

Artemisia armeniaca Lam. Perennial plant. It is found scattered throughout the steppe part of the Central Kazakhstan. It grows in steppe communities along the slopes of hills, in interstitial depressions, in steppe meadows.

Artemisia austriaca Jacq. Perennial plant. It is the most widespread species in the Central Kazakhstan. It is found in steppe, bush communities, a dominant in the strip of grass-feathered steppes.

Artemisia camelorum Krsch. Semi-low shrub. It grows on the border of steppe and desert vegetation of the Central Kazakhstan. It occurs in surrounding of Shubarkol, Balchash, Zhezkazgan cities, in the valley of the river Kulan-Otpes and Sarysu.

Artemisia dracunculus L. Perennial plant. It is found sporadically throughout the territory of the Central Kazakhstan. It grows in thickets of shrubs, in logs, along the banks of lakes and rivers, as part of meadow communities, along the edges of forests.

Artemisia frigida Willd. Perennial plant. The species is widespread in the Central Kazakhstan. It grows in typically steppe, petrophytic, and shrub communities. It is found on the slopes of hills, in logs, in flat areas, at the outcrops of granites, in cracked rocks.

Artemisia glabella Kar. et Kir. Semi-low shrub. It grows in a strip of dry steppes as part of different-type grain communities, along the outcrops of granites, on the slopes of hills, in river valleys. It is found in the steppe part of the Central Kazakhstan.

Artemisia gracilescens Krasch. et Iljin. Semi-low shrub. It grows in the zone of deserted steppes of the Central Kazakhstan. It occurs on the slopes of hills, on flat areas, less often as part of petrophytic communities and on salt marshes.

Artemisia juncea Kar. et Kir. Semi-low shrub. It lives in the southern part of the Central Kazakhstan - Lake Balkhash, the Betpakdala upland. It is confined to southern steppe communities, rock cracks, hills, dry river beds.

Artemisia kasakorum (Krasch.) Pavl. Semi-low shrub. It grows in a strip of grass-carpet steppes of the Central Kazakhstan. It is found in depressions, on flat, often saline areas, lake basins. Endem of Kazakhstan.

Artemisia laciniata Willd. Perennial plant. It is found scattered in the low mountains of the Central Kazakhstan: Kent, Karkaraly, Temirshi, Bakhty, Zhiltau, Semizbug and others. It is confined to meadow and variegated-feathered steppes, on which it grows along the slopes of hills, in shrub thickets, under the canopy of small-leaved forests.

Artemisia latifolia Ledeb. Perennial plant. It is found scattered throughout the steppe and forest part of the Central Kazakhstan. It is confined to saline meadow soils.

Artemisia lercheana Web. ex Stechm. Perennial plant. It grows on sandy and sandy soils. It is found in the valley of the river Sarysu.

Artemisia macrantha Ledeb. Perennial plant. It grows in mountain meadows, in cracks of rocks, in thickets of shrubs. It is found sporadically in the low mountains of the eastern part of the Central Kazakhstan: Karkaraly and Kent.

Artemisia marschalliana Spreng. Perennial plant. It is a widespread species in the Central Kazakhstan. It grows in various types of steppe communities, in pine forests, along the slopes of hills, at the outcrops of granite rocks.

Artemisia nitrosa Web. ex Stechm. Полукустарничек. Широко распространенный вид в Центральном Казахстане. Доминант многих степных типов сообществ. Встречается в степях, по склонам сопок, в высохших озерных котловинах, на засоленных участках. Обилен.

Artemisia pauciflora Web. ex Stechm. Semi-low shrub. It is found on saline territories in deserted steppes, along the slopes of hills. It grows in the southwestern part of the Central Kazakhstan.

Artemisia pontica L. Perennial plant. It is a widely found species in the Central Kazakhstan. It grows in dry, saline meadows, in river valleys, on the edges of small-leaved forests, in steppe declines.

Artemisia obtusiloba Ledeb. Perennial plant. It grows in steppe communities, along the cracks of rocks, along the slopes of granite hills. It is noted in in the Karkaraly Mountains.

Artemisia proceraeformis Krasch. Perennial plant. It grows in the steppe part of the Central Kazakhstan. It is confined to saline, moistened soils: in logs, along the banks of rivers and lakes, among shrub thickets.

Artemisia radicans A. Kuprijanov. Perennial plant. It grows in the strip of multi-grass-carpet steppes of the Central Kazakhstan along the outcrops of granites, along the slopes of hills and interstitial depressions.

Artemisia rupestris L. Perennial plant. It is found for the most part in the northern and northeastern parts of the Central Kazakhstan.

Artemisia santolinifolia Turcz.ex Bess. Perennial plant. It is found in the low mountains of the Central Kazakhstan - Kent, Chyngistau. It grows on the slopes of hills, on the edges of deciduous forests.

Artemisia schrenkiana Ledeb. It is found throughout the Central Kazakhstan, mostly in southern and southeastern. It grows on in steppe, shrub communities, in the valleys of rivers and lakes.

Artemisia scopaeformis Ledeb. Perennia plantl. It grows on flat saline soils. In ecology, it is close to *Artemisia nitrosa*. It is found in the valley of the river Sarysu. Endem of Kazakhstan.

Artemisia scoparia Waldst.et Kit. Perennial plant, psammophyte. It is found scattered throughout the territory of the Central Kazakhstan on sandy soils, sometimes inhabits abandoned fields as a weed.

Artemisia semiarida (Krasch. et Lavr.) Filat. Semi-low shrub. It grows in the desert zone of the Central Kazakhstan - the vicinity of the Ulytau Mountains, the Betpakdala upland, the coast of Lake Balkhash. It is found on flat areas and intersoop depressions, often saline soils. Endem of Kazakhstan.

Artemisia sericea Web.ex Stechm. Perennial plant. It grows as part of variegated-feathered and stepped meadow communities, along the slopes of hills and low mountains, less often in shrub thickets and on the edges of pine forests. It is found sporadically throughout the territory of the Central Kazakhstan.

Artemisia serotina Bunge. Perennial plant. It is found in the eastern part of the Central Kazakhstan. It grows along the slopes of rocky hills as part of wormwood-grass communities.

Artemisia sieversiana Willd. Biennial plant. Weed species. It grows along roads, in settlements, in abandoned fields.

Artemisia subchrysolepis Filatova. Semi-low shrub. It is found in the steppes, along the slopes of hills, in saline areas. Found in the vicinity of Karaganda city.

Artemisia sublessingiana (B. Keller) Krasch.ex Poljak. Perennial plant, petrophyte. It is found in the southern regions of the Central Kazakhstan. It lives in steppe communities, on the slopes of hills, on rocky areas, in logs, in thickets of shrubs.

Artemisia terrae-albae Krasch. Semi-low shrub. It grows in the desert zone of the Central Kazakhstan, covering the territories of the Betpakdala upland and the Northern Balchash. It is dominant of wormwood steppes. It is plentiful.

Artemisia tomentella Trautv. Perennial plant. It is found on sandy soils in the valley of the river. Sarysu, less - on granite low mountains. Endem of Kazakhstan.

Artemisia tournefortiana Reichb. Annual plant; weed species. It grows on the slopes of hills, along roads, in settlements, in places of grazing.

Artemisia vulgaris L. Perennial plant. It is found in the northern and northeastern parts of the Central Kazakhstan. It grows along the slopes of hills, as part of meadow communities, in shrub thickets, sometimes as a weed species.

Epy Bidens tripartita L. Annual plant. It is found throughout Central Kazakhstan. It lives on the banks of rivers, lakes, near springs, in raw meadows.

Cancrinia discoidea (Ledeb.) Poljak. Perennial plant. It grows on the slopes of the low mountains of the Central Kazakhstan, on saline rocky soils. It is marked populations in the Karkaraly district of the Karaganda region.

Cancriniella krascheninnikovii (N.Rubtz.) Tzvel. Perennial plant. It grows on rocky saline soils, slopes of rocky hills, on takyr. In is found in the southern part of the Central Kazakhstan, near Lake Balchash.

Conyza canadensis L. Annual plant. Tearful, stale species.

Galatella angustissima (Tausch) Novopokr. Perennial plant. It is found throughout the Central Kazakhstan. It grows in diverse-feathered communities, on the slopes of low mountains, in thickets of shrubs, in logs, natural declines, less often under the canopy of pine forests.

Galatella divaricata (Fisch.ex Bich.) Novopokr. Perennial plant. It grows in the steppe part of the Central Kazakhstan, meeting in saline areas.

Galatella punctata (Waldst. et Kit.) Nees. Perennial plant. It grows throughout the Central Kazakhstan. It grows along rivers, lakes, reservoirs, live thickets, in meadow depressions.

Galatella tatarica (Less.) Czer. Perennial plant. The component of steppe evenly-feathered and evenly-wormwood-cereal communities; could grow on salty soils. It is widely distributed in the Central Kazakhstan.

Galatella villosa (L.) Cass. Perennial plant. It is similar in ecology to *Galatella tatarica*, confined to more xerophytic habitats.

Helichrysum arenarium (L.) Moench. Perennial plant. It is found scattered throughout the territory of the Central Kazakhstan on sandy soils, granite and gravel slopes of low mountains, less often in pine forests and shrub thickets.

Inula helenium L. Perennial. It is found sporadically throughout the territory of the Central Kazakhstan in moistened meadows, along springs, in shrub thickets, along the edges of forests.

Pulicaria prostrata (Gilib.) Aschers. Annual plant. Weed species. It is found on well-moistened saline depressions, in places of grazing.

Tanacetum achilleifolium (Bieb.) Sch. Bip. Perennial plant. It is found throughout the territory of the Central Kazakhstan in variegated-feathered communities, along the slopes of hills, in logs.

Tanacetum millefolium (L.) Tzvel. Perennial plant. It is found in the western part of the Central Kazakhstan in steppe communities; in dry meadows. It is rare species.

Tanacetum santolina C. Winkl. Perennial plant. It is found in a strip of dry and deserted steppes. It grows along the slopes of gentle hills, in depressions, in flat areas, less often on saline soil.

Tanacetum scopulorum (Krasch.) Tzvel. Perennial plant. It is noted in the Ortau, Bektauata Mountains. It grows in the cracks of rocks, along the rocky slopes of hills, at the foot. Endem of Kazakhstan.

Tanacetum vulgare L. Perennial plant. It is found throughout the territory of the Central Kazakhstan as part of meadow-steppe, shrubby communities, grows along river banks, along the edges of forests, in intersoop declines.

Tanacetum ulutavicum Tzvel. Perennial plant. It grows along the cracks of granite cliffs, in intersectoral depressions, on crushed slopes as part of petrophytic communities. It is found limited in the Ulytau Mountains. Endem of Kazakhstan.

Tripleurospermum inodorum (L.) Sch. Bip. Annual plant. Weed species. It is found in settlements, on abandoned lands, along roads.

Tripolium vulgare Nees. Annual plant, halophyte. It is rare in meadow areas, around salty lakes, along river banks. It is identified in the vicinity of Zhezkazgan city.

Family Betulaceae S.F. Gray

Alnus glutinosa (L.) Gaertn. Tree; a rare species. It is found in small areas in the Karkaraly district of the Karaganda region (Belagash mountain forest) in river valleys, along the slopes of hills, wet gorges.

Betula kirghisorum Sav.-Ryczg. Дерево. It grows sporadically throughout the northern and central parts of the Central Kazakhstan. It is found in the valleys of rivers, springs, in interstitial depressions, logs, in places with close occurrence of groundwater. Endem of Kazakhstan.

Betula microphylla Bunge. Tree. It grows throughout the Central Kazakhstan. It has a similar ecology with previous species.

Betula pendula Roth. Tree. The most widespread species in Central Kazakhstan. Forms deciduous steppes along the steppe part, low mountains.

Betula pubescens Ehrh. Tree. It grows throughout the territory of the Central Kazakhstan, occupying the most humid places - the vicinity of springs, in the valleys of rivers and streams, along river floodplains.

Family Biebersteniaceae Endl.

Bieberstenia multifida DC. Perennial plant. It grows along rocky slopes, peaks, rocks, hills, less often in deserts on takyr. It is found in the Betpakdala upland.

Family Brassicaceae Burnett (Crucifrae)

Brassica campestris L. Annual plant. Weed species. It grows in fields, crops, in settlements, along roads.

Brassica juncea (L.) Czern. Biennial plant. Weed species. It grows on deposits, in crops, on gardens, near housing, along the roadsides.

Camelina glabrata (DC.) Fritsch. Annual plant. It grows sporadically in the Central Kazakhstan as a weed species. It is found in crops, in settlements, in abandoned fields.

Camelina microcarpa Andrz. Annual plant. It is found in steppe communities, in places of grazing, in river valleys, in settlements. Weed species.

Capsella bursa-pastoris (L.) Medic. Annual plant. It is typical weed species widespread in all regions of the Central Kazakhstan.

Cardamine impatiens L. Biennial plant. It grows in pine and deciduous forests of the Central Kazakhstan, less often in thickets of shrubs, willows.

Eruca sativa Lam. Annual plant. It is weed species, living mainly along roads, in settlements, on abandoned lands.

Herperis sibirica L. Biennial plant. It is found along the banks of rivers, along roads, along the slopes of hills, often as a weed.

Isatis costata C.A. Mey. Biennial plant. It grows along the slopes of clay hills, along roads, on crushed slopes, weed view.

Isatis emarginata N. Busch. Annual plant. It occurs as a weed species along roads and grazing sites in the Betpakdala upland.

Isatis tinctoria L. Biennial plant. It grows along roads, settlements, on sandy soils. Weed species.

Mattiola robusta Bunge. Semi-low shrub. It grows sporadically in dry steppes at the outcrops of limestone rocks. It is marked in the Betpakdala upland.

Mattiola superba Conti. Perennial plant. It grows in steppe communities, less often on rocky slopes of mountains. It is discovered in the Karkaraly Mountains.

Sinaps arvensis L. Annual plant. It is weed species, living on crops, less often along roads, in weed places.

Thlaspi arvense L. Annual plant. It grows as a weed species along roads, in weeds, in settlements, in crops.

Family Boraginaceae Juss.

Arnebia decumbens (Vent.) Coss. et Kral. Annual plant. It is found in clay and rocky places, showers. It is noted sporadically in the Ulytau Mountains and the Betpakdala upland.

Family Cannabaceae Endl.

Cannabis ruderalis Janisch. Annual plant; weed species. It grows in crops, along roads, in settlements.

Humulus lupulus L. Perennial plant, liana; weed species. It is found in gardens, in settlements. It is cultivated.

Family Caryophyllaceae Juss.

Dianthus campestris Bieb. Perennial plant, petrophyte. It is found mainly in the northern and central regions of the Central Kazakhstan along the slopes of low mountains, at the outcrops of granites.

Dianthus leptopetalus Willd. Perennial plant. It is widely distributed in the Central Kazakhstan.

Dianthus rigidus M. Bieb. Perennial plant, petrophyte. It is found throughout the Central Kazakhstan. It grows in typical steppe communities at the outcrops of granites, in low mountains, in cracks of rocks.

Herniaria glabra L. Perennial plant. It grows on sandy or crushed soils, under rocks, in cracks, along rivers on shallows. Found in the low mountains of the Central Kazakhstan.

Herniaria polygama J. Gay. Perennial plant. Ecology and habitats correspond to the previous species.

Family Chenopodiaceae Vent.

Camphorosma monspeliaca L. Perennial plant. It is sporadically common species, mainly in the southern and southwestern parts of the Central Kazakhstan. It grows on saline soils, along the outcrops of clays, along the slopes of hills.

Camphorosma soongorica Bunge. Perennial plant. It is rare on the territory of the Central Kazakhstan, confined to salty soils, takyrs.

Chenopodium botris L. Annual plant. It is rare. It grows along roads, in places of grazing, along crops, like a weed species.

Chenopodium hybridum L. Annual plant. It is a fairly common species in the Central Kazakhstan, weed.

Family Cupressaceae Bartl.

Juniperus sabina L. Shrub, petrophyte. It is a rare species in the Central Kazakhstan. Habitation is confined to low mountains and outcrops of granite.

Family Cyperaceae Juss.

Cyperus fuscus L. Perennial plant. It is noted only on the border of the region in the eastern part of the Central Kazakhstan. It grows on the banks of reservoirs.

Family Elaeagnaceae Juss.

Elaeagnus oxycarpa Schlecht. Tree. It is sporadic species in the Central Kazakhstan. It grows along the valleys of rivers, rivers and temporary watercourses, in intermountain depressions, on saline and clay soils. It is widely used in landscaping and creating protective strips.

Family Fabaceae Lindl.

Melilotus dentatus Waldst. et Kit. Perennial plant. It is distributed throughout the Central Kazakhstan. It grows in saline meadows, along river valleys, along roads, often in crops.

Melilotus suaveolens Ledeb. Perennial plant. It grows throughout the territory of the Central Kazakhstan, but it is rarer. It is found along river valleys, on sandy deposits.

Ononis arvensis L. Perennial plant; rare in the Central Kazakhstan. It grows in meadows, along rivers and lakes, on the edges of small-leaved forests.

Family Gentianaceae Juss.

Gentiana cruciata L. Perennial plant. It occurs sporadically throughout the Central Kazakhstan, mainly in the northern, central and eastern regions. It grows in meadow communities, less often in shrub thickets.

Family Geraniaceae Juss.

Geranium collinum Steph. & Willd. Perennial plant. It grows throughout the Central Kazakhstan. It is found in meadows, in inter-hill depressions, in well-moistened logs.

Geranium transversale (Kar. et Kir.) Vved. Perennial plant. It grows in dry and deserted steppes, in shrub thickets, sometimes on the crushed slopes of hills. It is found mainly in the southern and southwestern parts of the Central Kazakhstan.

Geranium pratense L. Perennial plant. It grows on more humidified habitats in comparison in the previous species, in meadows, on forest edges, in interstitial depressions. The main places of growth are confined to the low mountains of the Central Kazakhstan.

Geranium sibiricum L. Perennial plant. It is ecologically similar to previous species. Populations are found in the Karkaraly Mountains.

Family Glossulariaceae DC.

Ribes nigrum L. Bush. It grows under the canopy of forests, in logs, at the edges in wet meadows. It is found sporadically throughout the Central Kazakhstan.

Family Hypericaceae Juss.

Hypericum scabrum L. Perennial plant. It grows along flat areas in about low mountains, along gentle slopes of hills and outcrops of granites. It is found in the Ortau, Ulytau and Kyzyltau Mountains.

Hypericum hirsutum L. Perennial plant. It grows on the slopes of rocky low mountains, in thickets of shrubs. It is rare in the Ulytau Mountains.

Hypericum perforatum L. Perennial plant. It is found practical throughout the territory of the Central Kazakhstan under the canopy of pine and deciduous forests, along the grassy slopes of hills, in shrub thickets, on the edges of forests. It is plentiful.

Family Iridaceae Juss.

Iris halophila Pall. Perennial plant. It is a widespread species in the Central Kazakhstan, especially in low mountains. It grows in salted meadows, in thickets of shiny chia, along the banks of rivers.

Iris haematophylla Fisch. ex Link. Perennial plant. It grows in meadows, less often on saline soils. It is found in the eastern part of the Central Kazakhstan.

Iris scariosa Willd. ex Link. Perennial plant. It grows quite widely in the strip of dry steppes and deserts of the Central Kazakhstan on crushed rainfall, rocky outcrops.

Iris songarica Schrenk. Perennial plant. It is found along river valleys, on clay soils, in logs and interstitial depressions. It is found in the valley of the river Sarysu.

Iris tenuifolia Pall. Perennial plant. It grows on sandy and crushed soils. It is found in the Betpakdala upland.

Family Lamiaceae Lindl.

Dracocephalum nutans L. Многолетник, петрофит. Встречается по всему Центральному Казахстану в степной части, по выходам гранитных скал, в низкогорьях, в сосновых и смешанных лесах. Обилен в горах Каркаралы, Кент, Ку, Бугулы, Улутау.

Dracocephalum peregrinum L. Perennial plant. It grows on the territory of the Karkaralinsky district along the slopes of hills, as part of steppe and steppe meadow communities. It is rare species.

Dragocephalum ruyschiana L. Perennial plant. It is found in the eastern part of the Central Kazakhstan, on the territory of the Karkarlinsky and Bukhar-Zhyrau districts. It grows in steppe communities, in cracks of rocks, along rocky showers.

Dragocephalum thymiformis L. Perennial plant. It is widely distributed in the Central Kazakhstan, growing in steppe, meadow and bush communities.

Eremostachys molucelloides Bunge. Perennial. It is rare. It is found in the southern part of the Central Kazakhstan on rock outcrops.

Galeopsis bifida Boenn. Annual weed species living along the roads, in places of grazing. It is rare.

Galeopsis ladanum L. Annual weed species living along the roads, in places of grazing, near settlements. It is rare.

Glechoma hederacea L. Liana. It is found only in the Ulutau Mountains, along the northern slopes of the hills, on rocky and crushed rainfall, under the canopy of deciduous forests. It is rare.

Hyssopus ambiguus (Trautv.) Iljin. Petrophyte, semi-shrub. It is rare; found in the Karkaraly, Kent, Bektauata Mountains on the slopes of hills, crushed and rocky showers, along the outcrops of granites.

Hyssopus macranthus Boriss. Petrophyte, semi-shrub. It is widely distributed in the Central Kazakhstan. It lives on the slopes of hills, in petrophytic communities, at the outcrops of granites. Endem of Kazakhstan.

Lagochillus acutilobus (Ledeb.) Fisch. et Mey. Perennial plant. It is a rare species; found along the southern border of the Central Kazakhstan in the Betpakdala upland. Endem of Kazakhstan.

Lagochillus pungens Schrenk. Perennial plant. It is a rare species found in the western parts of the Central Kazakhstan. It lives on rocky and crushed slopes of hills, in dry steppe communities.

Lallemantia royleana Benth. Annual plant. It grows in the southern and southwestern part of the Central Kazakhstan in dry steppes, desert, along a plume of low mountains, often as a weed species. It is rare.

Lamium amplexicaule L. Annual or biennial plant. It is found in the Ulytau Mountains and in the surrounding territories. It grows on the slopes of steppe low mountains, on crushed rainfall, in meadows, on the edges of deciduous forests. Like a weed plant it can grow along roads, near housing. It is rare.

Leonurus glaucescens Bunge. Herbaceous perennial plant. It grows in the western, northern and northern parts of the Central Kazakhstan in river floodplains, along roads, in shrubby thickets, in intersoop depressions, under the canopy of deciduous forests. It is plentiful.

Lophanthus schrenkii Levin. Petrophytes, perennial plant. It is rare. Places of growth in the Karkaraly, Kent, Bektauata, Kyzylrai Mountains were noted. It grows along shaded slopes, among the cracks of rocks, on granites.

Lycopus exaltatus L. Herbaceous perennial. It is abundant, widely distributed in the Central Kazakhstan. It is found on wet forests, in live thickets, on the shallows of rivers, along rivers and streams.

Lycopus europaeus L. Herbaceous perennial plant. It is rare. It grows across all territory of the Central Kazakhstan, along small rivers, to coast of reservoirs, reservoirs, under a canopy of the boggy woods, in the willow thickets.

Mentha arvensis L. Rhizomatous perennial plant. It is abundant, found throughout the territory of the Central Kazakhstan. It grows in wet meadows, in shrub thickets, less often under the canopy of deciduous forests.

Mentha longifolia L. Rhizomatous herbaceous perennial plant. It is rare. It is found under the canopy of forests, along streams and temporary watercourses. It grows in the northern part of the Central Kazakhstan.

Mentha micrantha L. Rhizomatous perennial plant. It is rare. It grows in meadow thickets, in thickets of shrubs, on the shallows of rivers, along the banks of reservoirs, forms joint thickets with zyuznik. Found in the Ortau, Bektauata, Ulutau Mountains.

Mentha aquatica L. Perennial plant. It is rare, arrogant. It is found along the banks of reservoirs, in humid places. Range is specifying.

Nepeta cataria L. Perennial plant, petrophyte, a rare species. It grows in the Ulutau and Ortau Mountains, Spassky hills. It grows along the slopes of rocky hills, along the cracks of rocks.

Nepeta micrantha Bunge. Herbaceous perennial plant; a very rare. It is found only in the Ulutau Mountains. It grows along the slopes of hills, in intersopic logs, in shrub thickets.

Nepeta pannonica L. It grows sporadically in the northern and western parts of the Central Kazakhstan. It is found in meadow steppes, in thickets of shrubs, edges of mixed and deciduous forests.

Nepeta ucranica L. Herbaceous perennial plant. It is widely distributed in the Central Kazakhstan. It grows in dry and meadow steppes, along the slopes of hills and intersoop depressions, in shrub thickets. It is abundant; forms industrially significant thickets.

Phlomis agraria Bunge. Herbaceous perennial plant. It is abundant, found throughout the Central Kazakhstan. It grows on dry steppes, in steppe meadows, in thickets of shrubs and in logs.

Phlomis puberula Kryl. et Serg. Herbaceous perennial plant. It is found scattered in the zone of dry feathered steppes, less often in shrub thickets.

Phlomis pungens L. Herbaceous perennial plant. It is plentiful. It is found throughout the territory of the Central Kazakhstan, in steppe, meadow, bush communities, on the edges of forests.

Phlomoides tuberosa L. Perennial plant. It is found throughout the Central Kazakhstan. It grows in feathered and variegated-feathered steppes, in steeped meadows, in logs, thickets of shrubs.

Prunella vulgaris L. Rhizomatous perennial plant. It is rare, the only place of growth is noted - the Ulutau Mountains. It grows in meadow thickets, along the banks of streams.

Salvia deserta deserta Schang. It is found scattered throughout the territory of the Central Kazakhstan. It grows in steppe communities, in steppe meadows, at the edges of forests.

Salvia stepposa Schost. Herbaceous perennial plant. It is widely distributed in the Central Kazakhstan, forms commercial thickets. It is found in steppe communities, in meadow thickets.

Schizonepeta annua (Pall.) Schischk. Annual plant. It is found along roads, in places of grazing, often as a weed species.

Scutellaria dubia Tab. et Schir. Herbaceous perennial plant. It is widely found in the Central Kazakhstan. It grows in humid places, along river banks, in swamps, in mixed and deciduous forests.

Scutellaria galericata L. Herbaceous perennial plant. It grows widely in wet meadows, in swamps, along the banks of streams, under the canopy of aspen-birch and black-alder forests. It is plentiful.

Scutellaria grandiflora Sims. Herbaceous perennial plant. It is rare. It is found in the northern and eastern parts of the Central Kazakhstan, grows under the canopy of mixed and birch-aspen forests.

Scutellaria scordiifolia Fisch.ex Schrank. Herbaceous perennial plant. It is rare. It grows only in the eastern part of the Central Kazakhstan, in steppe and real meadows.

Scutellaria supina L. Herbaceous perennial plant. It is widely distributed in the Central Kazakhstan. It grows in petrophytic communities, dry steppes.

Siderites montana L. Herbaceous perennial plant. It is found scattered in the western part of Central Kazakhstan. It grows on crushed soils, along the slopes of hills, in steppe communities.

Stachys palustris L. Herbaceous perennial plant. It is rare. It grows in meadows and in small-leaved forests.

Thymus marschallianus Willd. Herbaceous perennial plant. It is widely distributed in the Central Kazakhstan, forms commercial thickets. It grows in steppe and meadow communities, along the slopes of gentle hills, in intersoop depressions, in shrub thickets.

Thymus stepposus Klok.et Schost. Herbaceous perennial plant, petrophyte. It is rare. It is found scattered in the western and southern parts of the Central Kazakhstan. It grows in petrophytic versions of steppes, along the slopes of hills, in the cracks of rocks.

Thymus lavrenkoanus Klok. Semi-low shrub. It grows along steppe slopes in thickets of grains or shrubs. It is identified populations in surrounding of Karaganda city (Spassky hills) and on the territory of the Bukhar-Zhyrau district (Belagash mountain forest). Endem of Kazakhstan.

Thymus minussinesis Serg. Semi-low shrub. It grows in dry steppe communities, less often along the slopes of hills and at the outcrops of granites. It is found in the Karkaraly and Bektauata Mountains. It is rare.

Thymus crebrifolius Klok. Semi-low shrub, petrophyte. It is found in the Ulytau Mountains along the slopes of hills, in the cracks of rocks. Endem of Kazakhstan.

Thymus asiaticus Serg. Semi-low shrub, petrophyte. It is rare in the southern part of the Central Kazakhstan. It grows in dry steppe communities.

Thymus rasitatus Klok. Semi-low shrub, petrophyte. It grows along the slopes of hills, in the cracks of granite rocks, along rocky showers. It is found in the Karkaraly, Kent, Ku, Temirshi, Bektauata, Ortau, Chyngistau Mountains of. Endem of Kazakhstan.

Thymus guberbinensis Iljin. Semi-low shrub, petrophyte. It grows on rocky slopes, in cracks of rocks. The only habitat in the Bektauata Mountains was noted. It is rare.

Thymus roseus Schipz. Semi-low shrub, petrophyte. It grows on rocky peaks and slopes of low mountains, on granite showers. It is found scattered in the northern and central part of the Central Kazakhstan. It is rare.

Thymus kirgisorum Dub. Semi-low shrub. It grows in the steppes, on sandy loam. It is found in the western part of the Central Kazakhstan. It is rare.

Thymus kasakstanicus Klok. Semi-low shrub. It lives on the outcrops of crystalline shales, dry steppe valleys. There is a growth in the mountains of Ulytau. Endem of Kazakhstan.

Thymus eremita Klok. Semi-low shrub, petrophyte. It is grow in the Shetsky and Aktogai districts of the Karaganda region. It grows on the slopes of granite hills, in low mountains, on crushed showers, in the cracks of rocks. Endem of Kazakhstan.

Ziziphora bungeana Juz. Petrophyte, semi-shrub. It is found scattered throughout the territory of the Central Kazakhstan, mainly in the southern part. It grows on the slopes of low mountains, in shrub thickets, along temporary watercourses, along steppe thickets.

Ziziphora clinopodioides Lam. Petrophyte, semi-shrub. It is a species widespread in the Central Kazakhstan; forms commercial thickets. It is found in dry steppes, in steppe meadows, in shrub thickets, along crushed and rocky slopes of hills, along the outcrops of granites, in cracks of rocks.

Family Liliaceae Juss.

Asparagus officinalis L. Perennial plant. It is found throughout the Central Kazakhstan. It grows in steppe communities, along the slopes of hills, in intersoop depressions, in shrub thickets, along springs, on the edges of small-leaved forests.

Family Malvaceae Juss.

Althaea officinalis L. Perennial plant; it is a rare species for the Central Kazakhstan. It is found in the northern and central regions. It grows in meadow communities, along rivers, in meadows.

Lavatera thuringiaca L. Perennial plant. It is found in the northern and central regions. It grows in meadow communities, along rivers, in meadows.

Family Papaveraceae Juss.

Chelidonium majus L. Perennial plant. It is found scattered in the northern part of the Central Kazakhstan. It is noted in low mountains (Ortau, Genghistau, Karkaraly, Kent, Temirshi Mountains).

Family Pinaceae Lindl.

Pinus sylvestris L. Tree. It grows in the eastern part of the Central Kazakhstan on granite rocks of low mountains, on crushed slopes, less often on sandy massifs.

Family Poaceae Barnhart.

Elytrigia repens (L.) Nevski. Perennial plant; weed species. It grows in fields, in settlements, in places of grazing. It is found throughout the Central Kazakhstan.

Family Polygalaceae R.Br.

Polygala hybrida Schkuhr. Perennial plant. It is found sporadically throughout the territory of the Central Kazakhstan. It grows in meadows, grass-feathered steppes, less often in pine forests.

Family Polygonaceae Juss.

Polygonum thymifolium Jaub.et Spach. Perennial plant. It is found in raw places, along river valleys, in meadows. It is rare. It grows scattered in the northern and eastern parts of the Central Kazakhstan.

Polygonum junceum Ledeb. Perennial plant. It is found sporadically throughout the territory of the Central Kazakhstan. It grows in meadows, on moistened saline soils, in declines, along the valleys of steppe rivers.

Rheum nanum Sievers. Ephemeroïd. It grows in the Betpakdala upland and the Northern Balkhash. It is found on plains, on clay, crushed soils, less often in shrub thickets. It is plentiful.

Family Ranunculaceae Juss.

Clematis orientalis L. Perennial, liana. It grows under the canopy of small-leaved forests and in shrub thickets. Found in the Karkaraly and Kent Mountains.

Pulsatilla multifida (Pritz.) Juz. Perennial plant, ephemeroïd. It is found throughout the Central Kazakhstan, mainly in the northern and eastern regions. It grows on meadow thickets, grassy-cereal communities, along the slopes of hills, in shrub thickets.

Pulsatilla patens (L.) Mill. Perennial plant, ephemeroïd. It has a similar ecology to the previous species.

Ranunculus sceleratus L. Perennial plant. It is found sporadically throughout the territory of the Central Kazakhstan. It grows in moist meadows, along natural thickets, in swampy places.

Thalictrum foetidum L. Perennial plant. It grows in the northern part of the Central Kazakhstan, in the southern - marked in the Ortau Mountains. It grows along the slopes of hills, along granites, in cracks of rocks, in meadow communities. It is not abundant.

Family Rosaceae Juss.

Agrimonia asiatica Juz. Perennial plant. It grows scattered throughout the northern and eastern parts of the Central Kazakhstan. It grows in meadows, on edges in teal forests. It is rare.

Amygdalus nana L. Bush. It is noted in the northern, eastern and central parts of the Central Kazakhstan. It grows on river beds, in shrub thickets.

Cerasus fruticosa (Pall.) G. Woron. Bush. It is rare. It is noted as an arrogant plant in the northern part of the Central Kazakhstan, where it is possible to settle in birch peaks, at the edges of forests, on rocks.

Crataegus sanguinea Pall. Tree, shrub. It grows in the mountains and forests. It is found on the slopes of low mountains, under the canopy of small-leaved forests.

Filipendula ulmaria (L.) Maxim. Perennial plant. It is widely distributed in the steppe and low mountain parts of the Central Kazakhstan. It grows in humid places - meadows, interstitial depressions, shrub thickets, forest edges, river valleys and springs.

Geum rivale L. Perennial plant. It is rare in the Karkaraky and Kent Mountains. It grows on meadow thickets, on edges and under the canopy of small-leaved forests.

Geum urbanicum L. Perennial plant. It has a similar ecology to the previous species, but is more widespread, habitation reaches the Mountains Ulytau.

Hulthemia berberifolia (Michx.ex Juss.) Bornm. Semi-low shrub. It is widely distributed throughout the Central Kazakhstan. It lives in dry steppes, deserts, along the slopes of hills and low mountains; sometimes along roads and settlements grows as a weed species.

Padus racemosa Mill. Tree. It is found in all low mountains of the Central Kazakhstan under the canopy of small-leaved forests.

Rosa canina L. Bush. It is widely found in the Central Kazakhstan. It grows in logs, interstitial depressions, along the slopes of hills.

Rosa laxa Retz. Bush. It is found throughout the Central Kazakhstan. It grows in river valleys, under the canopy of island forests, in interhill depressions.

Rubus idaeus L. Bush. It is found in low mountains and island forests of the Central Kazakhstan. It grows on the slopes of hills, under rocks, in logs, on the edges of forests, in shrub thickets.

Rubus saxatilis L. Perennial plant. It is widespread species. It grows under the canopy of pine and small-leaved forests, in island forests. It is plentiful.

Spiraea crenata L. Bush. It lives throughout the Central Kazakhstan. It grows along rocks, slopes of low mountains.

Spiraea hypericifolia L. Bush. It is very widespread species. It grows in steppe communities, in logs, on the slopes of hills, on granite rocks, on the edges of forests, goes into deserts.

Spiraea trilobata L. Bush. It is a rare species. It is found in the mountains of Ku, Karkaraly, Kent and Ulytau. It grows on the slopes of hills, in the cracks of granites.

Family Rubiaceae Juss.

Gallium aparine L. Редок. Perennial plant. It occurs sporadically in the Central Kazakhstan, settling in meadows and shrubs.

Galium boreale L. Perennial. It grows throughout the Central Kazakhstan in meadows, on the edges of forests, in shrub thickets.

Galium spurium L. Perennial plant. It is found in a strip of deserted steppes. It grows in thickets of shrubs, in depressions, in river valleys.

Galium uliginosum L. Perennial plant. It is found sporadic throughout the Central Kazakhstan. It grows in swampy places, along rivers and springs, under the canopy of deciduous forests.

Galium verum L. Perennial plant. It is found sporadic throughout the Central Kazakhstan. It grows in swampy places, along rivers and springs, under the canopy of deciduous forests. It is a widespread species.

Family Rutaceae Juss.

Dictamnus angustifolius G. Don fil.ex Sweet. Perennial. It is noted in the Karkaraly, Ulytau Mountains. It grows in shrubby and meadow thickets.

Family Salicaceae Mirb.

Populus canescens (Ait.) Smith. Tree. It is widely cultivated species in planting, forest protection strips, along roads, settlements.

Populus nigra L. Tree. It grows in floodplains of rivers, along springs. Natural thickets in the Chyngistau Mountains are noted. It is widely cultivated in the Central Kazakhstan.

Populus tremula L. Tree. It grows throughout the Central Kazakhstan. It is found in river valleys, temporary watercourses, along springs, in interstitial logs, along the slopes of hills and low mountains.

Salix bebbiana Sarg. Bush. It is widely found in the Central Kazakhstan. It grows in swampy places, along rivers and rivers, near springs, in forests and along the slopes of low mountains.

Salix caprea L. Bush. It is a rare species, grows in river valleys and under the canopy of small-leaved forests. It is found in the Karkaraly district of the Karaganda region.

Salix caspica Pall. Bush. It is found in most parts of the Central Kazakhstan, but mainly in the southern regions (the valleys of the Sarysu, Moyynty, Tokrau, Talap and others). It prefers to settle on sandy or finely pebble shallows of rivers, in dried channels.

Salix cinerea L. Bush. It is found throughout the Central Kazakhstan. It grows along rivers, streams, springs, less often under the canopy of deciduous forests.

Salix rosmarinifolia L. Bush. It grows scattered throughout the territory of the Central Kazakhstan. It has a similar ecology to the previous species.

Salix tenujulis Ledeb. Bush. It settles in the southern regions of the Central Kazakhstan, like the Chyngistau and Ortau Mountains of. It grows along the banks of springs, in logs, less often along the slopes of granite low mountains.

Salix viminalis L. Bush. It is found throughout the Central Kazakhstan. It grows on pebble and sandy deposits of rivers.

Family Solanaceae Juss.

Datura stramonium L. Annual plant. It is weed and, rare. It is found in crops, along roads, in settlements. It is often cultivated as an ornamental plant.

Family Valerianaceae Batsch.

Patrinia intermedia (Hornem.) Roem.et Schult. Perennial plant, petrophyte. It is widely distributed in the Central Kazakhstan, abundant in the northern, eastern and central parts. It grows on rocks, on low mountains, on the outcrops of granites, on crushed rainfall.

3.3 Study of raw material resources of some essential oil plants of the Karaganda region

Essential oil plant resources were evaluated throughout the region, taking into account different types of communities [87-91].

Ferula ferulaeoides (Fig. 10). The main communities in the Central Kazakhstan are concentrated in the southern and southwestern part (the Betpakdala desert and the northern Balkhash).



Figure 10. Flowering samples of *Ferula ferulaeoides* in the Betpakdala upland

We conducted surveys of the southwestern part of the Betpakdala upland. Extensive thickets of *Ferula ferulaeoides* have been identified, forming the

following populations: 1) *Herba xerophytica* - *Artemisia terrae-albae* + *Artemisia pauciflora*; 2) *Ferula ferulaeoides* - *Artemisia terrae-albae*; and 3) *Artemisia terrae-albae* – *Herba varia* (Tab. 6).

Table 6. General characteristics of communities with participation *Ferula ferulaeoides* in the Betpakdala upland

Name of community	Dominant	Co-dominant	General projective cover, %
<i>Herba xerophytica</i> - <i>Artemisia terrae-albae</i> + <i>Artemisia pauciflora</i>	<i>Rheum tataricum</i>	<i>Artemisia terrae-albae</i>	29-31
<i>Ferula ferulaeoides</i> - <i>Artemisia terrae-albae</i>	<i>Ferula ferulaeoides</i>	<i>Artemisia terrae-albae</i> , <i>Artemisia pauciflora</i>	40-44
<i>Artemisia terrae-albae</i> – <i>Herba varia</i>	<i>Artemisia terrae-albae</i>	<i>Descurainia sophia</i>	35-40

The occurrence of ferula plants is 0.2-0.3 units/m². Yield of raw materials ranges was from 8.0 to 9.9 c/ha. Total community area estimated in 74.5 ha (Tab. 7), exploitation reserve was 62676 kg. The volume of possible collection is calculated at 25071 kg.

Table 7. Plant resources of *Ferula ferulaeoides* in the Betpakdala upland (on air-dried weight)

Name of community	Square, ha	Yield, c/ha	Exploitation reserve of plant raw material, kg	Volume of possible collection, kg
<i>Herba xerophytica</i> - <i>Artemisia terrae-albae</i> + <i>Artemisia pauciflora</i>	34.1	8.2±0.3	27962	11185
<i>Ferula ferulaeoides</i> - <i>Artemisia terrae-albae</i>	12.6	9.9±0.4	12474	4990
<i>Artemisia terrae-albae</i> – <i>Herba varia</i>	27.8	8.0±0.2	22240	8896
Total	74.5		62676	25071

Artemisia terrae-albae (Fig. 11). The growth of this species together with the ferula is noted (Fig. 6). Yield of raw materials ranges was from 11.0 to 16.2 c/ha. Total community area estimated in 74.5 ha (Tab. 8), exploitation reserve was 9327 kg; the volume of possible collection is calculated at 4650 kg.



Figure 11. Thickets of *Artemisia terrae-albae* in the Betpakdala upland

Table 8. Plant resources of *Artemisia terrae-albae* in the Betpakdala upland (on air-dried weight)

Name of community	Square, ha	Yield, c/ha	Exploitation reserve of plant raw material, kg	Volume of possible collection, kg
<i>Herba xerophytica</i> - <i>Artemisia terrae-albae</i> + <i>Artemisia pauciflora</i>	34.1	12.4±0.6	4228	2100
<i>Ferula ferulaeoides</i> - <i>Artemisia terrae-albae</i>	12.6	16.2±0.8	2041	1020
<i>Artemisia terrae-albae</i> – <i>Herba varia</i>	27.8	11.0±0.5	3058	1530
Total	74.5		9327	4650

Ziziphora clinopodioides (Fig. 12). In the Central Kazakhstan, we identified thickets of *Ziziphora clinopodioides* in the Ulytau, Ortau, Karkaraly, Kent Mountains, valley of the river Taldy. This species forms the following types of communities: 1) *Ziziphora clinopodioides* - *Hypericum perforatum* + *Hypericum scabrum* - *Sedum hybridum* in the Ulytau, Kent, Ortau Mountains; 2) *Herba varia* - *Ziziphora clinopodioides* in the valley of river Taldy and Karkaraly Mountains; 3) *Thymus roseus* – *Herba varia* – *Ziziphora clinopodioides* in surrounding of Kent, Kyzyltau and Ortau Mountains (tab. 9)



Figure 12. Internal view of *Ziziphora clinopodioides* at the Ulytau Mountains

Table 9. General characteristics of communities with participation *Ziziphora clinopodioides* in the Karaganda region

Name of community	Dominant	Co-dominant	General projective cover, %
<i>Ziziphora clinopodioides</i> - <i>Hypericum perforatum</i> + <i>Hypericum scabrum</i> - <i>Sedum hybridum</i>	<i>Sedum hybridum</i>	<i>Ziziphora clinopodioides</i> , <i>Hypericum perforatum</i>	25-35
<i>Herba varia</i> - <i>Ziziphora clinopodioides</i>	<i>Ziziphora clinopodioides</i>	<i>Festuca valesiaca</i>	32-45
<i>Thymus roseus</i> – <i>Herba varia</i> – <i>Ziziphora clinopodioides</i>	<i>Ziziphora clinopodioides</i>	<i>Thymus roseus</i> , <i>Artemisia frigida</i>	40-50

Yield of raw material was from 2.7 till 6.1 c/ha; Exploitation reserve of plant raw material was calculated in 21721 kg; volume of possible collection – 8687 kg (Tab. 10).

Table 10. Plant resources of *Ziziphora clinopodioides* in the Karaganda region (on air-dried weight)

Name of community	Square, ha	Yield, c/ha	Exploitation reserve of plant raw material, kg	Volume of possible collection, kg
<i>Ziziphora clinopodioides</i> - <i>Hypericum perforatum</i> + <i>Hypericum scabrum</i> - <i>Sedum hybridum</i>	12.6	5.4±0.5	6804	2720
<i>Herba varia</i> - <i>Ziziphora clinopodioides</i>	21.4	6.1±0.8	13054	5222
<i>Thymus roseus</i> – <i>Herba varia</i> – <i>Ziziphora clinopodioides</i>	6.9	2.7±0.2	1863	745
Total	40.9		21721	8687

Achillea nobilis (Fig. 13). Thickets suitable for the industrial harvesting of raw materials were found on the territory of the Shetsky district, the Karkaraly Mountains, in the Spassky hills.



Figure 13. Internal view of flowering sample of *Achillea nobilis* in the Karkaraly Mountains

In these habitats, *Achillea nobilis* grows in the following communities: 1) *Herba varia - Achillea nobilis + Achillea millefolium*; 2) *Agropyron cristatum + Bromus scoparium - Herba varia - Achillea nobilis + Achillea millefolium*; 3) *Herba varia - Achillea nobilis + Achillea millefolium*; 4) *Achillea nobilis + Achillea millefolium - Agropyron cristatum* (Tab. 11).

Table 11. General characteristics of communities with participation *Achillea nobilis* in the Karaganda region

Name of community	Dominant	Co-dominant	General projective cover, %
<i>Herba varia - Achillea nobilis + Achillea millefolium</i>	<i>Achillea nobilis + Achillea millefolium</i>	<i>Festuca valesiaca</i>	45-65
<i>Agropyron cristatum + Bromus scoparium - Herba varia - Achillea nobilis + Achillea millefolium</i>	<i>Achillea nobilis + Achillea millefolium</i>	<i>Agropyron cristatum + Bromus scoparium</i>	50-60
<i>Herba varia - Achillea nobilis + Achillea millefolium</i>	<i>Achillea millefolium</i>	<i>Achillea nobilis</i>	70-80
<i>Achillea nobilis + Achillea millefolium - Agropyron cristatum</i>	<i>Agropyron cristatum</i>	<i>Achillea nobilis</i>	80-85

The total area of *Achillea nobilis*' communities is determined in 127.6 ha, yield was 0.8-3.3 c/ha, exploitation reserve was 19750 kg, the volume of possible collection per air-dry weight was 9870 kg (Tab. 12).

Table 12. Plant resources of *Achillea nobilis* in the Karaganda region (on air-dried weight)

Name of community	Square, ha	Yield, c/ha	Exploitation reserve, kg	Volume of possible collection, kg
1	2	3	4	5
<i>Herba varia - Achillea nobilis + Achillea millefolium</i>	27.5	3.3±0.5	9080	4540
<i>Agropyron cristatum + Bromus scoparium - Herba varia - Achillea nobilis + Achillea millefolium</i>	20.4	1.4±0.1	2860	1430

1	2	3	4	5
<i>Herba varia - Achillea nobilis + Achillea millefolium</i>	32.0	0.8±0.2	2560	1280
<i>Achillea nobilis + Achillea millefolium - Agropyron cristatum</i>	47.7	1.1±0.2	5250	2620
Total	40.9		21721	8687

Achillea millefolium (Fig. 14) forms joint thickets with *Achillea nobilis* (Tab. 11). Plant resources are determined on the territory of Spassky hills, in the valley of the river Nura, Sherubay-Nura.



Figure 14. Internal view of flowering sample of *Achillea millefolium* in the Karkaraly Mountains

The area of communities was 127.6 hectares. Yield is estimated at 0.6-2.0 c/ha, exploitation reserve was 17030 kg (Tab. 13). The volume of possible collection of raw material is calculated at 8515 kg.

Table 13. Plant resources of *Achillea millefolium* in the Karaganda region (on air-dried weight)

Name of community	Square, ha	Yield, c/ha	Explotation reserve, kg	Volume of possible collection, kg
<i>Herba varia - Achillea nobilis + Achillea millefolium</i>	27.5	2.0±0.4	5500	2750
<i>Agropyron cristatum + Bromus scoparium - Herba varia - Achillea nobilis + Achillea millefolium</i>	20.4	1.2±0.4	2450	1225
<i>Herba varia - Achillea nobilis + Achillea millefolium</i>	32.0	0.6±0.1	1920	960
<i>Achillea nobilis + Achillea millefolium - Agropyron cristatum</i>	47.7	1.5±0.6	7160	3580
Total	127.6		17030	8515

Artemisia frigida (Fig. 15). The habitat of the species in the Central Kazakhstan was assessed in the Karkaraly Mountains, on the territory of which the plant is confined to cracks of granite outcrops, slopes of hills, crushed showers, often with typical petrophytes such, as *Juniperus sabina*, *Patrinia intermedia*, *Hyssopus macranthus*.



Figure 15. Internal view of *Artemisia frigid* in the Karkaraly Mountains

Species grows in the Karkaraly Mountains in the following communities: 1) *Artemisia glabella* + *Artemisia frigida* – *Centaurea sibirica* + *Hyssopus macranthus* + *Patrinia intermedia*; 2) *Artemisia glabella* + *Artemisia frigida* – *Ziziphora clinopodioides*; 3) *Artemisia glabella* - *Patrinia intermedia* – *Juniperus sabina* (Tab. 14).

Table 15. General characteristics of communities with participation *Artemisia frigida* in the Karkaraly Mountains

Name of community	Dominant	Co-dominant	General projective cover, %
<i>Artemisia glabella</i> + <i>Artemisia frigida</i> – <i>Centaurea sibirica</i> + <i>Hyssopus macranthus</i> + <i>Patrinia intermedia</i>	<i>Artemisia glabella</i>	<i>Artemisia frigida</i> , <i>Ziziphora clinopodioides</i>	23-25
<i>Artemisia glabella</i> + <i>Artemisia frigida</i> – <i>Ziziphora clinopodioides</i>	<i>Artemisia frigida</i>	<i>Ziziphora clinopodioides</i>	30-35
<i>Artemisia glabella</i> - <i>Patrinia intermedia</i> – <i>Juniperus sabina</i>	<i>Artemisia glabella</i>	<i>Patrinia intermedia</i> – <i>Juniperus sabina</i>	17-18

Communities occupied an area of 21.1 ha with a yield of 3.5-4.1 c/ha. The exploitation reserve of raw materials was 7980 kg, the volume of possible collection was 3990 (Tab. 16).

Table 16. Plant resources of *Artemisia frigida* in the Karaganda region

Name of community	Square, ha	Yield, c/ha	Exploitation reserve, kg	Volume of possible collection, kg
<i>Artemisia glabella</i> + <i>Artemisia frigida</i> – <i>Centaurea sibirica</i> + <i>Hyssopus macranthus</i> + <i>Patrinia intermedia</i>	10.5	3.5±0.5	3680	1840
<i>Artemisia glabella</i> + <i>Artemisia frigida</i> – <i>Ziziphora clinopodioides</i>	5.7	4.1±0.5	2340	1170
<i>Artemisia glabella</i> - <i>Patrinia intermedia</i> – <i>Juniperus sabina</i>	4.9	4.0±0.5	1960	980
Total	21.1		7980	3990

Thymus marschallianus (Fig. 16). In the Central Kazakhstan species forms the following types of communities: 1) *Thymus marschallianus* – *Filipendula ulmaria* - *Herba varia* in Spassky hills; 2) *Thymus marschallianus* – *Herba varia* - *Spiraea hypericifolia* in the Karkaraly Mountains; 3) *Thymus marschallianus* – *Herba varia* – *Festuca valesiaca* + *Stipa capillata* in the Ulytau Mountains; 4) *Herba varia* – *Thymus marschallianus* in Karkaraly Mountains (Tab. 17).



Figure 16. Internal view of *Thymus marschallianus* in Spassky hills

Table 17. General characteristics of communities with participation *Thymus marschallianus* in the Karaganda region

Name of community	Dominant	Co-dominant	General projective cover, %
<i>Thymus marschallianus</i> – <i>Filipendula ulmaria</i> - <i>Herba varia</i>	<i>Thymus marschallianus</i>	<i>Filipendula ulmaria</i> , <i>Galium verum</i>	95-100
<i>Thymus marschallianus</i> – <i>Herba varia</i> - <i>Spiraea hypericifolia</i>	<i>Thymus marschallianus</i>	<i>Spiraea hypericifolia</i> , <i>Rosa laxa</i>	85-90
<i>Thymus marschallianus</i> – <i>Herba varia</i> – <i>Festuca valesiaca</i> + <i>Stipa capillata</i>	<i>Thymus marschallianus</i>	<i>Festuca valesiaca</i> , <i>Stipa capillata</i>	80-85
<i>Herba varia</i> – <i>Thymus marschallianus</i>	<i>Thymus marschallianus</i>	<i>Artemisia pontica</i> , <i>Arenaria asiatica</i>	100

The communities area was 31.6 ha, the average yield of above-ground organs was 1.0-3.2 c/ha (Tab. 18). The production reserve of raw materials amounted to 7000 kg, the volume of possible collection was 3520 kg.

Table 18. Plant resources of *Thymus marschallianus* in the Karaganda region

Name of community	Square, ha	Yield, c/ha	Explotation reserve, kg	Volume of possible collection, kg
<i>Thymus marschallianus</i> – <i>Filipendula ulmaria</i> - <i>Herba varia</i>	5.2	2.6±0.6	1350	680
<i>Thymus marschallianus</i> – <i>Herba varia</i> - <i>Spiraea hypericifolia</i>	11.4	3.2±0.3	3650	1830
<i>Thymus marschallianus</i> – <i>Herba varia</i> – <i>Festuca valesiaca</i> + <i>Stipa capillata</i>	8.3	1.6±0.2	1330	670
<i>Herba varia</i> – <i>Thymus marschallianus</i>	6.7	1.0±0.1	670	340
Total	31.6		7000	3520

Thymus crebrifolius (Fig. 17) in the Ulytau Mountain grows in two types of communities: 1) *Thymus crebrifolius*; 2) *Thymus crebrifolius* - *Spiraea hypericifolia* (Tab. 19).



Figure 17. Samples of *Thymus crebrifolius* in the Ulytau Mountains

Table 19. General characteristics of communities with participation *Thymus crebtifolius* in the Ulytau Mountains

Name of community	Dominant	Co-dominant	General projective cover, %
<i>Thymus crebtifolius</i>	<i>Thymus crebtifolius</i>	-	20-30
<i>Thymus crebrifolius</i> - <i>Spiraea hypericifolia</i>	<i>Spiraea hypericifolia</i>	<i>Thymus crebrifolius</i>	30-35

The occurrence of plants ranged from 0.5 to 3.4 pieces per 1 m², the yield of above-ground organs ranged from 62.0 to 164.8 kg/ha (Tab. 20). The total area of thickets was estimated at 22.8 hectares, exploitation reserve was 2770 kg; the volume of possible annual collection of raw materials was 1692 kg.

Table 20. Plant resources of *Thymus crebrifolius* in the Ulytau Mountains

Name of community	Square, ha	Yield, c/ha	Exploitation reserve, kg	Volume of possible collection, kg
<i>Thymus crebtifolius</i>	9.6	62.0±4.0	595	387
<i>Thymus crebrifolius</i> - <i>Spiraea hypericifolia</i>	13.2	164.8±8.0	2175	1305
Total	22.8		2770	1692

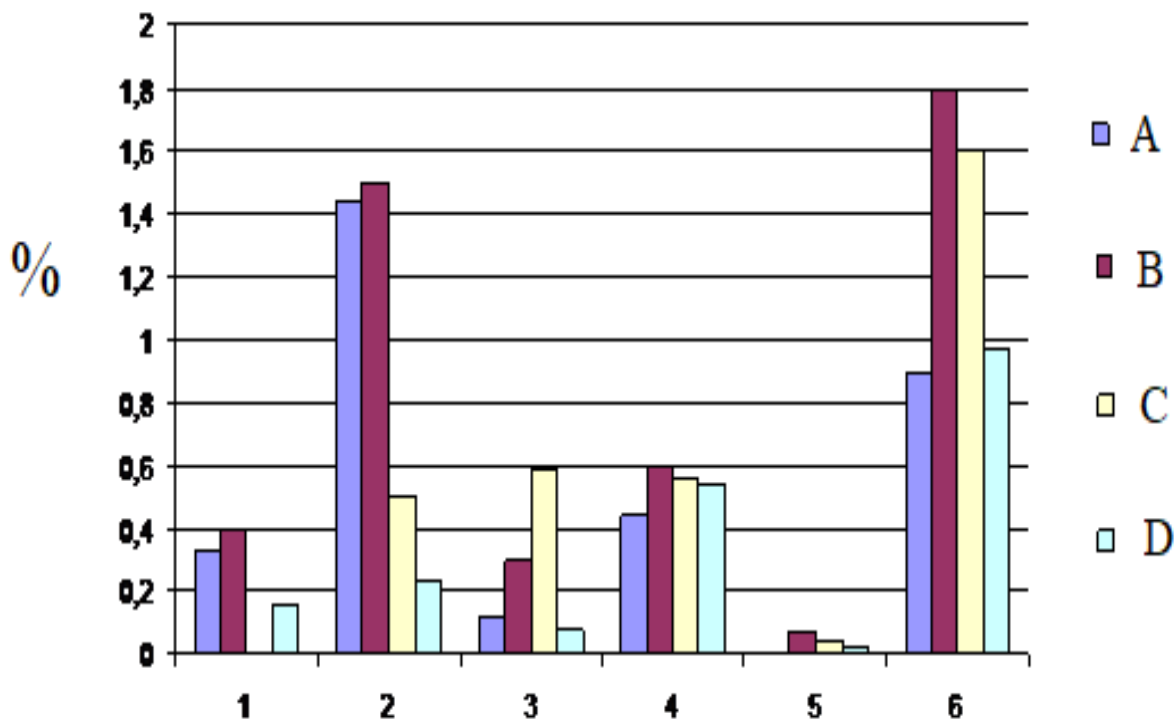
Thus, on the territory of the Karaganda region, significant raw materials have been identified for several species of essential oil plants. There is potential for further study and exploration of resources.

3.4 Study of dynamics of quantitative accumulation of essential oils in some species

In 2009-2019 we collected plant raw materials of various species of essential oil plants by vegetation phases and growth points [92-104] to assess the quantitative accumulation of essential oil (Appendix C).

Analysis of quantitative accumulation of essential oil in above-ground organs showed that the largest accumulation was noted in species of family *Apiaceae* (0.02-2.50%), *Cupressaceae* (0.27-0.34%), *Asteraceae* (0.01-0.78%), *Lamiaceae* (0.02-1.44%). The maximum amount of essential oil accumulates in species such as *Chaerophyllum prescottii* (1.22 %), *Cnidium dubium* (1.22 %), *Ferula soongorica* (2.50 %), *Achillea filipendulina* (1.88 %), *Artemisia dracuncululus* (1.43 %), *Artemisia semiarida* (1.80 %), *Salvia aethopsis* (1.15 %), *Thymus marschallianus* (1.44 %).

Dynamics of essential oil accumulation in above-ground organs by vegetation phases is determined for a number of objects (Fig. 18).



1 – *Ajania fruticulosa*, 2 – *Thymus marschallianus*, 3 – *Achillea nobilis*, 4 – *Ziziphora clinopodioides*, 5 – *Artemisia vulgaris*, 6 – *Artemisia semiarida*;
 phases of vegetation: A – beginning of growing, B – blossoming, C – flowering, D – fruitening

Figure 18. Dynamics of essential oil quantity content depending on vegetation phase

The obtained data show that by the phases of vegetation there is an increase in the quantitative accumulation of essential oil from the beginning of vegetation (growing) to blossoming, less often – to flowering. After that there is a gradual decrease in the accumulation of essential oil to the fruiting phase. Thus, the optimal phase of collecting raw materials of essential oil plants is the blossoming - the beginning of flowering.

The accumulation of essential oil by individual organs of *Ajania fruticulosa*, *Ziziphora clinopodioides* and *Ferula soongorica* was investigated (Tab.21).

Thus, it was revealed that the largest content of essential oil accumulates in inflorescences and leaves of plants, the minimum - in stems. When harvesting essential oils, to optimize processing conditions, it is advisable to use individual plant organs - leaves and inflorescences.

Table 21. Quantitative accumulation of essential oils in separated organs of plants (on air-dried weight)

Species	Phase of vegetation	Organ	Accumulation os essential oil, %
<i>Ajanis fruticulosa</i>	Flowering	Herb	0.42
		Leaves	0.59
		Stems	0.15
		Inflorescences	1.37
	Fruiting	Herb	0.19
<i>Ziziphora clinopodioides</i>	Flowering	Herb	0.56
		Leaves	0.60
		Stems	0.06
		Inflorescences	0.64
	Fruiting	Herb	0.41
<i>Ferula soongorica</i>	Flowering	Herb	2.50
		Leaves	2.56
		Stems	0.54
		Inflorescences	2.74
	Fruiting	Seeds	3.15

We conducted an analysis of the accumulation of essential oil in the raw materials of *Artemisia sieversiana*, depending on the place of collection (Tab. 22).

Table 22. Accumulation of essential oil in raw material of *Artemisia sieversiana* by different places of collection (the Karaganda region, phase flowering)

Place of collection of raw material	Accumulation os essential oil, %
Surrounding of Zhezkazgan city	0.22
The Northern Balkhash	0.23
Spassky hills	0.08
Surrounding of Aksy settlemenet	0.11
Karkaraly Mountains	0.05
Valley of Shiderty river	0.03
Valley of Nura river	0.07
Surrounding of Karaganda city	0.10

It was revealed that the species accumulates different volumes of essential oil at different collection points. So, there is a positive dynamics from north to south and from east to west.

Obtained data can be used to organize preparation of raw material of essential-oil plants.

4 ASSESSMENT OF INTRODUCTION INTO CULTURE ESSENTIAL OIL PLANTS IN THE CONDITIONS OF THE CENTRAL KAZAKHSTAN

Introduction of medicinal and essential-oil plants into the culture is important task for further industrial cultivation and production of plant raw materials [105-107].

Over the past 40 years, the production of essential oil has increased from 50 to 250 thousand tons per year. At the same time, Kazakhstan practically does not cultivate essential oil raw materials.

Introduction of essential-oilseeds allows maintaining a common gene pool of crops, to expand the existing range, to preserve biodiversity, to develop technologies for industrial production of required volumes of plant raw materials [108, 109].

To understand which crops can be grown in the regions, it is necessary to conduct an introductory test, to evaluate the success of their introduction [108-111], to develop agrotechnical conditions for their cultivation.

4.1 Evaluation of the introduction potential of essential oil plants in the conditions of the city of Karaganda and Zhezkazgan

The objects of the study were plants of the collection of natural flora and medicinal plants of the biological and geographical faculty of E.A. Buketov Karaganda University (the Karaganda city); a collection of medicinal and aromatic plants, a collection of local natural flora of the Zhezkazgan botanical garden (the Zhezkazgan city). Both regions are located in dry-steppe (Karaganda) and desert (Zhezkazgan) zones, characterized by differences in soil conditions, annual precipitation and average air temperature [113-117].

The success analysis was carried out according to visual observations for the period 1998-2019 on the 100-point scale of R.A. Karpisonova for herbaceous plants, which was supplemented by A.N. Kupriyanov [118-120].

The following indicators were taken into account:

1). Winter resistant in spring period after plant growth:

0 point - the plant is completely frozen;

5 points - no more than 50% of individuals freeze;

10 points - 30-50% of individuals freeze;

15 points - less than 30% of individuals freeze;

20 points - plants have no winter damage.

2). Disease and pest resistance assessed in flowering phase:

0 point - plants die due to pests or diseases influence;

5 points - plants are damaged annually and abundantly (at least 50% of the leaf surface is damaged);

10 points - damage severe, but not annual;

15 points - annual or non-annual non-severe damage (less than 50% of sheet surface is damaged);

20 points - plants without damage.

3). *The general condition of plants is estimated by the end of the growing season:*

5 points - low-power plants that do not reach their natural size in culture;

15 points - do not differ in size from plants in natural habitats;

20 points - plants are more powerful than in nature.

4). *The state of plants in the growing season is determined at the end of the growing period:*

5 points - grow, but do not bloom and do not form seeds;

10 points - bloom, but do not form fruit;

15 points - fruiting small or not annual;

20 points - bloom annually and form seeds.

5). *Methods of reproduction in culture are determined according to the results of long-term observations:*

5 points - re-involvement in culture;

10 points - artificial vegetative reproduction;

15 points - natural vegetative reproduction;

20 points – subsequent reproduction.

Scores for all categories were summarized. Species with 90 to 100 points were classified as highly prospective plants for a given region; from 80 to 90 points - to perspective; from 60 to 80 points - to low perspective; below 60 points - to not perspective for cultivation

In the conditions of the city of Karaganda, 130 species from 20 genera and 12 families were tested inculture [113-115, 117, 121] (Tab. 23).

Table 23. Indicators of the success of the introduction of essential oil plants in the conditions of the city of Karaganda

Family	Genus	Species	Indicators of the success of the introduction, points
1	2	3	4
Apiaceae Lindl.	<i>Anethum</i> L.	<i>A. graveolens</i> L.	95
	<i>Angelica</i> L.	<i>A. archangelica</i> L.	85
	<i>Bupleurum</i> L.	<i>B. longifolium</i> L.	60
	<i>Carum</i> L.	<i>C. carvi</i> L.	85
	<i>Chaerophyllum</i> L.	<i>Ch. prescottii</i> DC.	80
	<i>Eryngium</i> L.	<i>E. planum</i> L.	90
	<i>Ferula</i> L.	<i>F. soongarica</i> Pall. ex Spreng.	90
	<i>Foeniculum</i> Hill	<i>F. vulgare</i> Mill.	90

1	2	3	4
	<i>Heracleum</i> L.	<i>H. sibiricum</i> L.	95
	<i>Seseli</i> L.	<i>S. libanotis</i> (L.) Koch.	90
		<i>S. schrenkianum</i> (C.A. Mey. ex Schischk.) M. Pimen. et Sdobnina	85
<i>Asteraceae</i> Dumort.	<i>Achillea</i> L.	<i>A. alpina</i> L.	70
		<i>A. asiatica</i> Serg.	70
		<i>A. bucharica</i> C. Winkl.	50
		<i>A. carpatica</i> Blocki ex Dubovik	65
		<i>A. clusiana</i> Tausch	50
		<i>A. collina</i> J. Beck. ex Reichenb.	70
		<i>A. distans</i> Waldst. & Kit. ex Willd.	50
		<i>A. filipendulina</i> Lam.	85
		<i>A. inundata</i> Kondr.	70
		<i>A. macedonica</i> Rouy	70
		<i>A. micrantha</i> Willd.	75
		<i>A. millefolium</i> L.	90
		<i>A. leptophylla</i> Bieb.	85
		<i>A. nobilis</i> L.	90
		<i>A. pannonica</i> Scheele	80
		<i>A. ptarmica</i> L.	75
		<i>A. setacea</i> Waldst. et Kit.	90
		<i>Ajania</i> Polajk.	<i>A. fruticulosa</i> (Ledeb.) Poljak.
	<i>Artemisia</i> L.	<i>A. absinthium</i> L.	75
		<i>A. annua</i> L.	95
		<i>A. arborescens</i> L.	85
		<i>A. armeniaca</i> Lam.	75
		<i>A. austriaca</i> Jacq.	85
		<i>A. cina</i> Berg. ex Poljak.	15
		<i>A. filatovae</i> A. Kuprjanov	90
		<i>A. frigida</i> Willd.	85
		<i>A. glabella</i> Kar. et Kir.	85
		<i>A. glauca</i> Pall. ex Willd.	80
		<i>A. laciniata</i> Willd.	80
		<i>A. latifolia</i> Ledeb.	80
		<i>A. leucodes</i> Schrenk	75

1	2	3	4
		<i>A. marschalliana</i> Spreng.	90
		<i>A. nitrosa</i> Weber ex Stechm.	50
		<i>A. pontica</i> L.	85
		<i>A. proceriformis</i> Krasch.	85
		<i>A. rupestris</i> L.	75
		<i>A. schrenkiana</i> Ledeb.	80
		<i>A. sericea</i> Web.	70
		<i>A. sieversiana</i> Willd.	95
		<i>A. stelleriana</i> Bess.	45
		<i>A. terrae-albae</i> Krasch.	80
		<i>A. vulgaris</i> L.	90
	<i>Aster</i> L.	<i>A. alpinus</i> L.	75
	<i>Bidens</i> L.	<i>B. tripartita</i> L.	45
	<i>Calendula</i> L.	<i>C. officinalis</i> L.	95
	<i>Dendranthema</i> (DC.) DesMoul.	<i>D. zawadskii</i> (Herbich) Tzvel.	80
	<i>Galatella</i> Cass.	<i>G. angustissima</i> (Tausch) Novopokr.	90
		<i>G. divaricata</i> (Fisch. ex M. Bieb.) Novopokr.	85
		<i>G. fastigiiformis</i> Novopokr.	90
		<i>G. punctata</i> (Waldst. & Kit.) Nees	85
		<i>G. tatarica</i> (Less.) Novopokr.	85
		<i>G. villosa</i> (L.) Reichenb.	80
	<i>Echinacea</i> Moench.	<i>E. purpurea</i> (L.) Moench.	85
	<i>Helichrysum</i> Mill.	<i>H. arenarium</i> (L.) Moench	85
	<i>Matricaria</i> L.	<i>M. reticulata</i> L.	90
	<i>Ptarmica</i> Hill	<i>P. alpina</i> (L.) DC.	70
		<i>P. cartilaginea</i> (Ledeb. ex Reichenb.) Ledeb.	75
		<i>P. impatiens</i> (L.) DC.	50
		<i>P. vulgaris</i> Hill	70
	<i>Pyrethrum</i> Zinn.	<i>P. coccineum</i> (Willd.) Worosch.	50

1	2	3	4	
		<i>P. corymbiforme</i> Tzvel.	65	
		<i>P. kelleri</i> (Kryl. & Plotn.) Krasch.	60	
		<i>Solidago</i> L.	<i>S. virgaurea</i> L.	90
	<i>Tanacetum</i> L.		<i>T. achilleifolium</i> (L.) Druce	75
			<i>T. santolina</i> C. Winkl.	85
			<i>T. scopulorum</i> (Krasch.) Tzvel.	90
			<i>T. tanacetoides</i> (DC.) Tzvel.	100
			<i>T. ulutavicum</i> Tzvel.	90
			<i>T. vulgare</i> L.	100
<i>Brassicaceae</i> Burnett	<i>Cardaria</i> Desv.	<i>C. draba</i> (L.) Desv.	65	
<i>Chenopodiaceae</i> Vent.	<i>Chenopodium</i> L.	<i>C. botrus</i> L.	90	
<i>Geraniaceae</i> Juss.	<i>Geranium</i> L.	<i>G. collinum</i> Steph.	90	
<i>Hypericaceae</i> Juss.	<i>Hypericum</i> L.	<i>H. perforatum</i> L.	95	
<i>Iridaceae</i> Juss.	<i>Iris</i> L.	<i>I. alberti</i> Regel	70	
		<i>I. florentina</i> L.	80	
		<i>I. halophila</i> Pall.	80	
		<i>I. imbricata</i> Lindl.	70	
		<i>I. pallasii</i> Fisch. ex Trev.	75	
		<i>I. pumila</i> L.	85	
		<i>I. scariosa</i> Willd. ex Link.	75	
		<i>I. sibirica</i> L.	85	
<i>Lamiaceae</i> Lindl.	<i>Dracocephalum</i> L.	<i>D. peregrinum</i> L.	95	
		<i>D. karataviense</i> Pavlov et Roldugin	70	
	<i>Hyssopus</i> L.		<i>H. ambiguus</i> (Trautv.) Iljin	95
			<i>H. macranthus</i> Boriss.	95
			<i>H. officinalis</i> L.	90
	<i>Lavandula</i> L.		<i>L. angustifolia</i> Mill.	90
	<i>Leonurus</i> L.		<i>L. cardiaca</i> L.	100
			<i>L. glaucescens</i> Bunge	95
			<i>L. quinquelobatus</i> Gilib.	95
	<i>Lophanthus</i> Adans.		<i>L. schrenkii</i> Levin	50
<i>Melissa</i> L.		<i>M. officinalis</i> L.	80	

1	2	3	4
	<i>Mentha</i> L.	<i>M. arvensis</i> L.	75
		<i>M. longifolia</i> (L.) Huds.	80
		<i>M. piperita</i> L.	65
	<i>Nepeta</i> L.	<i>N. pannonica</i> L.	85
	<i>Origanum</i> L.	<i>O. vulgare</i> L.	75
	<i>Phlomis</i> Moench	<i>Ph. tuberosa</i> (L.) Moench	90
	<i>Salvia</i> L.	<i>S. aethiopsis</i> L.	75
		<i>S. nemerosa</i> L.	90
		<i>S. officinalis</i> L.	50
		<i>S. patens</i> Cav.	75
		<i>S. stepposa</i> Shost.	95
		<i>S. x superba</i> Stapf	90
	<i>Stachys</i> L.	<i>S. officinalis</i> L.	80
<i>Thymus</i> L.	<i>Th. marschallianus</i> Willd.	95	
	<i>Th. serpyllum</i> L.	80	
<i>Ziziphora</i> L.	<i>Z. clinopodioides</i> Lam.	90	
<i>Paeoniaceae</i> Rudolphi	<i>Paeonia</i> L.	<i>P. anomala</i> L.	70
		<i>P. hybrida</i> Pall.	70
		<i>P. lactiflora</i> Pall.	70
<i>Rosaceae</i> Juss.	<i>Filipendula</i> Mill.	<i>F. ulmaria</i> (L.) Maxim.	85
		<i>F. vulgaris</i> Moench	80
<i>Rutaceae</i> Juss.	<i>Dictamnus</i> L.	<i>D. angustifolius</i> G. Don. fil. ex Sweet	65
	<i>Ruta</i> L.	<i>R. graveolens</i> L.	85
<i>Valerianaceae</i> Batsch	<i>Patrinia</i> Juss.	<i>P. intermedia</i> (Hornem.) Roem. et Schult.	90
		<i>Valeriana</i> L.	<i>V. officinalis</i> L.
		<i>V. rossica</i> P. Smirn.	95
		<i>V. tuberosa</i> L.	85

The largest number of species of introduced essential oil plants is concentrated in *Asteraceae* family; the second position is occupied by the *Lamiaceae* family, the third by *Apiaceae* family.

Scoring points ranged from 15 to 100 points. The results showed that 43 species were assigned to the group of highly perspective species, including *Achillea millefolium*, *A. nobilis*, *Artemisia annua*, *Hypericum perforatum*, *Leonurus cardiac*, *Hyssopus macranthus*, *Salvia stepposa*, *Valeriana rossica*, *Ziziphora clinopodioides* и другие (Fig. 19).

The group of perspective species included 39 taxa: *Filipendula ulmaria*, *Valeriana tuberosa*, *Melissa officinalis*, *Mentha longifolia*, *Iris halophila*,

Tanacetum santolina, *Galatella tatarica*, *Artemisia pontica*, *Artemisia schrenkiana*, *Achillea filipendulina* and other.

Low perspective species according to the results of the introduction test were 35 taxa, such as *Paeonia anomala*, *Salvia patens*, *Mentha piperita*, *Iris scariosa*, *Tanacetum achilleifolium*, *Ptarmica alpine*, *Aster alpinus* and others.

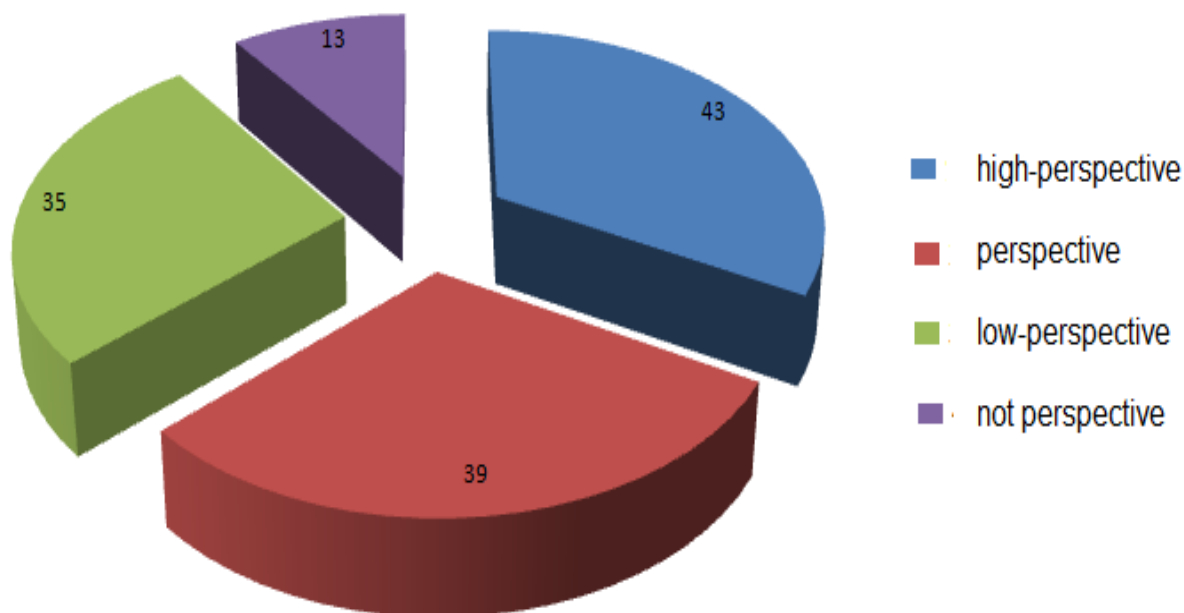


Рисунок 19. Distribution of essential-oil species by groups of introduction's success in the conditions of the city of Karaganda

Not perspective species were 13 taxa - *Ptarmica impatiens*, *Pyrethrum kelleri*, *Bidens tripartita*, *Artemisia rupestris*, *Artemisia cina* and others.

In the conditions of the city of Zhezkazgan [116, 122, 123], 63 species of essential-oil plants from 33 genera and 9 families passed the introduction test successfully (Tab. 24).

Table 24. Indicators of the success of the introduction of essential oil plants in the conditions of the city of Zhezkazgan

Family	Genus	Species	Indicators of the success of the introduction, points
1	2	3	4
<i>Apiaceae</i> Lindl.	<i>Anethum</i> L.	<i>A. graveolens</i> L.	100
	<i>Carum</i> L.	<i>C. carvi</i> L.	95

1	2	3	4
	<i>Cenolophium</i> Koch	<i>C.denudatum</i> (Hornem.) Tutin	75
	<i>Eryngium</i> L.	<i>E. planum</i> L.	80
	<i>Ferula</i> L.	<i>F.caspica</i> M. Bieb.	75
		<i>F.varia</i> (Schrenk ex Fisch., C.A. Mey. et Ave- Lall.)	85
		<i>F.songarica</i> Pall.ex Spreng.	85
	<i>Heracleum</i> L.	<i>H. sibiricum</i> L.	80
	<i>Hyalolaena</i> Bunge	<i>H.bupleuroides</i> (Schrenk) M. Pimen. et Kljuykov	65
Asteraceae Lindl.	<i>Achillea</i> L.	<i>A. millefolium</i> L.	90
		<i>A.nobilis</i> L.	90
		<i>A. setacea</i> Waldst. et Kit.	85
	<i>Ajania</i> Poljak.	<i>A. fruticulosa</i> (Ledeb.) Polajak	50
	<i>Artemisia</i> L.	<i>A. austriaca</i> Jack.	80
		<i>A.dracunculus</i> L.	90
		<i>A. glabella</i> Kar. et Kir.	45
		<i>A.lercheana</i> Weber ex Stechm.	85
		<i>A. leucodes</i> Schrenk	55
		<i>A. proceriformis</i> Krasch.	85
		<i>A. schrenkiana</i> Ledeb.	95
		<i>A.semiarida</i> (Krasch. et Lavrenko) Filatova	90
		<i>A.serotina</i> Bunge	80
		<i>A. sieversiana</i> Willd.	95
		<i>A.terrae-albae</i> Krasch.	95
	<i>A. vulgaris</i> L.	100	
	<i>Galatella</i> Cass.	<i>G.biflora</i> (L.) Nees	80
		<i>G.trinervifolia</i> (Less.) Novopokr.	75
	<i>Matricaria</i> L.	<i>M. recutita</i> L.	95
	<i>Pyrethrum</i> Zinn.	<i>P.balsamita</i> (L.) Willd.	75
	<i>Tanacetum</i> L.	<i>T.ulutavicum</i> Tzvel.	90
<i>T.vulgare</i> L.		95	
Chenopodiaceae Vent.	<i>Chenopodium</i> L.	<i>C. botrys</i> L.	95
Hypericaceae Juss.	<i>Hypericum</i> L.	<i>H. perforatum</i> L.	90

1	2	3	4
<i>Iridaceae</i> Juss.	<i>Iris</i> L.	<i>I. halophila</i> Pall.	85
		<i>I. pumila</i> L.	70
		<i>I. scariosa</i> Willd. et Link.	80
		<i>I. sibirica</i> L.	75
		<i>I. songarica</i> Schrenk	80
<i>Lamiaceae</i> Lindl.	<i>Dracocephalum</i> L.	<i>D. moldavica</i> L.	70
		<i>Glechoma</i> L.	<i>G. hederacea</i> L.
	<i>Hyssopus</i> L.	<i>H. officinalis</i> L.	90
	<i>Leonurus</i> L.	<i>L. cardiaca</i> L.	95
		<i>L. glaucescens</i> Bunge	100
	<i>Melissa</i> L.	<i>M. officinalis</i> L.	55
	<i>Mentha</i> L.	<i>M. longifolia</i> (L.) Huds.	80
		<i>M. piperita</i> L.	60
	<i>Phlomis</i> Moench	<i>P. tuberosa</i> (L.) Moench	95
	<i>Salvia</i> L.	<i>S. aethiopsis</i> L.	25
		<i>S. desserta</i> Schangin	75
		<i>S. officinalis</i> L.	25
		<i>S. sclarea</i> L.	55
		<i>S. stepposa</i> Shost.	90
	<i>Scutellaria</i> L.	<i>S. baicalensis</i> Georgi	55
		<i>S. grandiflora</i> Sims	65
	<i>Stachys</i> L.	<i>S. betoniciflora</i> Rupr.	90
		<i>S. officinalis</i> L.	65
	<i>Thymus</i> L.	<i>Th. marschallianus</i> Willd.	65
<i>Ziziphora</i> L.	<i>Z. clinopodioides</i> Lam.	85	
<i>Rosaceae</i> Juss.	<i>Filipendula</i> Mill.	<i>F. ulmaria</i> (L.) Maxim.	70
		<i>F. vulgaris</i> Moench	75
<i>Rutaceae</i> Juss.	<i>Ruta</i> L.	<i>R. suaveolens</i> L.	75
<i>Valerianaceae</i> Batsch	<i>Patrinia</i> Juss.	<i>P. intermedia</i> (Hornem.) Roem. et Schult.	85
		<i>Valeriana</i> L.	<i>V. officinalis</i> L.

Scoring points ranged from 25 to 100. The main introducents are concentrated in the families *Asteraceae*, *Lamiaceae* and *Apiaceae*. As for the city of Karaganda, 4 groups were allocated:

The group of high perspective species included 21 taxa (*Stachys betonicifolia*, *Salvia stepposa*, *Leonurus glaucescens*, *L. cardiaca*, *Tanacetum ulutavicum*, *T. vulgare*, *Artemisia vulgaris*) (Fig. 20).

The group of perspective species includes 16 taxa (*Eryngium planum*, *Ferula varia*, *Achillea setacea*, *Artemisia lercheana*, *Galatella biflora* and others).

17 species are classified as low perspective (*Ruta suaveolens*, *Filipendula ulmaria*, *Scutellaria grandiflora*, *Mentha piperita*, *Glechoma hederacea*, *Ferula caspica*).

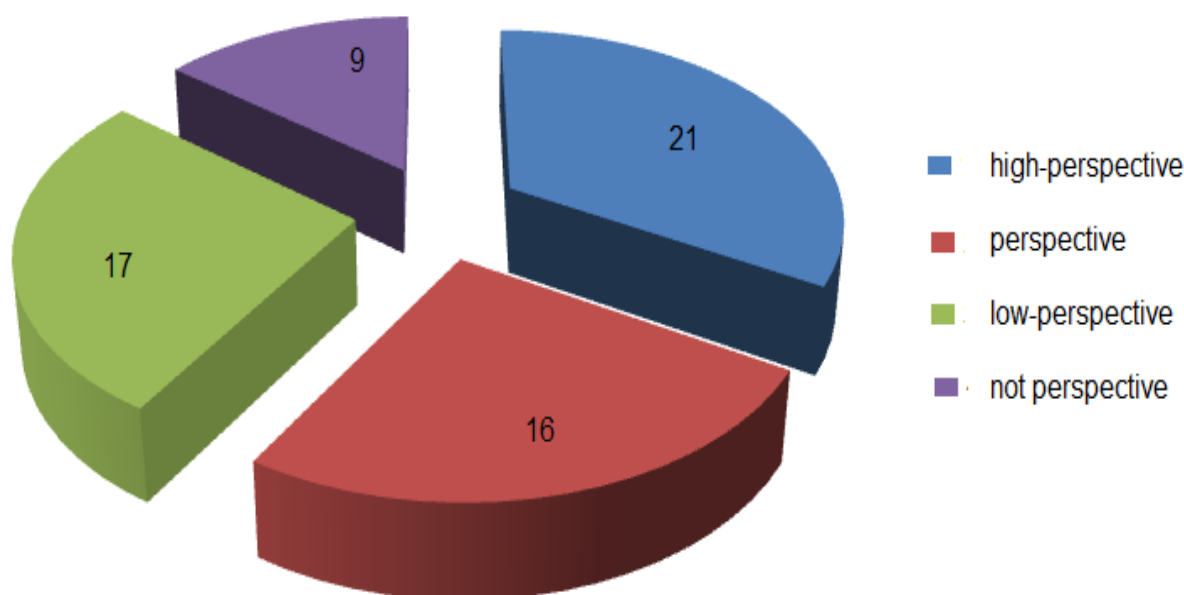


Figure 21. Distribution of essential-oil species by groups of introduction's success in the conditions of the city of Zhezkazgan

Not perspective for cultivation taxa includes 9 species (*Valeriana officinalis*, *Scutellaria baicalensis*, *Melissa officinalis*, *Artemisia glabella*, *Artemisia leucodes* and others).

A comparison of the two points of introduction showed that the same species received different scores for the success of introduction, which is associated with the biological conditions of taxa and the existing difference in soil and climatic conditions. Thus, the average score for species from *Apiaceae* family in Karaganda was 85.9, while for Zhezkazgan - 82.2 (Tab. 25).

Table 25. Average estimated points for the introduction of essential oil plants depending on taxonomic affiliation and point of introduction

Family	Introduction Success Scores	
	Karaganda	Zhezkazgan
1	2	3
<i>Apiaceae</i>	85.9	82.2
<i>Asteraceae</i>	76.8	82.6
<i>Brassicaceae</i>	65.0	-

1	2	3
<i>Chenopodiaceae</i>	90.0	95.0
<i>Geraniaceae</i>	90.0	-
<i>Hypericaceae</i>	95.0	90.0
<i>Iridaceae</i>	77.5	78.0
<i>Lamiaceae</i>	83.2	70.8
<i>Paeoniaceae</i>	70.0	-
<i>Rosaceae</i>	82.5	72.5
<i>Rutaceae</i>	75.0	75.0
<i>Valerianaceae</i>	90.0	70.0

For the *Asteraceae* and *Chenopodiaceae* family, scores were higher in the city of Zhezkazgan, than in the city of Karaganda - 82.6 and 76.8; 95.0 and 90.0, respectively. For more mesophytic species from the families *Hypericaceae*, *Lamiaceae*, *Rosaceae* and *Valerianaceae*, higher success scores for introduction were obtained in Karaganda, than for more arid conditions in the city of Zhezkazgan.

In general, in the conditions of the Central Kazakhstan, essential oil plants from the families *Apiaceae*, *Chenopodiaceae*, *Hypericaceae*, individual representatives of *Asteraceae*, *Lamiaceae*, *Valerianaceae* are able for successful cultivation.

Thus, according to the results of research, the results of the success of the introduction of essential oil plants in the conditions of the Zhezkazgan and Karaganda regions were determined, taxa that can be grown on an industrial scale were found.

CONCLUSION

The study of essential oil plants has interest, both from a scientific and practical point of view. The world has seen an increase in requirement in plant raw materials, as renewable sources for various branches of industries.

Plants can produce many groups of biological substances, such as proteins, tannins, polysaccharides, iridoids, phenols, alkaloids, and essential oils that exert activity in maintaining human health, as dietary supplements and, as veterinary drugs. Many biological active compounds' groups are synthesized as protective agents against bacteria, viruses, other microorganisms, insects and herbivores. Some biologically active plant compounds are very active against strains of viruses and bacteria, even those that have adapted to antibiotics over time.

Phytopreparations, as a rule, have a pronounced immunostimulating effect. Plants and animals are similar in chemical nature, and therefore plant preparations are easily included in the biochemical processes of animal and human organisms. Biological relationship between plant active substances and mammalian physiologically active substances evolved.

Therefore, within the framework of the monograph, a group of essential oil plants was chosen; which differed in a wide species composition in the territory of the Republic of Kazakhstan, containing species suitable for commercial use.

In the territory of the Central Kazakhstan (the Karaganda region), promising groups of essential oil plants with the maximum accumulation of essential oil for practical use in various industries have been identified.

So, the complete species composition has been determined, which included 275 species from 130 genera and 35 families. The leading families with are *Asteraceae*, *Lamiaceae*, *Apiaceae*, the largest genera *Artemisia*, *Achillea* and *Thymus*.

A conspectus of flora has been compiled; an environmental characteristic of species, an analysis of life forms and the degree of prevalence has been given. So, in Karaganda region were identified 5 ecological groups of essential oil plants: mesophytes, meso-xerophytes, xerophytes, xero-mesophytes and hydrophytes. The dominated position has a group of xerophytes.

By life (vital) forms it was identified 6 groups, among them annual and biannual herbaceous plants, herbaceous perennial plants, semi-low shrubs, bushes, trees and lianas. Herbaceous perennials plants have dominated position.

All essential oil plants were separated by degree of prevalence in nature. So, four groups were ranked: i) rare and endangered species, which are not subjects to collection; ii) species that are widespread, but do not form commercial thickets; iii) widespread species forming thickets suitable for collecting raw materials in small volumes; iv) widespread species forming thickets suitable for industrial collection of raw materials. For further investigation for assessment of resources of raw materials, essential oil plants belonging to the 3rd and 4th groups were selected.

Plant resources of the most widespread essential oil plants in nature have been determined. Recommendations on norms and volumes of annual harvesting from

places of natural growth are given.

Peculiarities of essential oil accumulation for some essential-oil plants are determined; dependence of quantitative content on place of growth, plant organ and vegetation phase is revealed.

Assessment of long-term observations of essential oil plants into culture in the Karaganda region. In the conditions of the city of Karaganda, 130 species from 20 genera and 12 families were tested inculture; and in the conditions of the city of Zhezkazgan were tested 63 species of essential-oil plants from 33 genera and 9 families.

It is determined the success of the introduction of essential oil plants, identified species suitable for industrial cultivation

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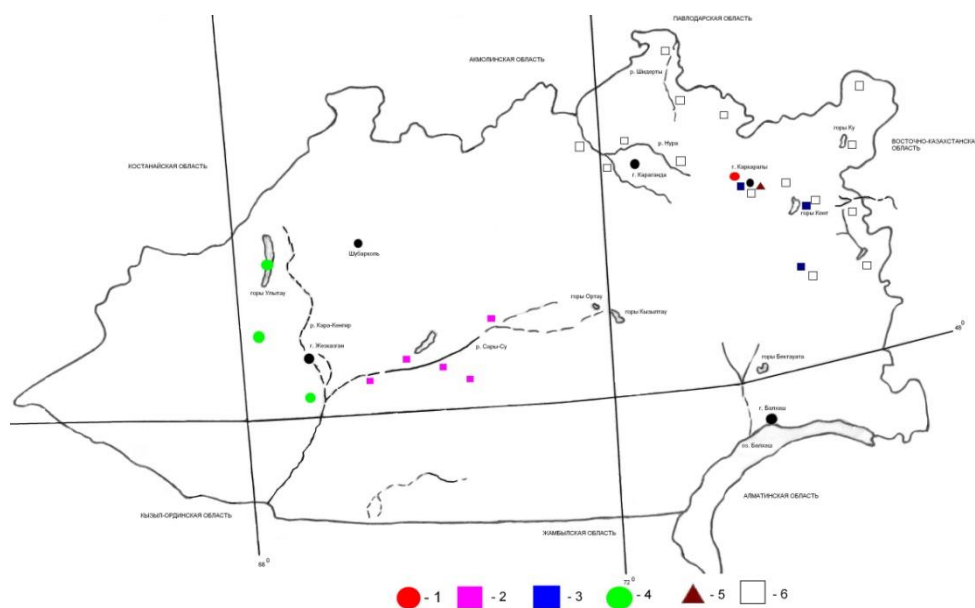
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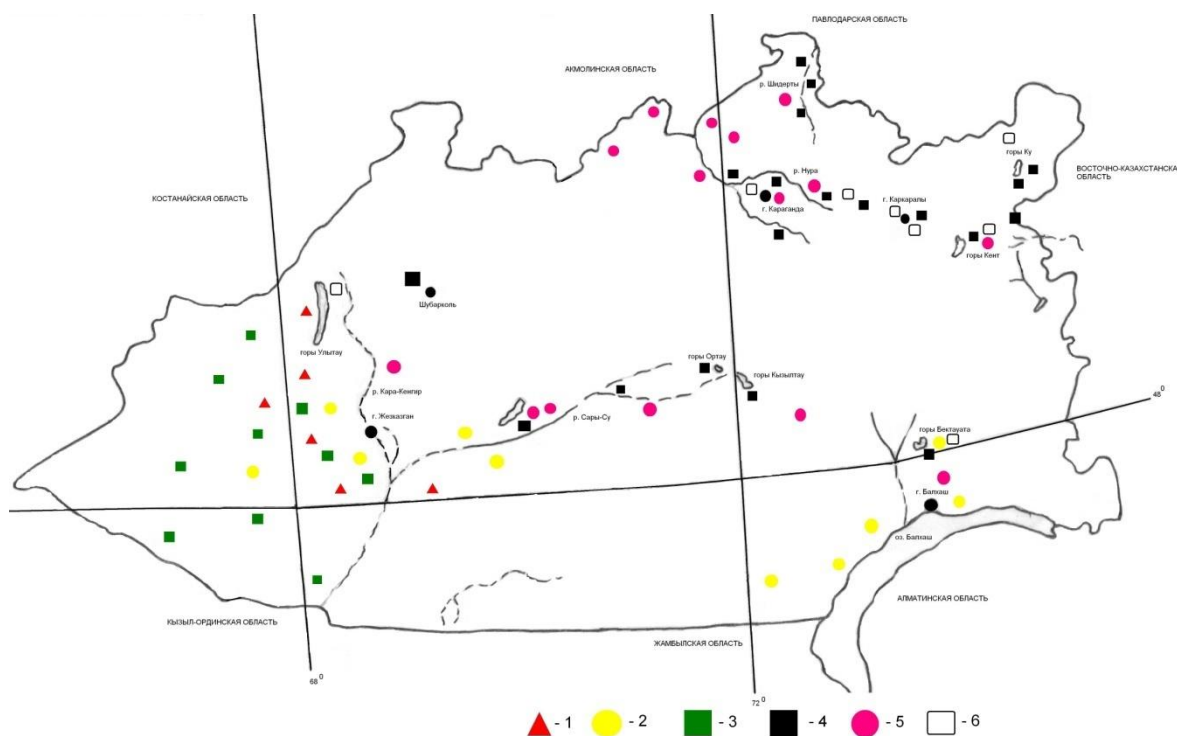
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APPENDIX A

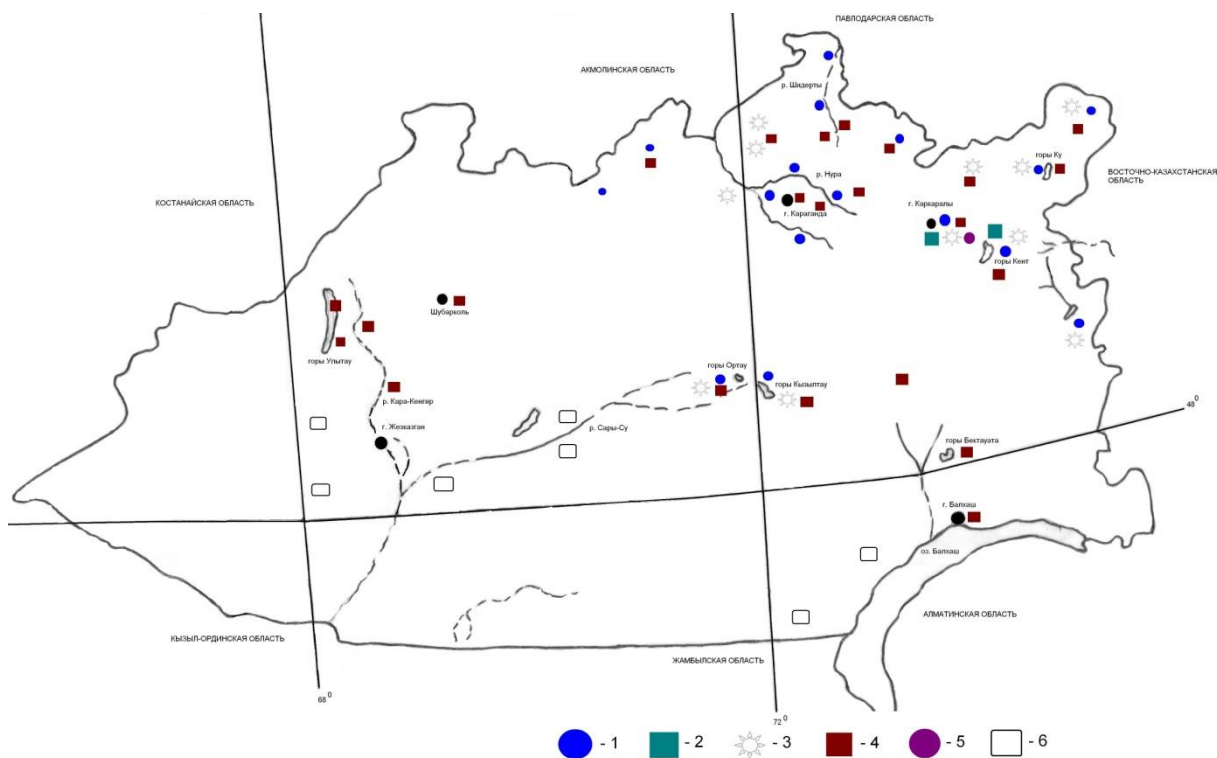
Point maps of spreading of some essential oil plants on the territory of the Karaganda region



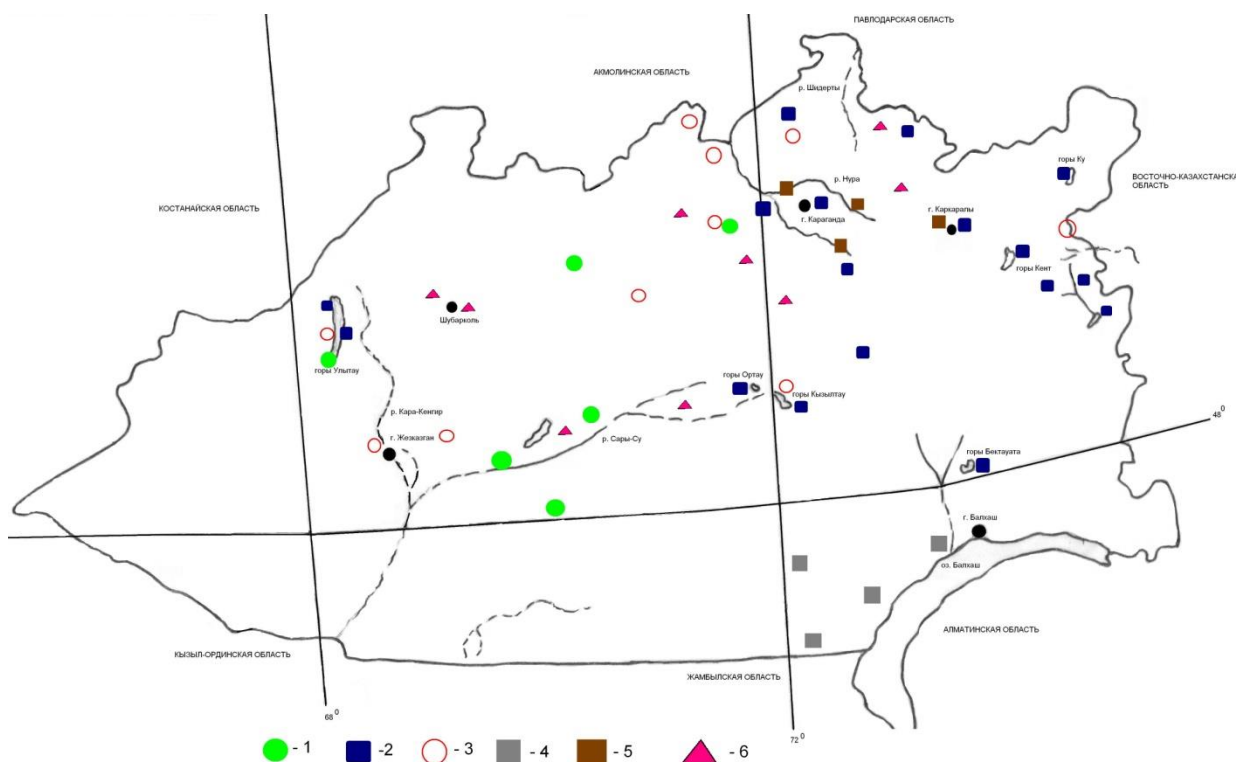
1 - *Anthriscus aemula*, 2 - *Bunium setosum*, 3 - *Bupleurum aureum*, 4 - *Cachrys macrocarpa*, 5 - *Carum carvi*, 6 - *Cenolophium fischeri*



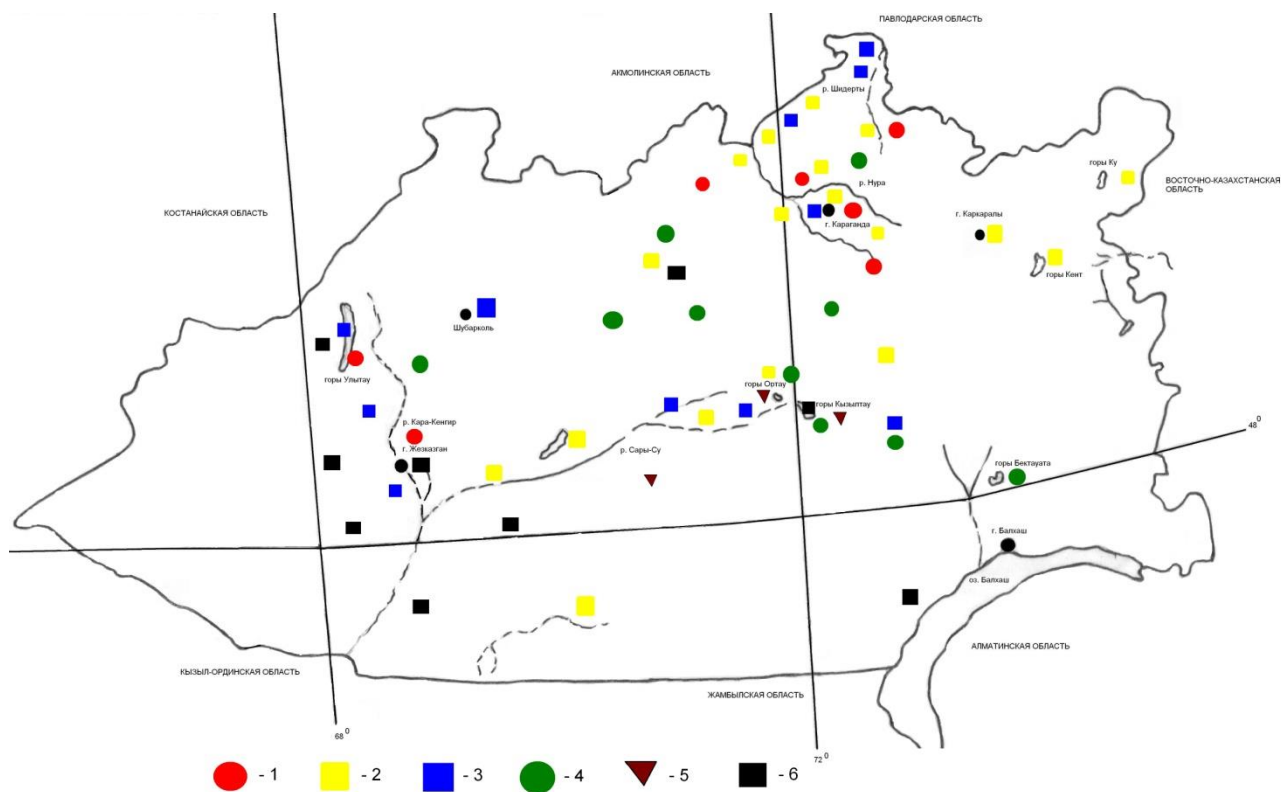
1 - *Ferula caspica*, 2 - *F. ferulaeoides*, 3 - *F. schair*, 4 - *F. soongarica*, 5 - *F. tatarica*, 6 - *Heracleum sibiricum*



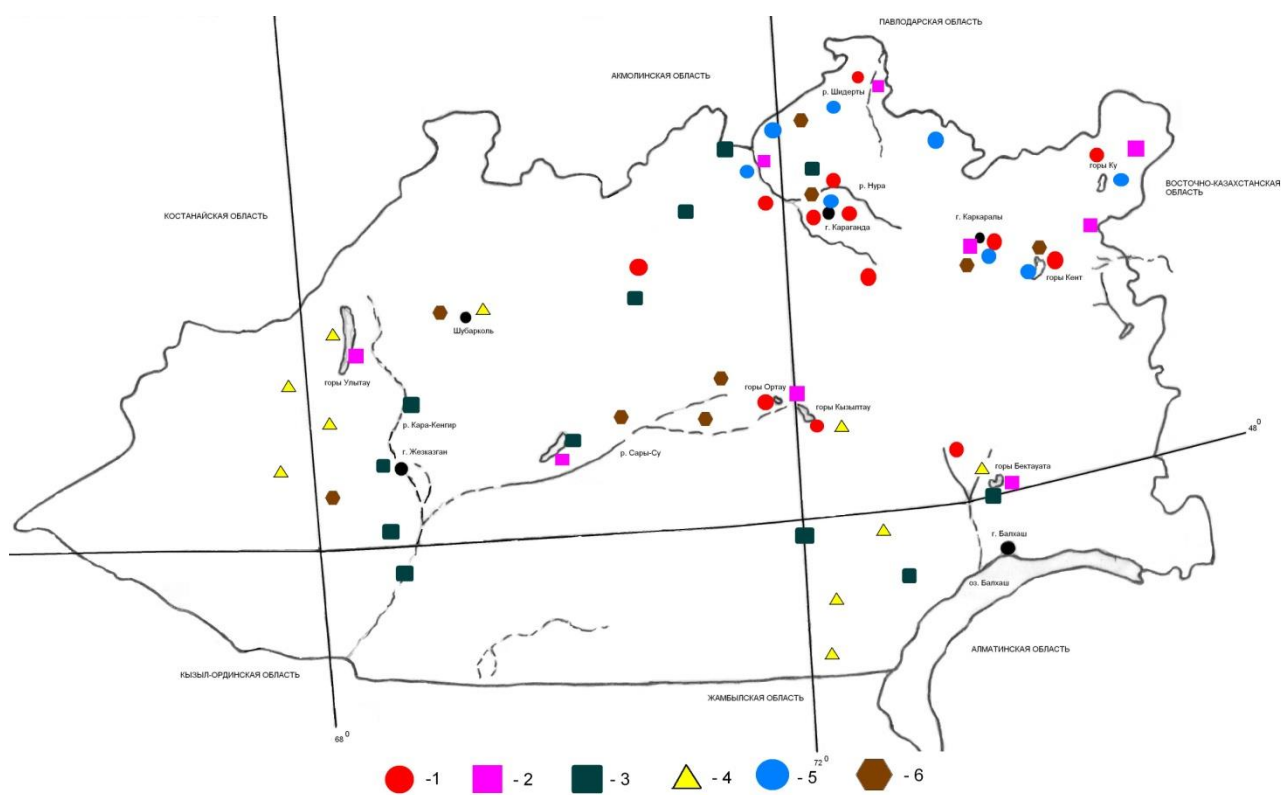
1 - *Chaerophyllum prescottii*, 2 - *Cicuta virosa*, 3 - *Cnidium dubium*, 4 - *Eryngium planum*, 5 - *Falcaria vulgaris*, 6 - *Ferula canescens*



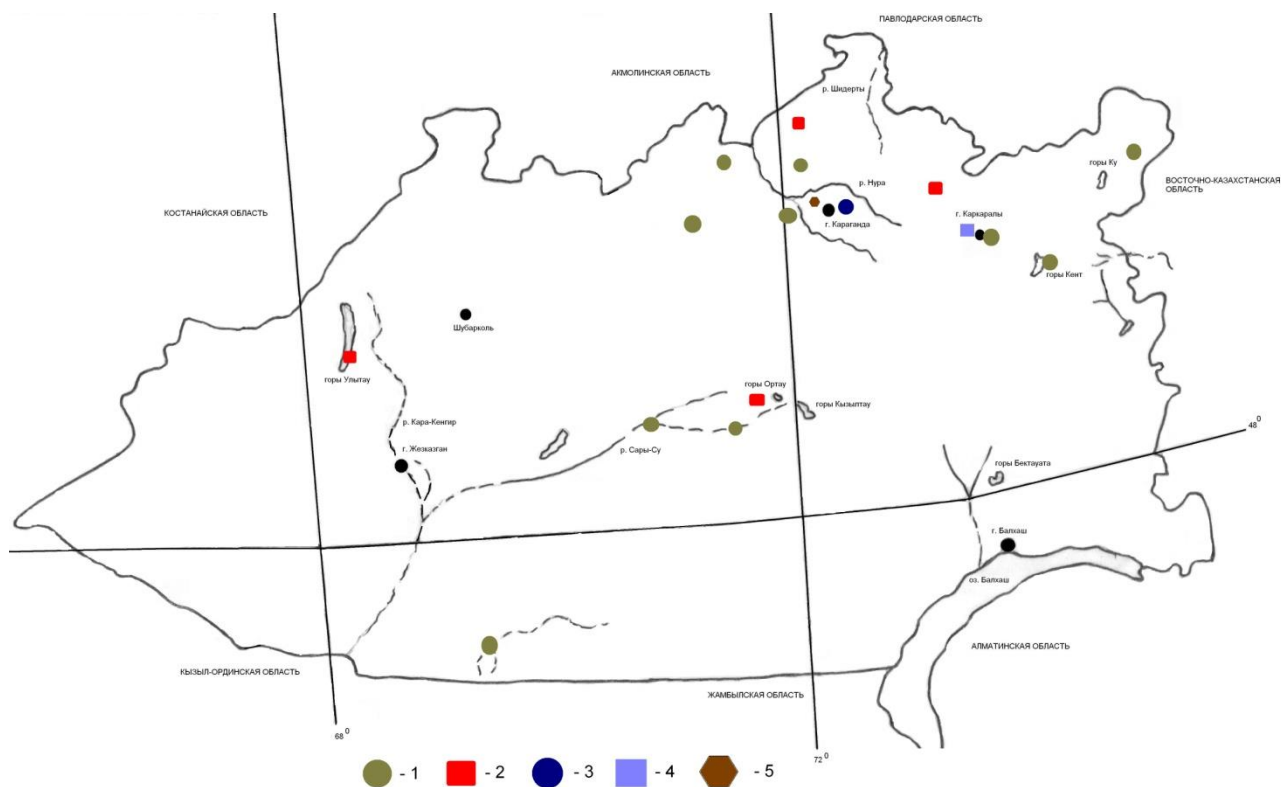
1 - *Hymenolyma bupleuroides*, 2 - *Libanotis buchtormensis*, 3 - *Leriocarpa*, 4 - *Oedibasis apiculata*, 5 - *Oenanthe aquatica*, 6 - *Palimbia salsa*



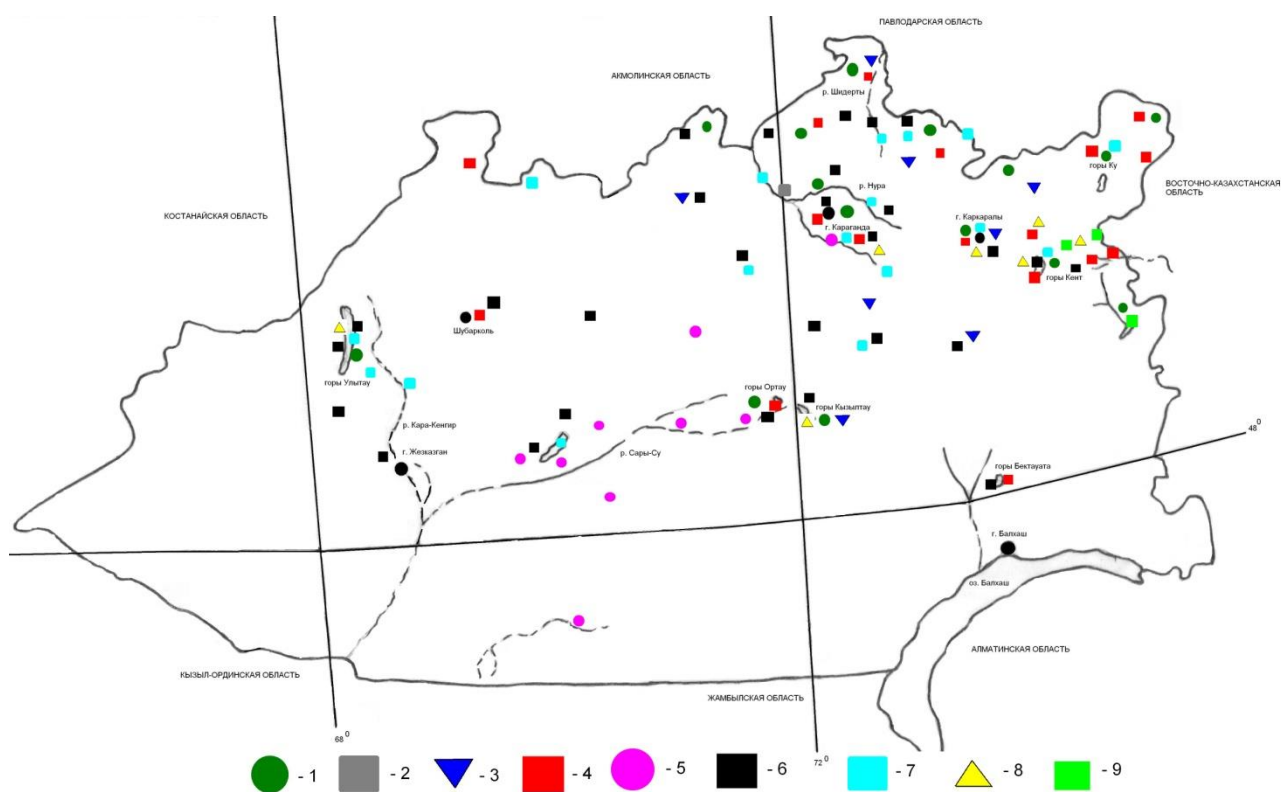
1 - *Pastinaca graveolens*, 2 - *Peucedanum morisonii*, 3 - *P. lubimenkoanum*,
4 - *Prangos ledebouri*, 5 - *Scaligeria setacea*, 6 - *Seseli eriocephalum*



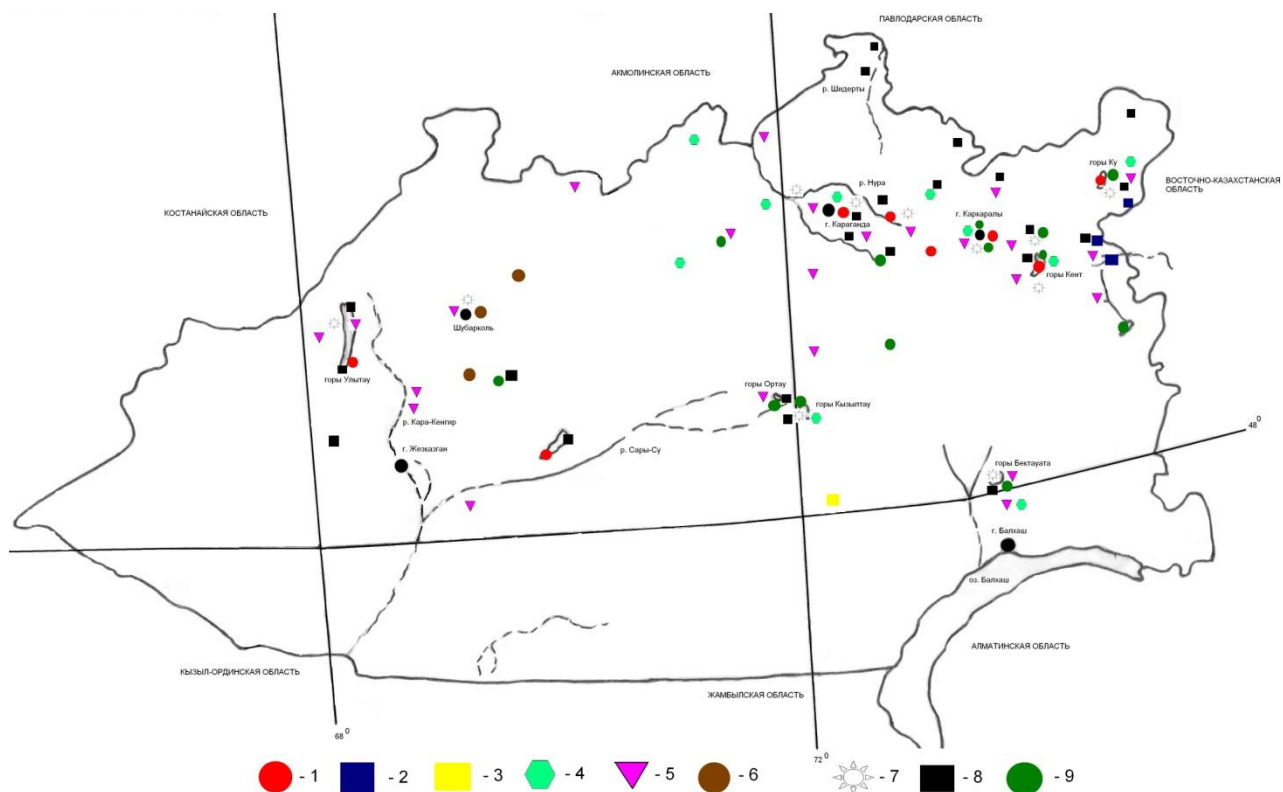
1 - *Seseli ledebourii*, 2 - *S. strictum*, 3 - *S. strictum*, 4 - *S. sesiliflorum*,
5 - *Silaum besseri*, 6 - *Sim sisaroides*



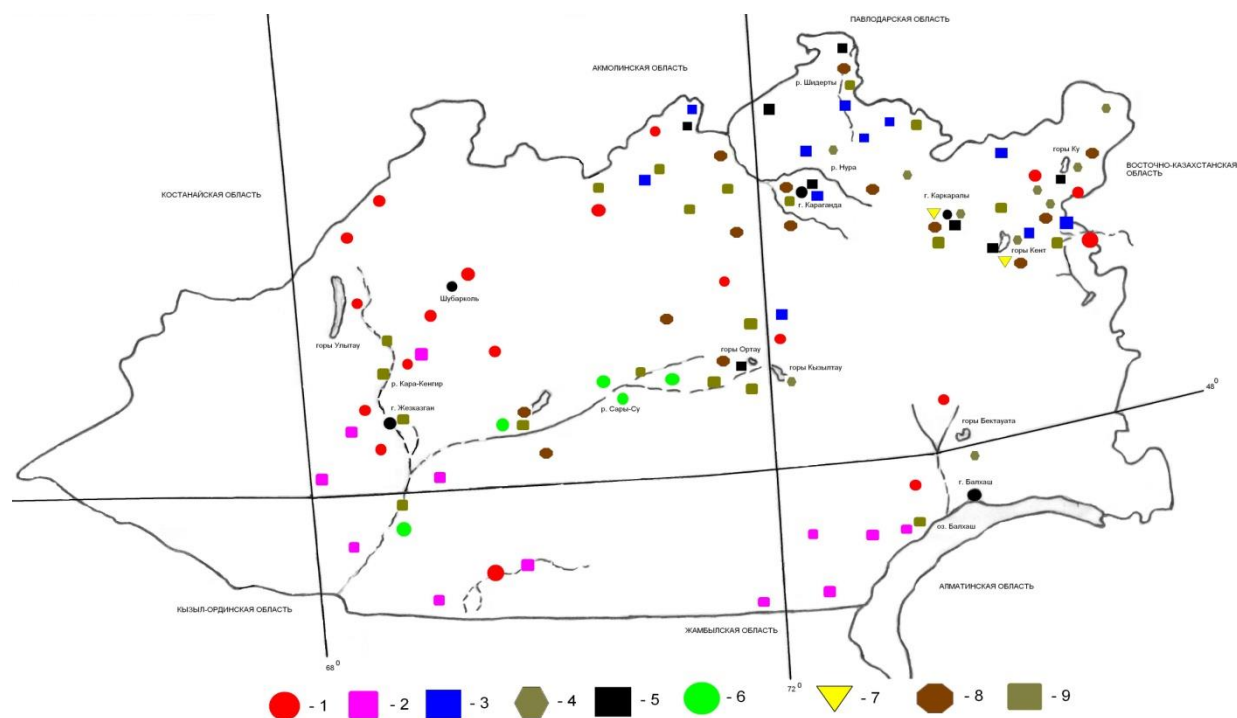
1 – *Sium latifolium*, 2 - *S. medium*, 3 - *Trinia hispida*, 4 - *T. polyclada*, 5 - *Turgenia latifolia*



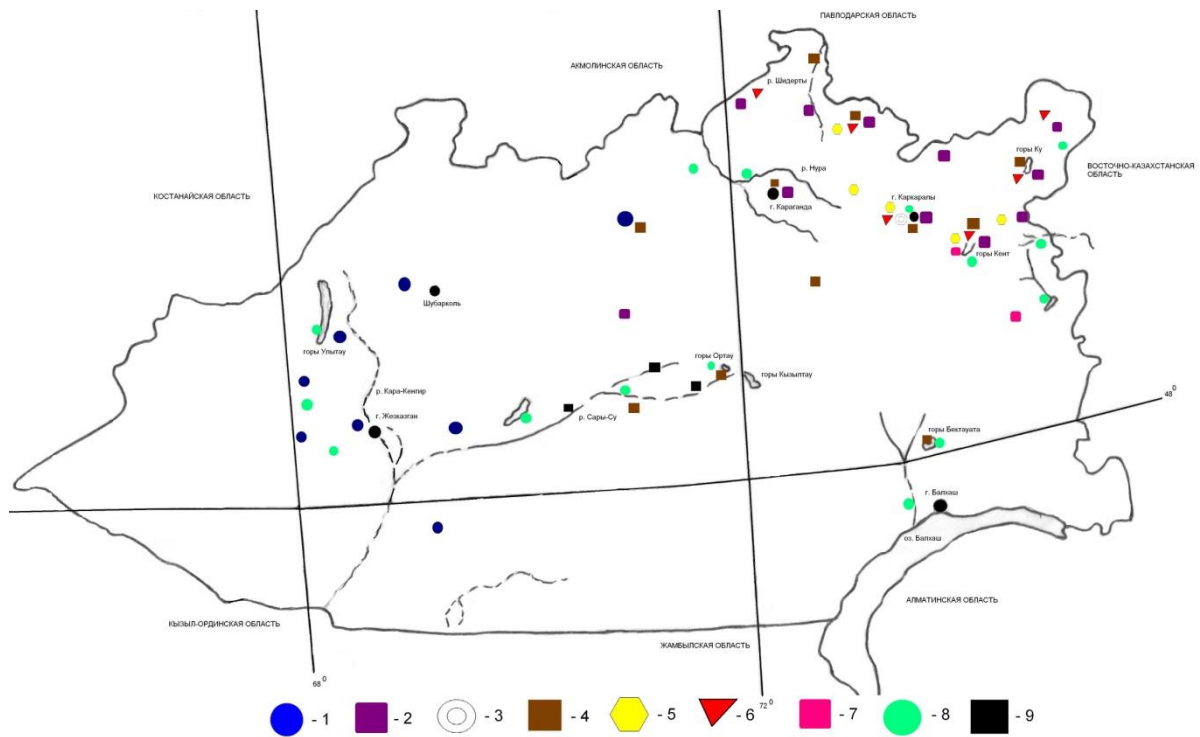
1 - *Eremurus altaicus*, 2 - *Acorus calamus*, 3 - *Achillea cartilaginea*, 4 - *A. millefolium*, 5 - *A. micrantha*, 6 - *A. nobilis*, 7 - *A. salicifolia*, 8 - *A. setacea*, 9 - *Ajania fruticulosa*



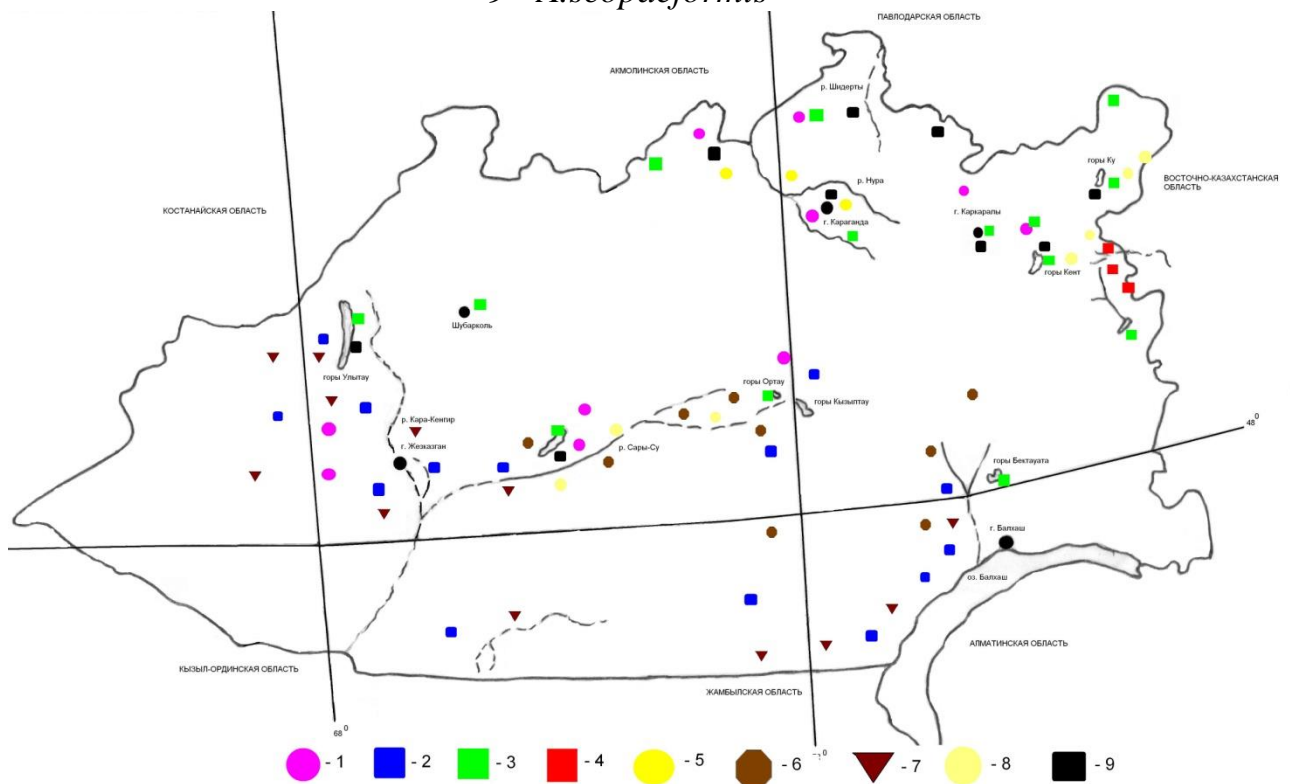
1 - *Artemisia absinthium*, 2 - *A. albida*, 3 - *A. aralensis*, 4 - *A. armeniaca*,
5 - *A. austriaca*, 6 - *A. camelorum*, 7 - *A. dracunculus*, 8 - *A. frigida*, 9 - *A. glabella*



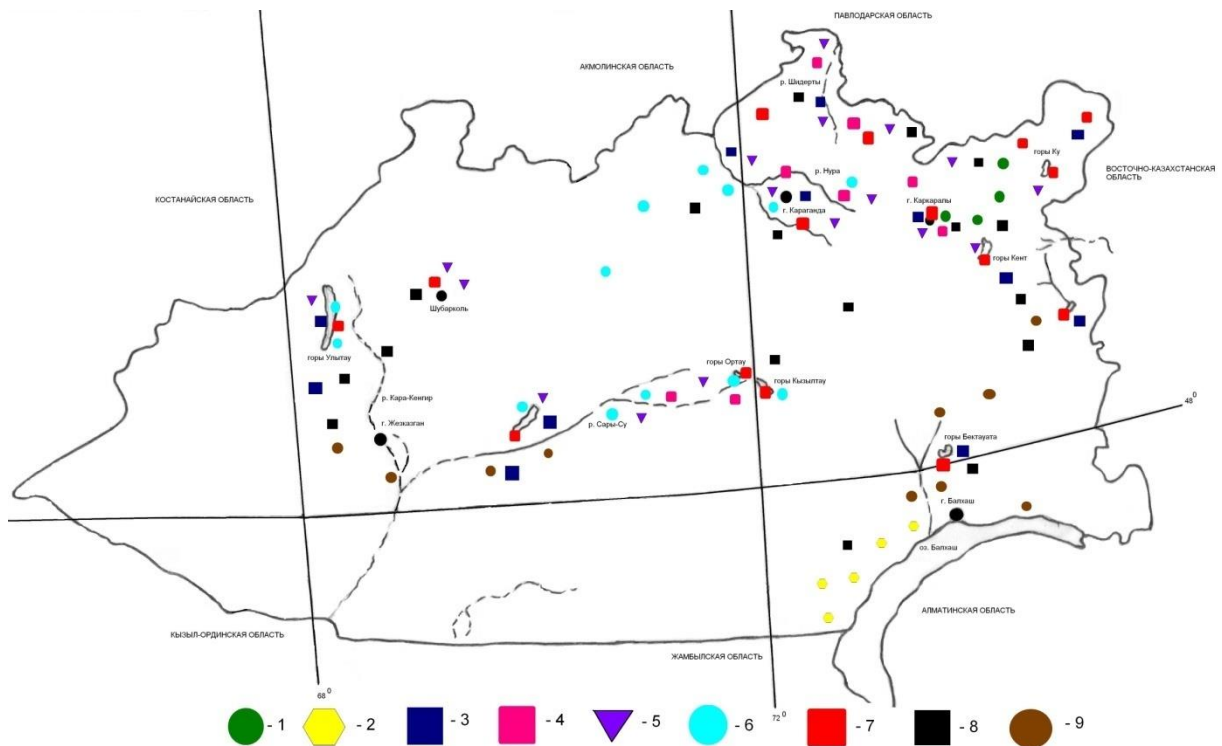
1 - *Artemisia gracilescens*, 2 - *A. juncea*, 3 - *A. kasakorum*, 4 - *A. laciniata*,
5 - *A. latifolia*, 6 - *A. lercheana*, 7 - *A. macrantha*, 8 - *A. marschalliana*, 9 - *A. nitrosa*



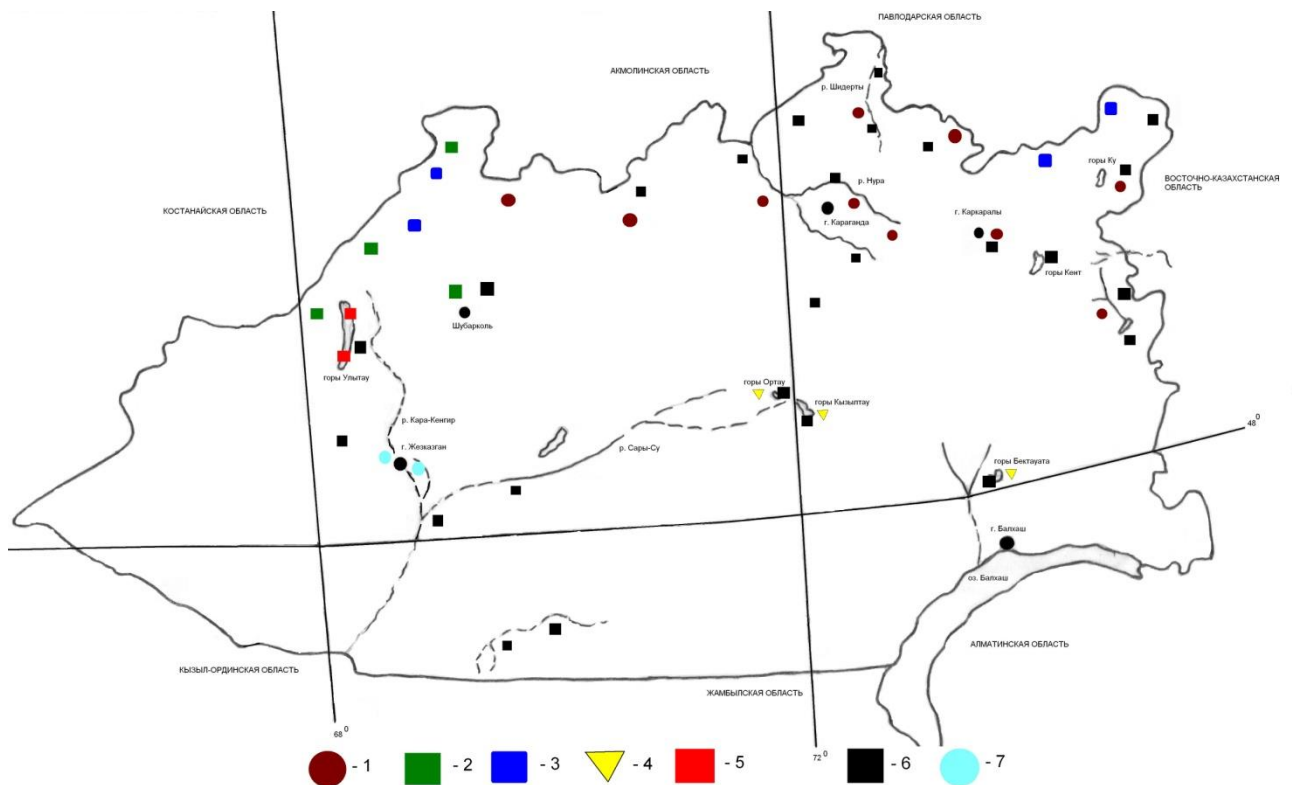
1 – *Artemisia pauciflora*, 2 - *A.pontica*, 3 - *A.obtusiloba*, 4 - *A.proceraeformis*,
 5 - *A.radicans*, 6 - *A.rupestris*, 7 - *A.santolinifolia*, 8 - *A.schrenkiana*,
 9 - *A.scopaeformis*



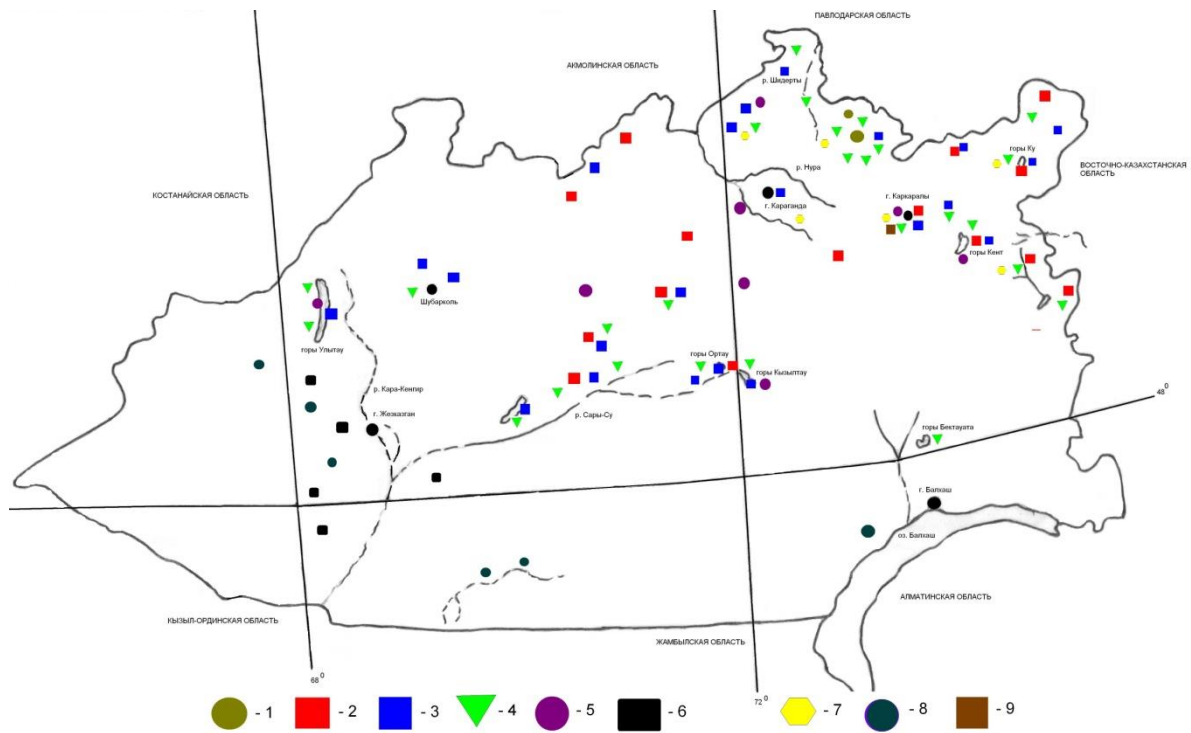
1 – *Artemisia scoparia*, 2 - *A.semiarida*, 3 - *A.sericea*, 4 - *A.serotina*,
 5 - *A.subchrisolepis*, 6 - *A.sublessingiana*, 7 - *A.terrae-albae*, 8 - *A.tomentella*,
 9 - *A.vulgaris*



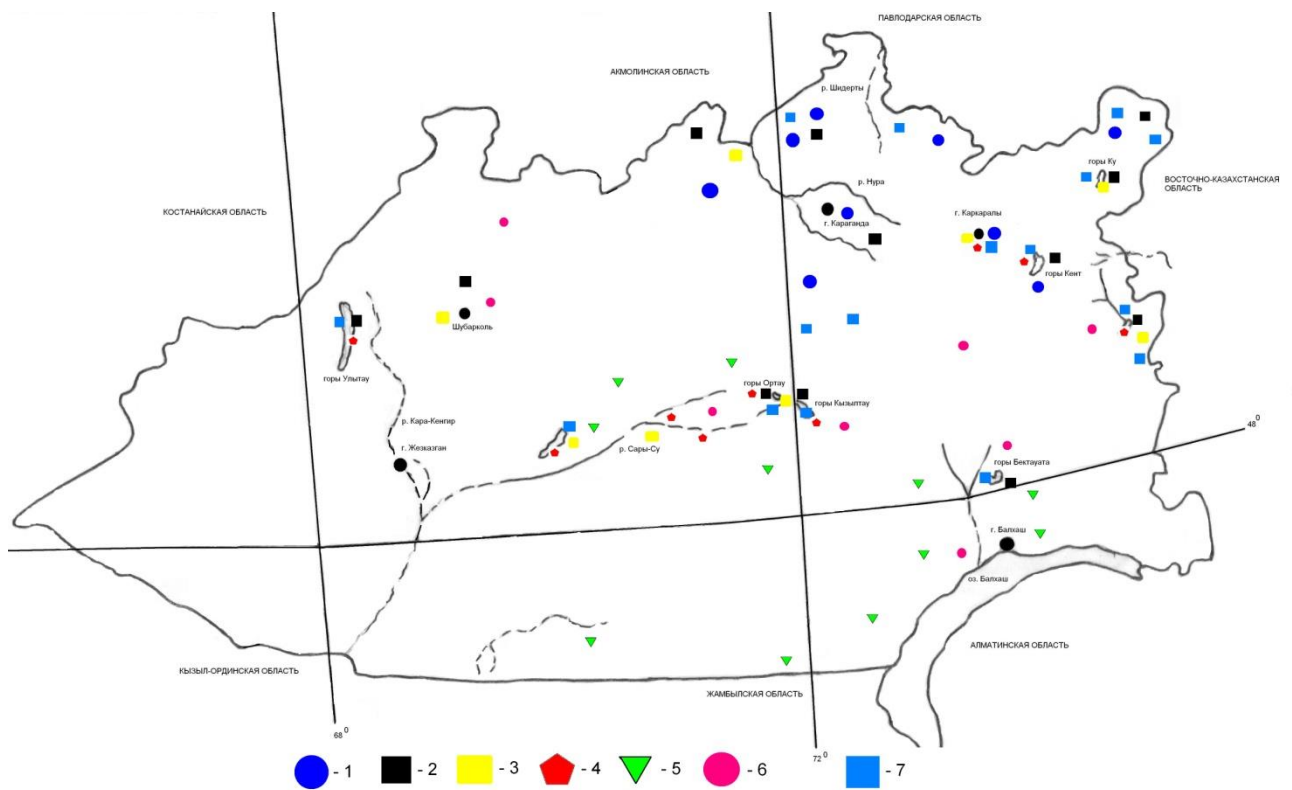
1 – *Cancrinia discoidea*, 2 - *Cancriniella krascheninnikovii*, 3 - *Galatella angustissima*, 4 - *G. divaricata*, 5 - *G.punctata*, 6 - *Helichrysum arenarius*, 7 - *Inula helenium*, 8 - *Linosyris tatarica*, 9 - *L. villosa*



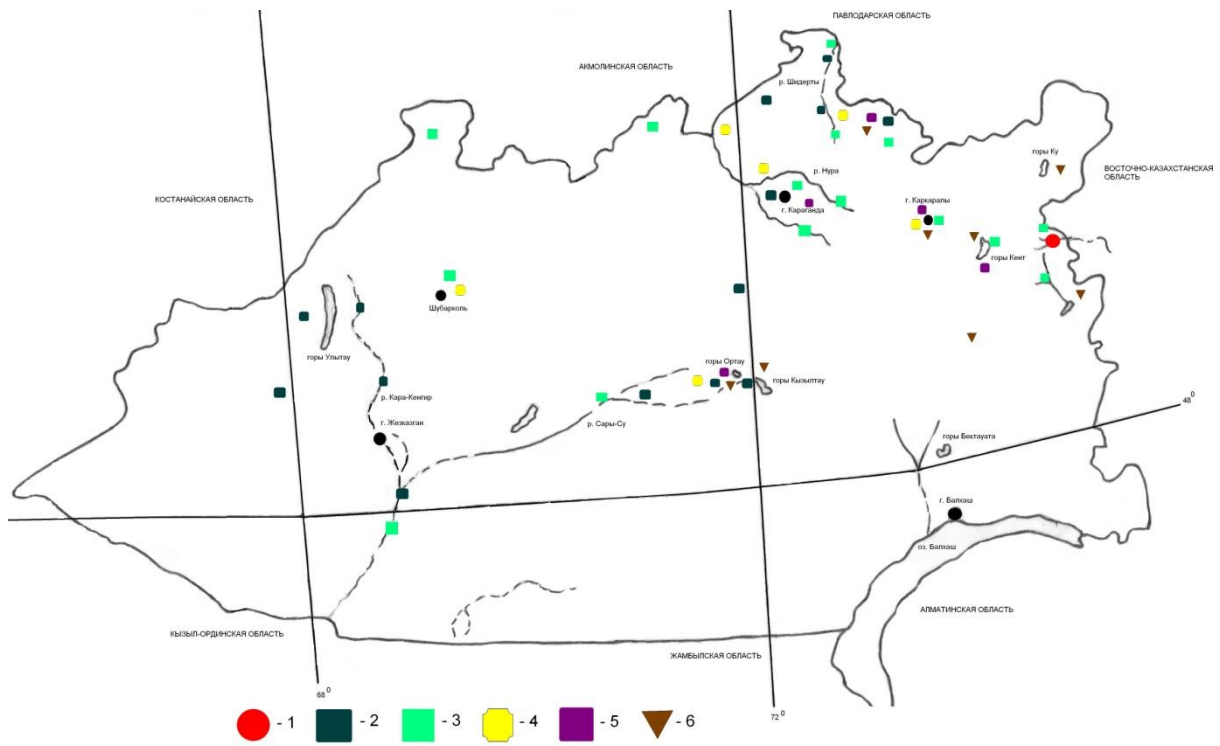
1 - *Tanacetum achilleifolium*, 2 - *T.millefolium*, 3 - *T.santolina*, 4 - *T.scopulorum*, 5 - *T.ulutavicum*, 6 - *T. vulgare*, 7 - *Tripolium vulgare*



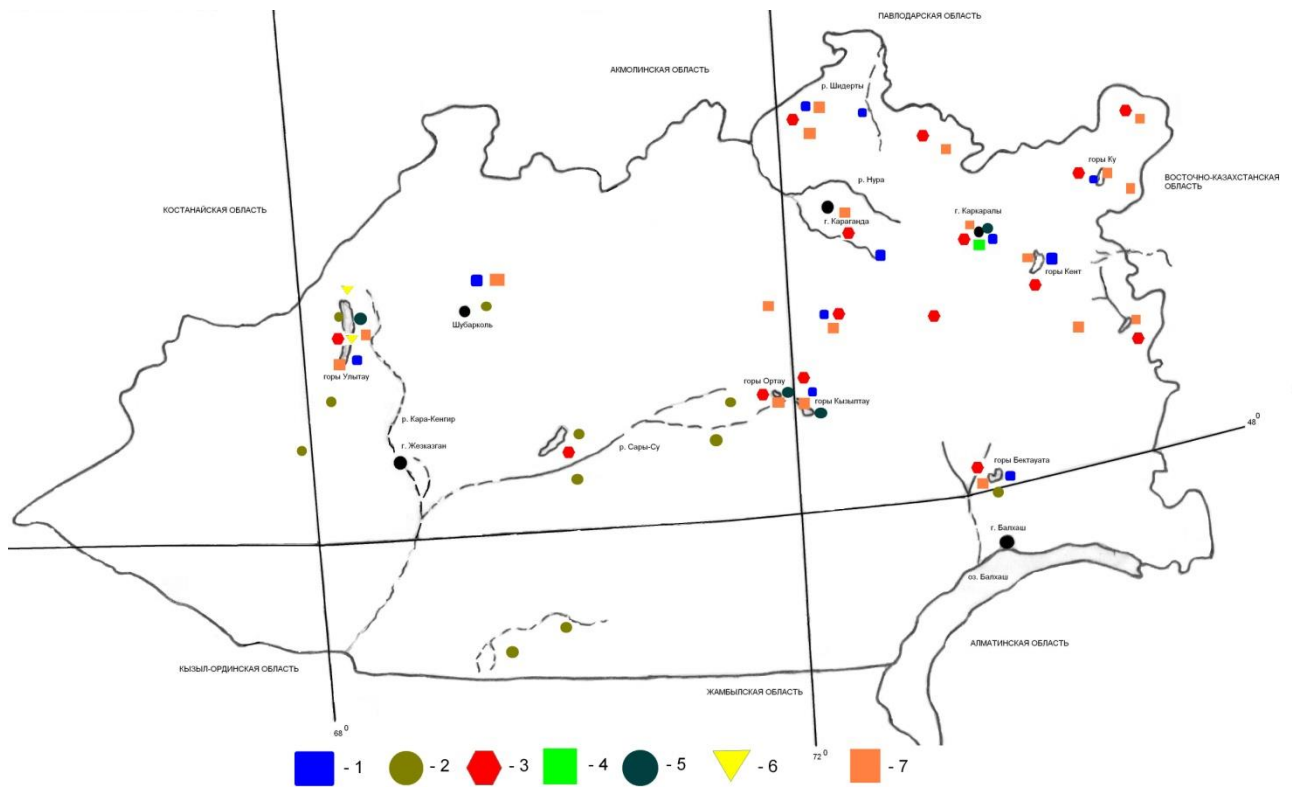
1 - *Alnus glutinosa*, 2 - *Betula kirghisorum*, 3 - *B.microphylla*, 4 - *B. pendula*,
5 – *B.pubescens*, 6 - *Bieberstenia multifida*, 7 - *Cardamine impatiens*, 8 – *Mattiola
robusta*, 9 - *M.superba*



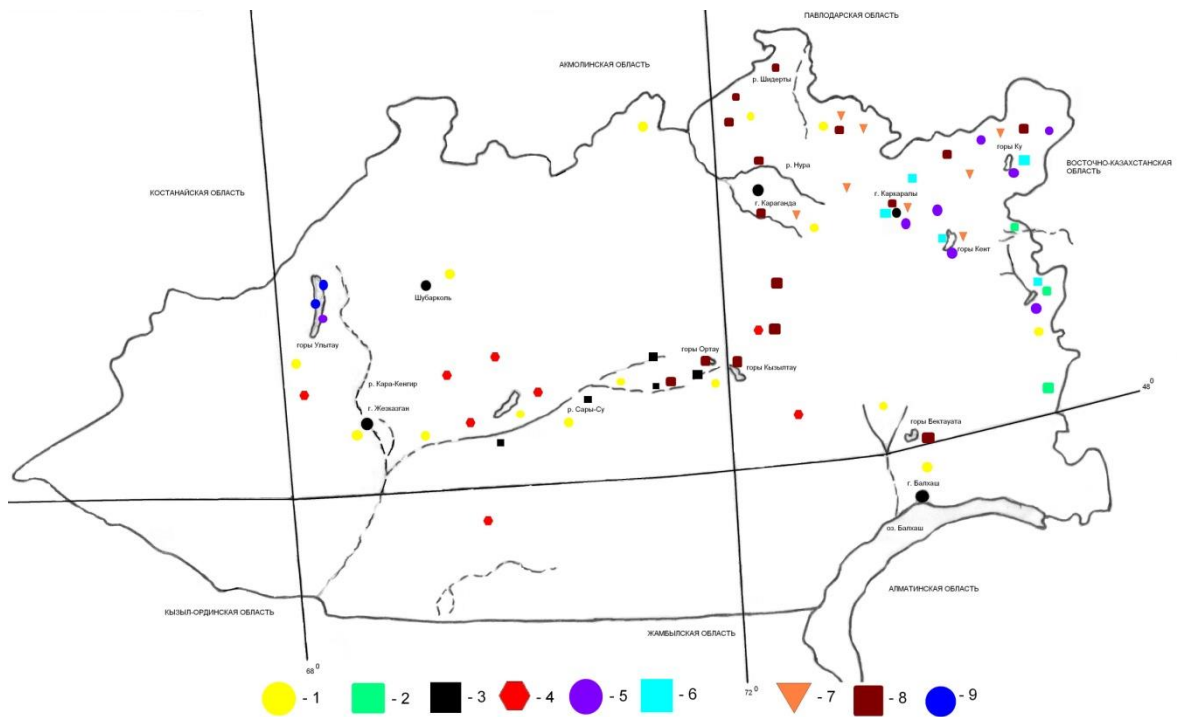
1 - *Dianthus campestris*, 2 - *D. leptopetalus*, 3 - *D.rigidus*, 4 - *Herniaria glabra*,
5 - *Camphorosma monspeliaca*, 6 - *C. soongorica*, 7 - *Juniperus sabina*



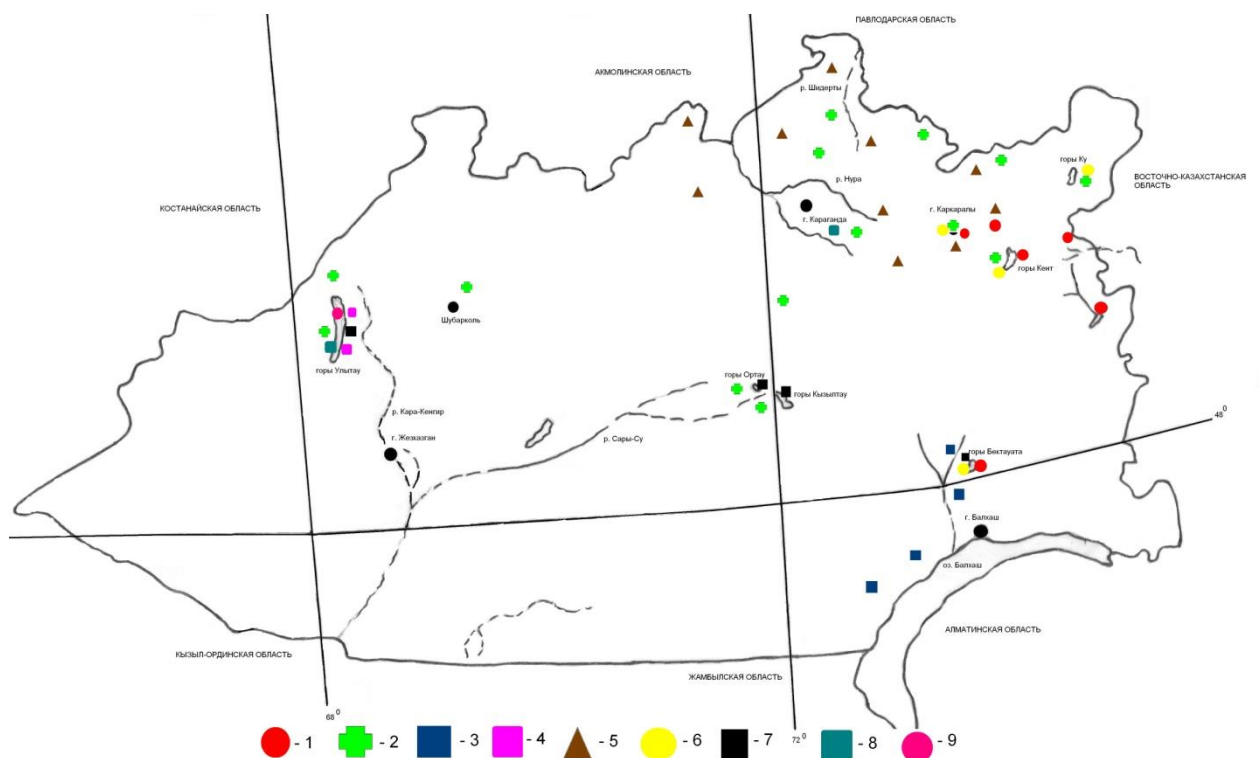
1 - *Cyperus fuscus*, 2 - *Elaeagnus oxycarpa*, 3 – *Melilotus dentatus*, 4 - *M.suaveolens*, 5 - *Ononis arvensis*, 6 - *Gentiana cruciata*



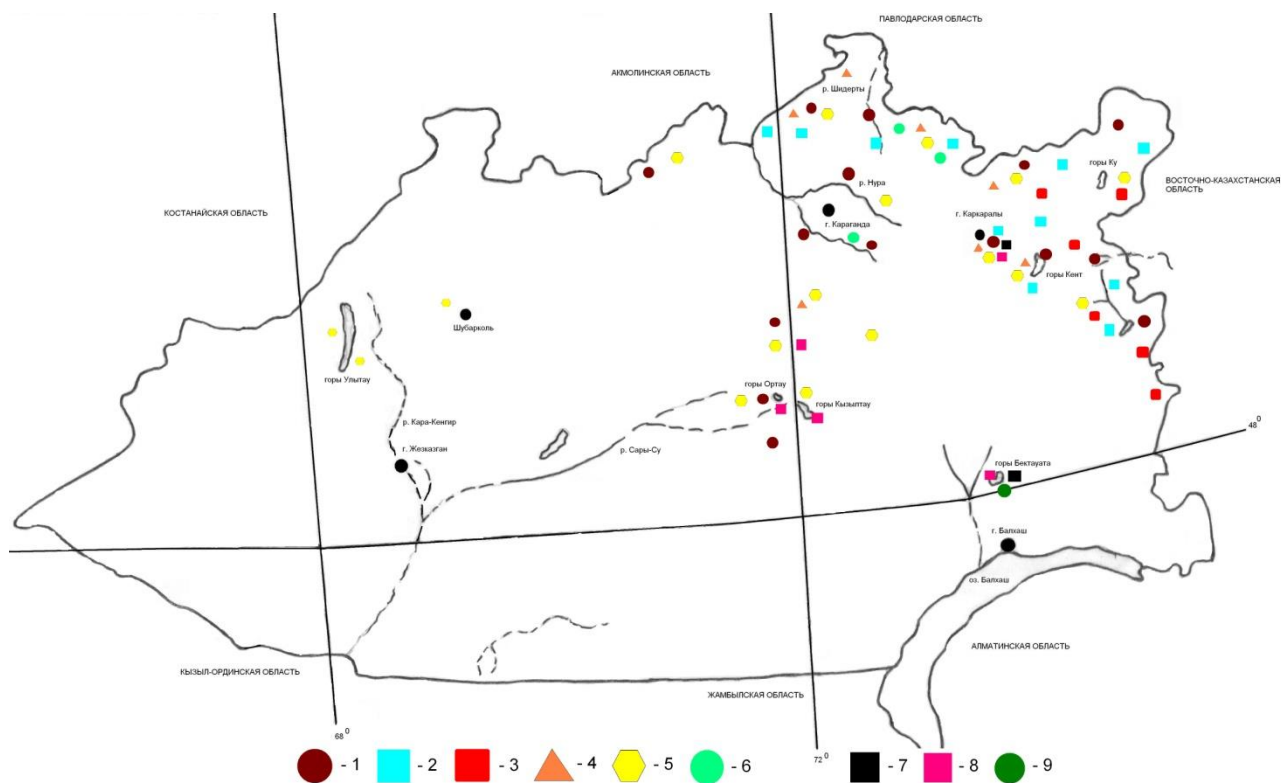
1 - *Geranium collinum*, 2 - *G.transversale*, 3 – *G.pratense*, 4 - *G. sibiricum*, 5 - *Hypericum scabrum*, 6 - *H.hirsutum*, 7 - *H. perforatum*



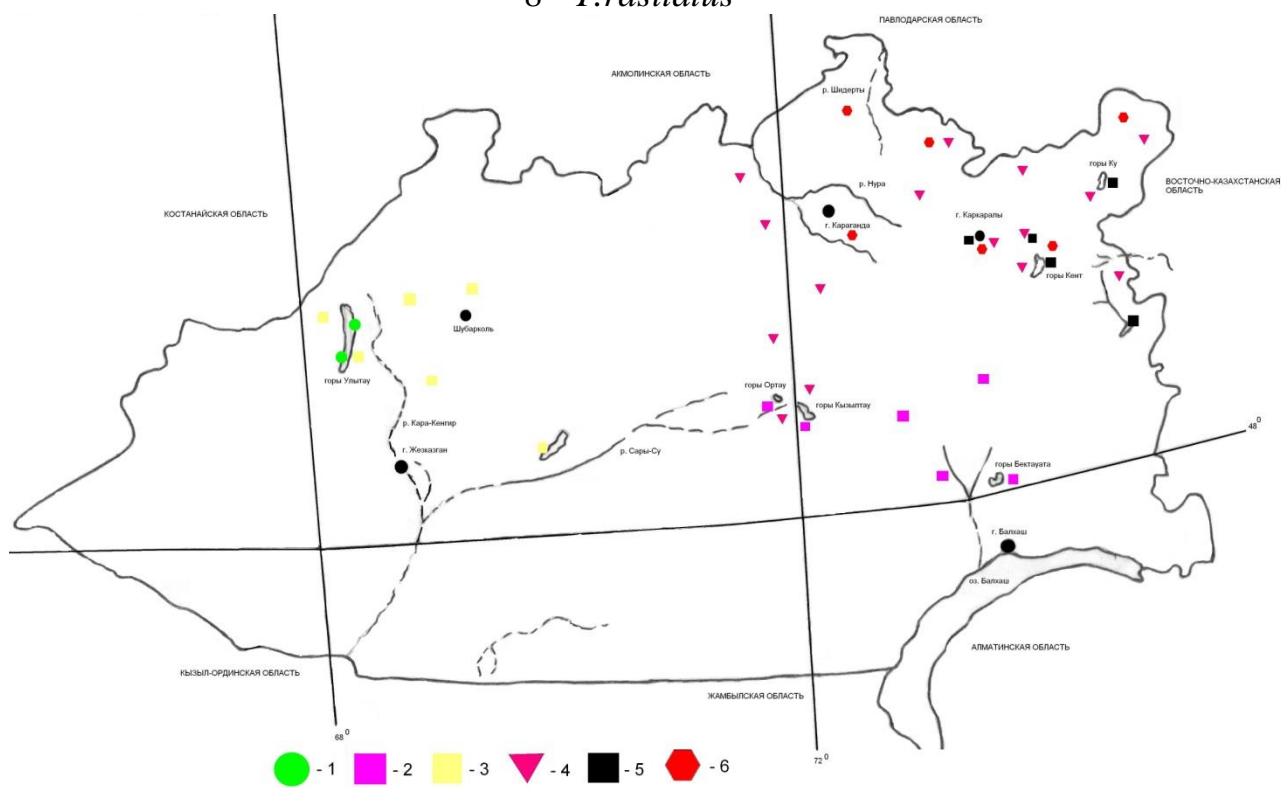
1 - *Iris halophila*, 2 - *I. haematophylla*, 3 - *I. scariosa*, 4 - *I. songarica*, 5 - *I. tenuifolia*, 6 - *Dragocephalum nutans*, 7 - *D. peregrinum*, 8 - *D. ruyschiana*, 9 - *Glechoma hederacea*



1 - *Hyssopus ambiguus*, 2 - *H. macranthus*, 3 - *Lagochillus acutilobus*, 4 - *Lamium amplexicaule*, 5 - *Leonurus glaucescens*, 6 - *Lophanthus schrenkii*, 7 - *Mentha micrantha*, 8 - *Nepeta cataria*, 9 - *Prunella vulgaris*



1 - *Salvia stepposa*, 2 - *Scutellaria grandiflora*, 3 - *S.scordiifolia*, 4 - *Thymus marschallianus*, 5 - *T.lavrenkoanus*, 6 - *T.minussinesis*, 7 - *T.crebrifolius*, 8 - *T.rasitatus*



1 - *Thymus kasakstanicus*, 2 - *T.eremita*, 3 - *Ziziphora bungeana*, 4 - *Z. clinopodioides*, 5 - *Pinus sylvestris*, 6 - *Asparagus officinalis*

APPENDIX B

PHOTOGRAPHS OF ESSENTIAL OIL PLANTS OF NATURAL FLORA OF THE KARAGANDA REGION



Dodartia orientalis



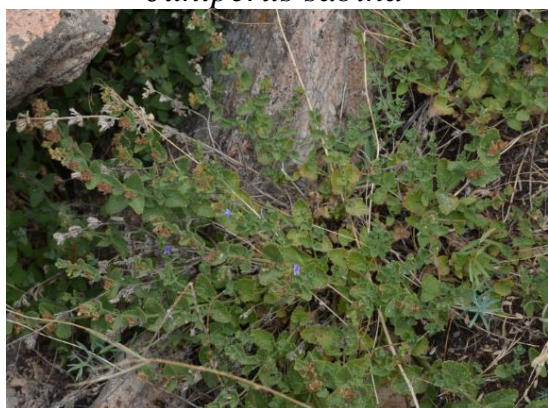
Thymus kirghisorum



Juniperus sabina



Seseli buchtormensis



Lophanthus schrenkii



Alnus glutinosa



Rubus idaeus



Achillea millefolium



Tanacetum vulgare



Rubus saxatilis



Humulus lupulus



Tripleurospermum inodorum



Pinus sylvestris



Pulsatilla patens



Helichrysum arenarium



Phlomis tuberosa



Achillea nobilis



Salvia stepposa



Filipendula ulmaria



Dracocephalum ruyschiana



Polygala comosa



Ribes nigrum



Betula pendula



Achillea salicifolia



Galatella tatarica



Artemisia radicans



Thymus marschallianus



Hyssopus macranthus



Artemisia vulgaris



Frula tatarica



Mentha arvensis



Scutellaria galericata



Ziziphora clinopodioides



Pulicaria prostrata



Prunella vulgaris



Artemisia frigida



Hypericum scabrum



Tanacetum ulutavicum



Eryngium planum



Populus tremula



Seseli sessiliflorum



Ajania fruticulosa



Amygdalus nana



Patrinia intermedia



Thymus serpyllum



Artemisia sericea

APPENDIX C

QUANTITATIVE ACCUMULATION OF ESSENTIAL OILS IN SOME ESSENTIAL OIL PLANTS OF THE CENTRAL KAZAKHSTAN'S FLORA

Species	Place of collection	Phase of vegetation	Quantitative amount of essential oil, %
1	2	3	4
<i>Family Apiaceae</i>			
<i>Aulacospermum denudatum</i>	Karkaraly Mountains	Blossoming – flowering	0.15
<i>Cachrys macrocarpa</i>	Betpakdala upland	Fruitening	0.19
<i>Chaerophyllum prescottii</i>	Korveyevsky forest	Fruitening	1.22
<i>Cicuta virosa</i>	Karkaraly Mountains	Flowering	0.19
<i>Cnidium dubium</i>	Korveyevsky forest	Fruitening	1.22
<i>Eryngium planum</i>	Korveyevsky forest	Flowering	0.24
<i>Ferula feralaioides</i>	Surrounding of settlement Torangilyk	Flowering	0.44
<i>Ferula schair</i>	Betpakdala upland	Fruitening	0.64
<i>Ferula soongorica</i>	Spassky hills	Flowering	2.50
<i>Ferula syreitschikowii</i>	Surrounding of settlement Gulshat	Flowering	0.02
<i>Ferula tatarica</i>	Spassky hills	Flowering	0,85
<i>Peucedanum morissonii</i>	Karkaraly Mountains	Vegetation	0.29
<i>Seseli buchtormense</i>	Bektauata Mountains	Flowering	0.52
<i>Seseli glabratum</i>	Ortau Mountains	Flowering	0.013
<i>Seseli sessiflorum</i>	Ulytau Mountains	Flowering	0.75
<i>Seseli sibiricum</i>	Betpakdala upland	Fruitening	0.28
	Korveyevsky forest	Flowering	0.27
<i>Seseli strictum</i>	Karkaraly Mountains	Flowering	0.19
<i>Family Asteraceae</i>			
<i>Achillea filipendulina</i>	Ortau Mountains	Flowering	1.88
<i>Achillea micrantha</i>	Betpakdala upland	Flowering	0.69
<i>Achillea millefolium</i>	Karkaraly Mountains	Flowering	0.21
<i>Achillea nobilis</i>	Surrounding of settlement Molodezhnii	Blossoming	0.3
	Karkaraly Mountains	Flowering	0.59
<i>Achillea salicifolia</i>	Korveyevsky forest	Flowering	0.28

1	2	3	4
<i>Ajania fruticulosa</i>	Surrounding of settlement Bakhty	Blossoming	0.40
	Surrounding of settlement Bakhty	Flowering	0.29
<i>Artemisia absinthium</i>	Valley of river Nura	Blossoming	0.55
<i>Artemisia armeniaca</i>	Spassky hills	Flowering	0.73
<i>Artemisia austriaca</i>	Betpakdala upland	Flowering	0.39
<i>Artemisia dracunculus</i>	Betpakdala upland	Flowering	1.43
<i>Artemisia frigida</i>	Ulytau Mountains	Fruitening	0.34
<i>Artemisia glabella</i>	Karkaraly Mountains	Vegetation	0.68
	Ulytau Mountains	Blossoming	0.66
<i>Artemisia juncea</i>	Betpakdala upland	Fruitening	0.88
<i>Artemisia kasakorum</i>	Surrounding of settlement Bakhty	Blossoming	0.12
<i>Artemisia lercheana</i>	Betpakdala upland	Fruitening	0.80
<i>Artemisia macrantha</i>	Kent Mountains	Blossoming	0.66
	Kent Mountains	Flowering	0.15
<i>Artemisia marcocephala</i>	Kent Mountains	Flowering	0.99
<i>Artemisia marschalliana</i>	Karkaraly Mountains	Blossoming	0.11
<i>Artemisia nitrosa</i>	Kent Mountains	Blossoming	0.32
<i>Artemisia pontica</i>	Kent Mountains	Blossoming	0.20
<i>Artemisia proceraeformis</i>	Betpakdala upland	Цветение	0.72
	Betpakdala upland	Flowering	0.67
<i>Artemisia santolinifolia</i>	Karkaraly Mountains	Fruitening	0.65
<i>Artemisia scoparia</i>	Betpakdala upland	Flowering	0.06
<i>Artemisia semiarida</i>	Betpakdala upland	Blossoming	1.80
	Betpakdala upland	Fruitening	0.97
<i>Artemisia sericea</i>	Karkaraly Mountains	Flowering	0.57
<i>Artemisia serotina</i>	Betpakdala upland	Fruitening	0.70
	Surrounding of settlement Bakhty	Fruitening	0.87
<i>Artemisia terrae-albae</i>	Betpakdala upland	Fruitening	0.89
<i>Artemisia tournefortiana</i>	Ortau Mountains	Vegetation	0.25

1	2	3	4
<i>Artemisia vulgare</i>	Karkaraly Mountains	Vegetation	0.01
	Ortau Mountains	Blossoming	0.07
<i>Galatella divaricata</i>	Korveyevsky forest	Flowering	0.08
<i>Galatella punctata</i>	Betpakdala upland	Flowering	0.44
<i>Galatella tatarica</i>	Bektauata Mountains	Blossoming	0.43
<i>Inula caspica</i>	Bektauata Mountains	Flowering	0.046
<i>Pulicaria prostrata</i>	Surrounding of settlement Bakhty	Flowering	0.3
<i>Tanacetum scopulorum</i>	Bektauata Mountains	Flowering	0.15
<i>Tanacetum tanacetoides</i>	Betpakdala upland	Flowering	0.51
<i>Tanacetum ulutavicum</i>	Ulytau Mountains	Flowering	0.09
<i>Tanacetum vulgare</i>	Betpakdala upland	Flowering	0.18
<i>Tripleurospermum inodorum</i>	Surrounding of Karaganda city	Flowering	0.56
<i>Family Cupressaceae</i>			
<i>Juniperus sabina</i>	Bektauata Mountains	Fruiting	0.27
	Ulytau Mountains	Fruiting	0.34
<i>Family Geraniaceae</i>			
<i>Geranium collinum</i>	Ortau Mountains	Flowering	0.021
<i>Family Lamiaceae</i>			
<i>Glechoma hederaceae</i>	Korveyevsky forest	Vegetation	0.15
<i>Hyssopus ambiguus</i>	Surrounding of Karaganda city	Flowering	0.17
<i>Hyssopus macranthus</i>	Bektauata Mountains	Flowering	0.94
<i>Lophanthus schrenkii</i>	Bektauata Mountains	Flowering	0.16
<i>Lycopus europaeus</i>	Bektauata Mountains	Flowering	0.29
<i>Mentha micrantha</i>	Bektauata Mountains	Flowering	0.45
<i>Nepeta ucranica</i>	Spassky hills	Flowering	0.47
<i>Phlomis agraria</i>	Karkaraly Mountains	Flowering	0.02
<i>Salvia stepposa</i>	Karkaraly Mountains	Flowering	0.17
<i>Thymus crebrifolius</i>	Ulytau Mountains	Flowering	0.9
<i>Thymus lavrenkoanus</i>	Korveyevsky forest	Fruiting	0.55
<i>Thymus marschallianus</i>	Karkaraly Mountains	Vegetation	1.44
	Spassky hills	Flowering	0.34
	Ortau Mountains	Flowering	0.50
<i>Thymus rasitatus</i>	Bektauata Mountains	Flowering	0.32

1	2	3	4
<i>Thymus roseus</i>	Ortau Mountains	Flowering	0.30
<i>Thymus stepposus</i>	Temirshi Mountains	Fruiting	0.14
<i>Ziziphora clinopodioides</i>	Karkaraly Mountains	Vegetation	0.44
	Valley of river Taldy	Blossoming	0.60
	Bektauata Mountains	Flowering	0.56
	Ulytau Mountains	Fruiting	0.54
<i>Family Pinaceae</i>			
<i>Pinus sylvestris</i>	Karkaraly Mountains	Vegetation	0.58
<i>Family Rosaceae</i>			
<i>Filipendula ulmaria</i>	Spassky hills	Flowering	0.01

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**ESSENTIAL OIL PLANTS OF THE
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Monograph

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