



## A FEW REPRESENTATIVES OF ASTEROIDAE (ASTERACEAE) SUBFAMILY AND GERANIUM (GERANIACEAE) GENUS IN THE BAIKAL REGION (REVIEW)

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**The aim** of the article was to analyze the state of knowledge of the following plants: *Heteropappus altaicus* (Willd.) Novopokr., *Solidago dahurica* L., *Leucanthemum vulgare* Lam., *Tripleurospermum inodorum* (L.), *Antennaria dioica* (L.) Gaertn., *Leontopodium conglobatum* (Turcz.) Hand.-Mazz. and *Geranium eriostemon* Fischer., *G. pratense* L., *G. wlassowianum* Fisch. ex Link. (*Geraniaceae*).

**Materials and methods.** To compile the review, the information from the following scientific open and available literature sources placed in scientific libraries of institutions, in electronic databases and search systems, was used: floristic summaries "Flora of Siberia"; "Flora of Central Siberia"; Electronic library of the Siberian branch of the Russian Academy of Sciences; Elibrary; PubMed; Scopus; CyberLeninka, Google Academy; The Plant List, Global *Compositae* Checklist. The search carried out, was based on the publications for the period of 2009-2020, on the information requests for names of families and sub-families, names of plant species, biologically active compounds in English, Latin and Russian.

**Results.** A comparative analysis of morphological characters, common species names and the synonyms for the listed species, has been carried out. The studied objects are characterized by the presence of polyphenolic compounds and substances of a triterpene structure, in particular, flavonoids, hydroxycinnamic acids, tannides. In addition, the representatives of the *Asteroidae* subfamily (*Asteraceae*) show the accumulation of essential oils, and the representatives of the *Geranium* genus (*geranium*) show the accumulation of anthocyanins. The spectrum of the pharmacological activity includes anti-inflammatory, choleric, antimicrobial, antispasmodic and other types of effects.

**Conclusion.** The presented review makes it possible to arrive at the conclusion about a certain knowledge level of the regional representatives of the *Asteroidae* subfamily and the *Geranium* genus. This determines the prospects of these plant objects for further pharmacognostic and pharmacological research and the creation of drugs on their basis – the sources of polyphenolic compounds.

**Keywords:** *Asteroidae* subfamily; *Geranium* genus; biologically active compounds; phytotherapy

**Abbreviations:** BAC – biologically active compound; HPLC – high performance liquid chromatography; GLC / MS – gas liquid chromatography – mass spectrometry; GC-FID – gas chromatograph with a flame ionization detector; GC-MS – gas chromatography – mass spectrometry; A. – *Antennaria* (e.g., *A. dioica*); C. – *Chrysanthemum* (e.g., *C. dentatum*); Ch. – *Chamomilla* (e.g., *Ch. Inodora*); G. – *Geranium* (e.g., *G. pratense*); H. – *Heteropappus* (e.g., *H. altaicus*); K. – *Kalimeris* (e.g., *K. altaica*); L. – *Leucanthemum* (e.g., *L. vulgare*); M. – *Matricaria* (e.g., *M. perforata*); S. – *Solidago* (e.g., *S. dahurica*); P. – *Pyrethrum* (e.g., *P. elegans*); T. – *Tripleurospermum* (e.g., *T. inodorum*).

## НЕКОТОРЫЕ ПРЕДСТАВИТЕЛИ ПОДСЕМЕЙСТВА ASTEROIDAE (ASTERACEAE) И РОДА GERANIUM (GERANIACEAE) ПРИБАЙКАЛЯ (ОБЗОР)

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**Цель.** В обзоре представлен анализ состояния изученности растений *Heteropappus altaicus* (Willd.) Novopokr. (гетеропаппус алтайский), *Solidago dahurica* L. (золотарник даурский), *Leucanthemum vulgare* Lam. (нивяник обыкновенный), *Tripleurospermum inodorum* (L.) (трехреберник непахучий), *Antennaria dioica* (L.) Gaertn. (кошачья лапка двудомная), *Leontopodium conglobatum* (Turcz.) Hand.-Mazz. (эдельвейс скученный) (*Asteraceae* – сложноцветные) и *Geranium eriostemon* Fischer. (герань волосистотычинковая), *G. pratense* L. (г. луговая), *G. wlassowianum* Fisch. ex Link. (г. Власова) (*Geraniaceae* – гераниевые).

**Материалы и методы.** Для составления обзора использовали сведения научной литературы из открытых и доступных источников, размещенных в научных библиотеках учреждений, в электронных базах данных и поисковых системах: флористические сводки «Флора Сибири»; «Флора Центральной Сибири»; Электронная библиотека Сибирского отделения Российской академии наук; Elibrary; PubMed; Scopus, Киберленинка; Google-Академия; The Plant List; Global Compositae Checklist. Поиск осуществлялся по публикациям за период с 2009 по 2020 гг. по информационным запросам названий семейств и подсемейств, названий видов растений, биологически активных соединений на английском, латинском и русском языках.

**Результаты.** Проведен сравнительный анализ морфологических признаков, общепринятых видовых названий и синонимов перечисленных видов. Для изучаемых объектов характерно присутствие полифенольных соединений и веществ тритерпеновой структуры. В частности, флавоноидов, гидроксикоричных кислот, танидов. Кроме того, у представителей подсемейства *Asteroideae* (астровые) отмечается накопление эфирного масла, а у представителей рода *Geranium* (герань) – антоцианов. Спектр фармакологической активности охватывает противовоспалительное, желчегонное, антимикробное, спазмолитическое и другие виды действия.

**Заключение.** Представленный обзор позволяет сделать вывод об определенном уровне изученности региональных представителей подсемейства *Asteroideae* и рода *Geranium*. Это обуславливает перспективность данных растительных объектов для дальнейшего фармакогностического и фармакологического исследования и создания на их основе лекарственных препаратов – источников полифенольных соединений.

**Ключевые слова:** подсемейство *Asteroideae*; род *Geranium*; биологически активные соединения; фитотерапия

**Список сокращений:** БАС – биологически активные соединения; ВЭЖХ – высокоэффективная жидкостная хроматография; ГЖХ/МС – газожидкостная хроматография / масс-спектрометрия; GC-FID – газовый хроматограф с пламенно-ионизационным детектором; GC-MS – газовая хроматография – масс-спектрометрия; А. – *Antennaria* (н-р, *A. dioica*); С. – *Chrysanthemum* (н-р, *C. dentatum*); Ch. – *Chamomilla* (н-р, *Ch. Inodora*); G. – *Geranium* (н-р, *G. pratense*); H. – *Heteropappus* (н-р, *H. altaicus*); K. – *Kalimeris* (н-р, *K. altaica*); L. – *Leucanthemum* (н-р, *L. vulgare*), M. – *Matricaria* (н-р, *M. perforata*), S. – *Solidago* (н-р, *S. dahurica*), P. – *Pyrethrum* (н-р, *P. elegans*); T. – *Tripleurospermum* (н-р, *T. inodorum*).

## INTRODUCTION

According to the forecasts of the World Health Organization<sup>1</sup>, the share of herbal medicines is constantly growing and reaches 60% in the total range of medicines. This is ensured by their objective advantages and possibilities [1]. In the medical practice of the Russian Federation, about 20 thousand medicines are used, more than 40% of which are made from medicinal plant materials. Traditional medical systems of numerous national ethnic groups (Tibetan, Buryat, Russian, etc.) rely primarily on natural resources [2–4].

Currently, in the scientific literature, a lot of attention is paid to the study of metabolites of plant objects as effective antioxidants. The main representatives of such natural substances are polyphenolic compounds – flavonoids, phenol carboxylic acids, tannides, coumarins. In comparison with other natural compounds, they have the highest prevalence, a significant structural diversity and versatile pharmacological properties. Polyphenolic compounds cause antioxidant, cardiotropic, angioprotective, capillary-strengthening, hepatoprotective, choleric, diuretic and other important effects [5–7]. It should be notified that the plant material contains a mixture of polyphenolic metabolites. This fact affects the specificity of the pharmacological action and forms

the scientific basis for modeling and creating new effective herbal preparations [1, 5–10].

In this regard, it is urgent to search for new types of plant materials containing polyphenolic compounds, used to treat the most common diseases.

In this context, some species of the *Asteraceae* or *Compositae* and *Geraniaceae* families growing in the Baikal region are of the greatest interest. In particular, these are: *Heteropappus altaicus* (Willd.) Novopokr., *Solidago dahurica* L., *Leucanthemum vulgare* Lam., *Tripleurospermum inodorum* (L.), *Antennaria dioica* (L.) Gaertn., *Leontopodium conglobatum* (Turcz.) Hand.-Mazz. (*Asteraceae*, *Asteroideae*), and *Geranium eriostemon* Fischer., *G. pratense* L., *G. wlassowianum* Fisch. ex Link. (*Geraniaceae*, *Geranium*).

**THE AIM** of the article was to analyze and review the data from domestic and foreign scientific literature on the current state of plants knowledge in the Baikal region as promising sources of polyphenolic compounds.

## MATERIALS AND METHODS

To compile the review, the information from the following scientific open and available literature sources placed in scientific libraries of institutions, in electronic databases and search systems, was used: floristic summaries “Flora of Siberia”; “Flora of Central Siberia”;

<sup>1</sup> WHO Traditional Medicine Strategy 2014–2023 Published by WHO, 2013.72 p.

Electronic library of the Siberian branch of the Russian Academy of Sciences; Elibrary; PubMed; Scopus; Cyber-Leninka; Google Academy; The Plant List; Global *Compositae* Checklist. The search carried out, was based on the publications for the period of 2009–2020, on the information requests for names of families and subfamilies, names of plant species, biologically active compounds in English, Latin and Russian.

## RESULTS AND DISCUSSION

### *Asteroidae* Subfamily

*Asteraceae*, or *Compositae*, are one of the largest families of dicotyledonous plants, widely represented in all floristic systems of the Earth. *Asteraceae* include 32,913 species, united in 1911 genera [11]. This accounts for approximately 8% of all known flowering plants [12].

Representatives of *Asteraceae* are actively involved in the construction of phytocenoses, they often have a pronounced confinement to the places with certain environmental factors. Some species are endemic, relics, naturalized or feral, as well as introduced because of anthropogenic activities [13].

A multiflorous inflorescence, an anthode, is one of the priority features of this family. The anthode is a short-cut torus, with small flowers collected on them (semiflorets and false – semiflorets, tubular and funnel-shaped). The anthodes are often grouped into complex aggregate inflorescences – spicas, racemes, panicles, cymoids or capitulum. In turn, the *Asteraceae* family, depending on the type of the flowers included in the inflorescence, is subdivided into 2 large subfamilies:

– *Asteroidae* Lindl. (*Tubuliflorae*) subfamily – in the inflorescence of the false-semiflorets, the flowers are tubular, funnel-shaped;

– *Lactuoidae* L. (*Liguliflorae*) subfamily – in the inflorescence there are semiflorets and laticifer [14].

Many representatives of the *Asteraceae* family (the *Asteroidae* and *Lactuoidae* subfamilies) are official and are included in all issues of the State Pharmacopoeia of our country. Currently, about 30 species of this family plants are allowed to be used as sources of medicinal plant raw materials in Russia<sup>2,3,4</sup>.

Pharmacopoeial representatives of *Asteraceae* are used as vitamin and diaphoretic (*Calendulae officinale flores*, *Bidentis tripartitae herba*), choleric and hepatoprotective (*Tanacetum vulgare flores*, *Helichrysum arenarium flores*, *Silibium mariani fructus*, etc.), anti-inflammatory (*Chamomilla recutita flores*), diuretics and choleric (*Arctium radices*), anti-inflammatory and expectorant (*Tussilaginifolia farfarae folia*), hemostatic (*Arnica*

*montana flores*), immunostimulating (*Echinacea purpurea herba*) remedies. They are also the sources of drugs that have biological antispasmodic and M-cholinolytic actions (*Senecionis platyphylloides herba*), etc. The main groups of biologically active compounds of these plants are vitamins, flavonoids, tannins, essential oils, alkaloids, polysaccharides.

The plants of the *Asteroidae* and *Lactuoidae* subfamilies are found in all areas of the Baikal region. The *Asteroidae* (*Tubuliflorae*) subfamily prevails: it comprises about 85% of all genera (or 61) of the *Asteraceae* family. The constancy of their position in the ecological systems of Siberia is the basis for a long-time use of *Asteroidae* species in folk medicine of this region. About 20 representatives of this subfamily are described as medicinal, mainly from *Solidago* L., *Tripleurospermum* Sch.Bip., *Leucanthemum* Mill., *Heteropappus* Less., *Leontopodium* L., *Antennaria* Gaertn. [15–17].

The analysis of the available literature sources showed that *H. altaicus*, *S. dahurica*, *L. vulgare*, *T. inodorum*, *A. dioica*, *L. conglobatum* species have a specific use in folk and traditional medicine, are popular for the treatment of digestive and genitourinary diseases and are objects for study in various scientific fields.

### *Antennaria dioica* (L.) Gaertn.

In “Flora of Central Siberia” [18] and the Electronic Library of the Siberian Branch of the Russian Academy of Sciences (EL SB RAS) [19], three species belonging to the *Antennaria* (L.) Gaertn have been described. – *A. monocephala* DC., *A. dioica* (D. Don) Greene and *A. villifera* Boriss. *A. friesiana* (Trautv.) Ekman has been additionally included in the list of volume 13 “Flora of Siberia” [13]. The species *A. dioica* (L.) Gaertn is more popular in folk medicine [20]. The synonymous names for this species are: *A. dioica* var. *australis* Gris, *A. dioica* var. *corymbosa* (E.E.Nelson) Jeps., *A. dioica* var. *dioica*, *A. dioica* var. *hyperborea* (D.Don) Greene, *A. dioica* var. *hyperborea* (D.Don) DC., *A. dioica* var. *kernensis* Jeps., *A. dioica* var. *marginata* (Greene) Jeps., *A. dioica* var. *parvifolia* (Nutt.) Torr. & A.Gray, *A. dioica* var. *rosea* (Greene) D.C. Eaton, *A. dioica* var. *rosea* Cockerell. [11, 19].

Distribution. In the Baikal region, *A. dioica* occupies all areas of the Central Siberian plateau, occurs in the Sayans and the Sayan-Baikal region, the Baikal and Stanovoe Highlands, as well as in the steppe regions of Buryatia. It prefers the following habitats: dry tundra slopes, pine forests, forest edges, dry meadows, stony-gravelly, light forests [13, 18, 19]. Besides, it grows in different countries: China, Japan, Kazakhstan, Mongolia, Europe, North America (Alaska) [21]. GLC / MS methods revealed the presence of sugars: D-glucose, D-sucrose and myo-inositol. The amino acid complex includes sixteen free and seventeen linked amino acids. In terms of the content, L-glutamic acid (up to 7.38±0.20 µg/mg) and L-aspartic acid (up to 5.38±0.12 µg/mg) prevailed [22, 23].

<sup>2</sup> State Pharmacopoeia of the Russian Federation. Ministry of Health of the Russian Federation. XIII ed. M., 2015. Available from: [http://193.2327\(13\). Russian](http://193.2327(13). Russian)

<sup>3</sup> State Pharmacopoeia of the Russian Federation / Ministry of Health of the Russian Federation. XIV ed. T. I–IV. M., 2018. Available from: [http://193.232.7.120 \(14\). Russian](http://193.232.7.120 (14). Russian)

<sup>4</sup> State Register of Medicines. Available from: <http://grls.rosminzdrav.ru. Russian>

From the aerial parts of *A. dioica*, the representatives of polyphenols were isolated, in particular, phenol carboxylic acids – caffeic and chlorogenic; flavonoids – apigenin, luteolin, 7-glucoside and 4<sup>l</sup>- apigenin glucoside, 7,4<sup>l</sup>-luteolin diglucoside, 7-O-β-D-glucoside and 4<sup>l</sup>-O-β-D-luteolin glucoside. Along with this, triterpene compounds such as ursolic acid and lupeol, steroids – β-sitosterol, sitosterol-3-O-glucopyranoside (daucosterol), which have antibacterial activity, were found [22, 24].

The composition of flavonoids, coumarins, and hydroxycinnamic acids of *A. dioica*, growing on the territory of the Vyzhnytsya district of the Chernivtsi region (Ukraine), has been studied. HPLC method revealed rosmarinic, caffeic, ferulic, coumaric, chlorogenic acids; quercetin-3-D-glucoside, luteolin, rutin, hyperoside, quercetin, apigenin, as well as umbelliferone and coumarin [25].

In the process of studying literary sources, information was found on the contents of tannins, flavonoids, vitamin K, resins and bitterness [24].

It was noted that the selenium content can be up to 0.012% of dry phytomass. Thus, *A. dioica* is considered a source of this element, an important microcomponent in the nutrition of animals and humans [26].

Traditional medicine suggests using the aerial part of *A. dioica* (D. Don) Greene – the anthode and herb. They are used orally in the form of infusions; externally in the form of powder, gruel made of raw materials, and applications [21]. The extracts from the herb of this plant are astringent. They are taken orally for dysentery, diarrhea, gastritis, stomach and duodenal ulcers. The herb infusion is used as an anti-inflammatory and emollient remedy in the form of rinses and poultices for angina, tonsillitis, stomatitis, goiter, abscesses, septic wounds, breast tumors and as a pain reliever for gout. Fresh herb is applied to the gums to relieve a toothache. Gruel from fresh leaves is applied to the fingers for panaritium, and the wounds are sprinkled with powder from dried leaves. Infusion in the form of applications is used for eye diseases, in the form of douching – for gonorrhoea and leucorrhoea. In the past, healers and root doctors advised chewing flowers and taking an infusion for epilepsy and other diseases of the nervous system [21].

Kalinin E.P. et al. confirmed the hemostatic effect of biologically active compounds of *A. dioica* *in vitro* and *in vivo*. It was found out that the anticoagulant activity is manifested by the fraction of the protein-peptide nature [27].

Morphological and anatomical studies of the aerial parts of *A. dioica* were carried out in order to establish the diagnostic signs of the vegetative organs [28, 29].

### *Leucanthemum vulgare* (Vaill.) Lam.

Along with *T. Inodorum*, *L. vulgare*, is an admixture to the official raw material of *Chamomillae recutitae*

*flores* и *Chamomillae suaveolentis flores*<sup>5,6,7,8</sup>. However, they are also objects of scientific research.

*L. vulgare* (*L. vulgare* (Vaill.) Lam.) is the only species of *Leucanthemum* genus, represented on the territory of the Baikal region (Eastern Siberia).

The database “The Plant List” contains 37 synonyms for this name, among which 3 have the status of unconfirmed or used without an agreement with the rules of the International Code of Botanical Nomenclature (see paragraphs 1, 3, 15) [11]: *Bellis major* Garsault [Invalid], *Chamaemelum leucanthemum* (L.) E.H.L.Krause, *Chrysanthemum dentatum* Gilib. [Invalid], *C. irtutianum* Turcz., *C. lanceolatum* Vest, *C. lanceolatum* Pers., *C. leucanthemum* L., *C. leucanthemum* var. *boecheri* B.Boivin, *C. leucanthemum* subsp. *lanceolatum* (DC.) E.Mayer, *C. leucanthemum* subsp. *Leucanthemum*, *C. leucanthemum* var. *leucanthemum*, *C. leucanthemum* f. *leucanthemum*, *C. leucanthemum* var. *pinnatifidum* Lecoq & Lamotte, *C. leucanthemum* var. *subpinnatifidum* Fernald, *C. montanum* Willd. [Illegitimate], *C. montanum* var. *heterophyllum* (Willd.) Koch, *C. praecox* (M.Bieb.) DC., *C. pratense* Salisb., *C. sylvestre* Willd., *C. vulgare* (Lam.) Gaterau., *C. vulgare* var. *vulgare*, *Leucanthemum atratum* var. *heterophyllum* (Willd.) Rouy, *L. lanceolatum* DC., *L. leucanthemum* (L.) Rydb. [Illegitimate], *L. praecox* (Horvatić) Villard, *L. vulgare* subsp. *heterophyllum* (Willd.) Soó, *L. vulgare* subsp. *incisum* Arcang., *L. vulgare* var. *pinnatifidum* (Lecoq & Lamotte) Moldenke, *L. vulgare* subsp. *praecox* Horvatić, *L. vulgare* var. *vulgare*, *L. vulgare* subsp. *vulgare*, *Matricaria leucanthemum* (L.) Scop., *M. leucanthemum* (L.) Desr., *Pontia heterophylla* (Willd.) Bubani, *P. vulgaris* Bubani, *Pyrethrum leucanthemum* (L.) Franch., *Tanacetum leucanthemum* (L.) Sch. Bip.

*L. vulgare* has grey fruits- achenes, up to 2 mm long, with 5–10 distinct ribs, there is no coronet, as a rule, only occasionally the seeds of semiflorets show a unilateral coronet. Representatives with a unilateral coronet of achenes from the Irkutsk region are described for the *L. irtutianum* DC species and occur sporadically throughout the *L. vulgare* range in all regions of Siberia. Moreover, the presence of this trait varies even within the population, which makes it possible to consider *L. irtutianum* as variety or *L. vulgare* var. *irtutianum* (DC) Krylov. [13, 19].

The *L. vulgare* range covers the western and southern parts of the Central Siberian Plateau, the Sayans and the Sayan-Baikal region, the Baikal Plateau in its western part, and the northern part of the North-Baikal Plateau. Its habitat is represented by meadows, meadow slopes,

<sup>5</sup> GOST 2237-93. Chamomile flowers. Technical conditions. 10 pp. Russian

<sup>6</sup> State Pharmacopoeia of the Russian Federation / Ministry of Health of the Russian Federation. XIII ed. M., 2015. Russian

<sup>7</sup> State Register of Medicines. Russian

<sup>8</sup> Register of medicines of Russia. Radar Encyclopedia of Medicines. Issue 26. M., 2018. Available from: [https://www.rlsnet.ru/news\\_101979.htm](https://www.rlsnet.ru/news_101979.htm). Russian

forest glades, the border areas; it is often a ruderal species [13]. An assessment of the raw material reserves of this type has been carried out in the Irkutsk region [30].

At the beginning of the previous century, *L. vulgare* used to spread throughout Europe (excluding the Arctic zone) and in most of Asia (excluding the Arctic zone). Thanks to the anthropogenic activities, including the globalization of migration processes, this species was introduced to other climatic zones and continents (North America). In any case, it is presented as a sun-loving plant that also prefers meadows, forest-steppes, mountainous and subalpine regions. In the places of human farming or in ruderal territories, it occurs along roadsides, on the outskirts of fields, in fallow lands, in crops, in pastures and meadows. It spreads very well on fertile soils; it is characterized as a field weed [31].

*L. vulgare* is included in the arsenal of traditional medicine in Russia, Azerbaijan, Georgia, Italy, America, Canada, Albania, Serbia, etc. [36-38]. According to the authors Telyat'ev VV, Minaeva VG, the main active ingredients are alkaloids, inulin, ascorbic acid and carotene are found in the leaves, 11% of fatty oil in the seeds, and dyes (in the flowers) [24]. The researchers are showing interest in various groups of organic compounds of this kind. The components of the alicyclic structure were isolated from the aerial parts: hexadecacyclobut [1.2:3.4] bicyclooctene, 13-hexyloxacyclotridec-10-en-2-one (aromatic component). Among the polyene compounds, (Z) -en-in-bicycloether was found out, and the group of aliphatic hydrocarbons and aldehydes was represented by n-nonadecane, dimethylpentadecane, n-eicosane, n-tricosane, n-pentacosane, n-octanal, n-undecanal, n-penta, (E, E) -2,4-decadienal, n-tridecanal. The chemical composition of the primary metabolites of the aerial parts of *L. vulgare* is characterized by the presence of higher fatty acids, such as octanoic, nonanoic, decanoic, n-undecanoic, cis-linoleic, rauric, myristic, palmitic and their derivatives – 2-methylbutyl-2-methylbutyrate, isoamyloisovalerate, 1-octenyl acetate, n-pentylisovalerianate,  $\gamma$ -palmitolactone [35].

The essential oil of *L. vulgare* inflorescences is in the amount not exceeding 0.5% and includes terpenoids – mono- and sesquiterpenes: sabinene, myrcene, n-cymene, limonene, (E) - $\beta$ -ocymene, 1,8-cineole, terpinene-4-ol,  $\alpha$ -terpniol, geranyl acetate, geranylisovalerianate,  $\alpha$ -cubeben,  $\alpha$ -copaen, (E) - $\beta$ -caryophyllene, aromadendrene,  $\alpha$ -humulene, (E) - $\beta$ -farnesene, germacrene,  $\alpha$ -amoren,  $\alpha$ -muurelen,  $\delta$ -cadinene,  $\gamma$ -cadinene, isofaurinone, elemol, caryophyllene oxide, 1,2-humulene epoxide,  $\gamma$ -eudesmol,  $\gamma$ -cadinol, (Z) -lanceol, chamazulene, bisabolol A oxide, hexahydropharsylacetone, farnesolene, nerolidol,  $\alpha$ -bisabolol [36]. A study of the essential oil of *L. vulgare* inflorescences growing on the territory of Estonia, was carried out. 115 compounds were identified by gas chromatography with flame ionization detection GC-FID and mass spectrometry GC-MS. It was found out that the composition of *L. vulgare* essential oil con-

sisted mostly of (E)- $\beta$ -farnesene (7.3%), hexadecahydrocyclobuta, dicyclooctene (5.3%), decanoic acid (4.9%),  $\gamma$ -eudesmol (4.5%) [36].

The composition of the essential oil from the aerial parts of *L. vulgare* growing on the territory of the Ardebil province (Iran) has been studied. In its composition, 47 compounds were identified, among which caryophyllene oxide (21.2%), aromadendrene oxide (13.7%), cis- $\beta$ -farnesene (6.5%), 1-octen-3-yl-acetate (5.6%) and trans-caryophyllene (4.9%) prevailed. According to the authors, the results prove the presence of chemical varieties of this plant species [37].

Polyphenolic compounds found in the aerial parts of *L. vulgare* are represented by flavonoids, phenol carboxylic acids, and coumarins. The following flavonoids were isolated from the flowers of *L. vulgare* growing in Georgia: apigenin, cosmosin, 7-O-(3-D-glucuronide) of apigenin, vitexin, rutin, hyperin, hyperoside, quercetin, luteolin, isorhamnetin, 7-O- $\beta$ -D-glucopyranoside of apigenin, chrysin, 7-O-(3-D-glucuronide) chrysin [38, 39]. Tubular flowers contain phenol carboxylic acids – chlorogenic and caffeic acids; coumarins are represented by umbelliferone and scopoletin [38, 39].

It is notified that in the folk medicine of Georgia and the Baikal region, *L. vulgare* water extracts are used for fevers, colds, coughs, pulmonary tuberculosis, eye diseases, involuntary urination, gastrointestinal colic, migraine, suffocation, pain, etc. Herbs decoction and infusions are prescribed for eye diseases, hernia, hemorrhoids. In addition, the herb and flowers are used externally – for skin rashes, lichen, ulcers, for bathing small children with intestinal spasms and convulsions. For skin diseases, a mixture consisting of crushed herbs together with flowers and rubbed with butter, is applied [15, 16, 39]. The studies devoted to the crude oil influence on the viability of *L. vulgare*, have been carried out. It was found out that this species is able not only to survive in soil exposed to crude oil, but also to reduce the concentration of this pollutant in the soil. The roots of *L. vulgare* successfully formed a symbiosis with mycorrhiza. At the same time, a positive correlation was shown between the concentration of the antioxidant compounds (including polyphenols) and the residual level of the oil concentration in the soil. The results showed that *L. vulgare* can survive under the conditions of pollution with oil products, and contribute to a decrease in their content in the substrate [40].

#### *Tripleurospermum inodorum* (L.)

According to the "Flora of Central Siberia", the *Tripleurospermum* genus of the *Asteroideae* subfamily has only one representative – *Tripleurospermum inodorum* (L.) [18]. According to the floristic summary "Flora of Siberia" [13], the genus has the name of *Matricaria* L. (*Tripleurospermum* Sch.Bip.) and includes three sections, two of which are widespread in Siberia with a population of one species – *Matricaria perforata* = *m.*

*inodora* = *tripleurospermum inodorum* from the section of *Matricaria* (*Tripleurospermum*), and *m. tetragonosperma* = *tripleurospermum tetragonosperma* from the section of *Tetragonosperma*. However, the species *T. inodorum* has been included in "Flora of Siberia" conditionally, since the authors notified its possible presence in the east of Yakutia. The synonyms of the described type [13] are: *Chamomilla inodora* (L.) Gilib. [Invalid], *Ch. inodora* (L.) K.Koch, *Chamaemelum inodorum* (L.) Vis., *Ch. inodorum* var. *inodorum*, *Chrysanthemum inodorum* (L.) L., *Ch. maritimum* var. *inodorum* (L.) Bech., *Dibothrospermum agreste* Knaf., *D. pusillum* Knaf., *Matricaria inodora* L., *M. inodora* var. *agrestis* Weiss., *M. inodora* f. *agrestis* (Weiss) Fiori & Paol., *M. inodora* f. *biennis* Fiori & Paol., *M. inodora* f. *inodora*., *M. inodora* var. *inodora*, *M. inodora* var. *pusilla* Fiori, *M. maritima* var. *agrestis* (Knaf) Wilmott., *M. maritima* subsp. *inodora* (L.) Soó., *M. maritima* subsp. *inodora* (L.) Clapham., *M. maritima* var. *inodora* (L.) Soó, *M. perforata* Mérat., *M. pumila* Nyman., *Pyrethrum elegans* Pollini, *P. inodorum* (L.) Moench., *P. inodorum* var. *inodorum*, *Rhytidospermum inodorum* Sch.Bip. (permission not granted), *Tripleurospermum maritimum* var. *agreste* (Weiss) Briq. & Cavill. *T. maritimum* subsp. *inodorum* (L.) Appleq., *T. maritimum* var. *pusillum* (Knaf) Briq. & Cavill., *T. perforatum* (Mérat) M.Láinz, *T. perforatum* (Mérat) Wagenitz (permission not granted).

In the Irkutsk Region, *T. inodorum* is distributed in the western and southern parts of the Central Siberian Plateau and on the southern coast of Lake Baikal. The main habitats are along ditches, riverbanks, along wastelands and near roads, along the edges and glades of light and dark coniferous, as well as small-leaved forests. Since the plant is ecologically unpretentious (xero-mesophyte, mesotroph), this species colonization is often anthropogenic [13, 18].

It is carried from one place to another by seeds, while one plant can produce a huge number of achenes, according to various estimates, from 50,000–200,000 to 1.5 million and more. The seeds in the soil retain their germination capacity for a long time (up to 7 years). Due to the cold resistance, the seeds germinate early and amicably enough at low soil temperatures, and overwinter well. *T. inodorum* is a weedy species in the agricultural production. It infests not only cereals, but also tilled crops. In the Non-Chernozem zone, it is most likely to infest crops of important perennial grasses (clover and lucerne) and winter grains. A negative impact is also reflected in the fact that *T. inodorum* consumes twice as much moisture as oats and spring wheat, that negatively affects the yield. At the same time, this indicates the ecological stability of the described species. The ecological features of this representative of the *Asteroideae* subfamily serve as the basis for their rapid introduction into culture, including for the purpose of creating an additional raw material base for medicinal plants [30].

In addition to Eastern Siberia, the main areas of *T.*

*inodorum* distribution include Western Europe, Atlantic Europe, the Balkans, Asia Minor, North America, the European part of Russia, the Caucasus, Western Siberia, and the Far East (as an invasive species) [21].

The data analysis from the available literature sources showed that *T. inodorum* contains essential oil, pyrethrin and related compounds, bitterness, mucus, gum, alkaloids, ascorbic acid; fatty oil (in seeds up to 20%) [21].

The essential oil composition of *T. inodorum* growing in Estonia has been studied in detail. The essential oil content did not exceed 0.2%. The main components are mono- and sesquiterpenoids, in particular: E- $\beta$ -ocimene, artemisiaquetone, pinkarvone, geranium isobutanoate,  $\beta$ -caryophyllene, aromadendrene,  $\alpha$ -humulene, E- $\beta$ -farnesene, germacrene D, bicyclgermacrene,  $\alpha$ -amorphin, spatulenol, caryophyllene oxide, bisopoxide trans- $\alpha$ -trans- $\alpha$ , Z- $\alpha$ -bergamotol,  $\gamma$ -eudesmol,  $\gamma$ -cadinol, chamomillol, (Z)-lanceol, bisabolol oxide A, bisabolol oxide B, bisabolone oxide A, aromadendrene oxide 2, alloaromadendrene epoxide, farnesyl acetate, hexylacetyloxyphenol.

The comparison of the essential oil composition of *T. inodorum* flowers and the essential oils of the *Chamomilla recutita* and *Ch. suaveolens* officinal species showed their significant similarity. In *T. inodorum* flowers, most were (Z, Z)-*matricaria ester* (77.9%), (E)- $\beta$ -farnesene (3.5%), *matricaria ester isomer* (3.5%), *matricaria lactone* (3.0%) [36, 41].

Other groups of chemical compounds found in *T. inodorum*, are benzene derivatives: benzyl benzoate; aromatic compound – 1,3,4,5,6,7-hexahydro-2,5,5-trimethyl-2H-2,4a-ethanonaphthalene; a furan derivative – 2-pentylfuran. At the same time, compounds of the aliphatic series were found: n-octadecane, n-nonadecane, n-eicosane, n-tricosane, n-pentacosan, 6-methyl-5-hepten-2-one; fatty acids and their derivatives: decanoic, cis-linoleic, 2-methylbutyl-2-methylbutyrate, isoamylisovalerianate, 2-pentylisovalerianate, cis-hexenylisovalerianate,  $\gamma$ -palmitolactone. From the group of phenylpropanoids, including polyphenolic compounds, the presence of isoeugenol was revealed, 8-methylcoumarin, cosmosin and cynaroside in the inflorescences [42].

In addition, according to the works by a group of Estonian researchers, in the roots and aerial part of *T. inodorum*, there is information about the presence of such a specialized group of chemically active natural compounds as polyacetylenes. They are: trans-methyl-2-decene-4,6,8-triionate; *matricaria ether*, (Z,Z) *matricaria ether*, dihydromatricaria ether, (Z)-lachnophyllum methyl ether, (E)-lachnophyllum methyl ether, (Z)-ene-in-bicycloether, (E)-ene-in-bicycloether; 2*cis*, 8*cis*-matrix triaether, 8*cis*- $\alpha$ , $\beta$ -dihydromatricaria ester, 2Z, 8Z-matrix triaether, 8Z-2,3-dihydromatricaria ester, (2E)-lachnophyllum ester, (2Z)-lachnophyllumate)-diEZ)-matrixia-lacton [36, 42]. On the basis of the Bryansk State Agri-

cultural Academy, the mineral composition of weeds, including *T. inodorum*, was studied. As a result, it was found out that in the aerial parts of this species, in the process of the development and growth, sodium, magnesium, phosphorus, sulfur, silicon, manganese, copper, and molybdenum are accumulated in high concentrations [43].

A comparative phytochemical study showed that the amount of flavonoids in *T. inodorum* flowers exceeds the content of this group BACs in *Ch. recutita* flowers [44, 45].

In folk medicine, the *T. inodorum* herb is used as an analgesic, anti-inflammatory, diuretic, wound healing, antispasmodic, antihelminthic, and insecticidal agent [21].

### ***Heteropappus altaicus* (Willd.) Novopokr.**

On the territory of the Baikal region, *Heteropappus* Less. genus is represented by three species – *Heteropappus hispidus* (Thunb.) Lees., *H. tataricus* (Lindl.), and *H. altaicus* (Willd.) Novopokr. [21]. “Flora of Siberia” [13], which includes descriptions of West and East Siberian plants and EL SB RAS [19], characterizes 3 species – *H. biennis* (Ledeb.) Tamamsch. ex grub. (syn. *H. tataricus*), *H. altaicus* subsp. *altaicus*, *H. altaicus* subsp. *appressifolius* Koroljuk.

According to the information base “The Plant List” [11], the name *H. hispidus* is synonymous with the species of *Kalimeris hispida* (Thunb.) Nees (*Kalimeris, Compositae* genus).

Taking into account the practical importance of the *H. tataricus* and *H. altaicus* species, a further was attention paid to these particular species.

*H. tataricus* Tamamsch. is the officially accepted name of the species, there are no synonyms [11]. However, there is information about the synonymy of *H. biennis* (Ledeb.) Tamamsch. ex Grub. (*H. tataricus* (Lindl.) Tamamsch.) [42]. *H. tataricus* is distributed in Western and Eastern Siberia, as well as in the Far East. It prefers valleys, steppe and dry meadows, forest edges, steppes. The species is a biennial [11, 13].

Triterpenoids such as polygalic acid, 28-O-[ $\alpha$ -L-rhamnopyranosyl-(1 $\rightarrow$ 2)]-[ $\beta$ -D-xylopyranosyl-(1 $\rightarrow$ 3)]- $\beta$ -D-glucopyranoside of arjunolic acid (heteropappusaponin I), as well as flavonoids – rutin, nicotiflorin, isoramnetin 3-O-rutoside – have been found in this species herb. An antifungal activity of polygalic acid isolated from the aerial organs of *H. tataricus*, has been experimentally established [42].

*H. altaicus* is a perennial herb. It inhabits the southern part of the Central Siberian plateau, in the mountains of the Eastern Sayans, in the Sayan-Baikal and Barguzinsky regions, Vitim Highlands, it is recorded in the southern part of Buryatia and Dauria. *H. altaicus* is a sun-loving xeromesophyte, preferring riverbanks, lakes, including saline ones, as well as dry and steppe meadows and steppes [13, 18 19]. *H. altaicus* (Willd.) Novo-

pokr. (syn. *Aster altaicus* Willd. 1809, Enum. Hort. Berol. 2: 880. – *Aster altaicus* Willd. var. *canescens* (Nees) Serg. – *Heteropappus canescens* (Nees) Novopokr. – *Heteropappus distortus* (Turcz. ex Ave-Lall.) Tamamsch. [18, 19].

The information base “The Plant List” [11] indicates the presence of 18 synonyms for this species: *Aster altaicus* var. *medius* Krylov, *A. altaicus* var. *uchiyamae* (Nakai) Kitam., *A. angustifolius* Lindl., *A. distortus* Turcz. ex Avé-Lall., *A. gebleri* Besser ex DC., *A. lithospermifolius* Desf., *A. medius* (Krylov) Serg., *A. millefolius* Vaniot, *A. pumilus* Fisch., *A. pyrrhopappus* Boiss., *A. spartioides* C.B. Clarke, *Brachyactis altaica* (DC.) Kitam., *Conyza altaica* DC., *Galatella altaica* Tzvelev., *G. juncea* Lindl. ex DC., *Heteropappus altaicus* subsp. *altaicus*, *H. altaicus* var. *altaicus*, *H. distortus* (Turcz. ex Avé-Lall.) Tamamsch.

The species is described in the lists of “Flora of China” [46] as *Aster altaicus* var. *altaicus*. The names *Aster gmelinii* Tausch, *Heteropappus altaicus* (Willdenow) Novopokrovsky, *Kalimeris altaica* (Willdenow) Nees, *K. altaica* var. *subincana* Avé-Lallemant are marked as synonymous. It occurs in some China provinces, in addition, in the state of Kashmir (India), Kazakhstan, Mongolia. In the described territories, the species is found in the steppe, in meadows, salt marshes, rocky hillsides, as well as along roadsides and along riverbanks.

According to different authors’ data, *H. altaicus* contains saponins, terpenoids, alkaloids, coumarins, flavonoids and tannins, essential oil. Foreign sources report that *H. altaicus* essential oil contains at least 54 components. The main ones are monoterpenes and triterpenes. Most of them are occupied by germacrane D, caryophyllene,  $\beta$ -pinene,  $\beta$ -felandrene, and limonene (20%, 7%, 5%, 4 and 3%, respectively, in the total amount of identified components) [47]. The composition of mono and sesquiterpenoids of the *H. altaicus* aerial parts has been studied in detail. As a result, the presence of the following components has been established: farnesol, (-)-spatulol,  $1\beta$  10 $\alpha$ -caryophyllene epoxide, 4 $\alpha$ 7 $\beta$ -dihydroxy-10 $\beta$ H-guai-5-ene-1 $\beta$ 8 $\beta$ -endoxide, 1 $\beta$ -methoxycariol-9-one;  $\alpha$ -thuyene,  $\alpha$ -pinene,  $\beta$ -pinene, camphene, sabinene, myrcene,  $\alpha$ -felandrene,  $\Delta$ 3-carene,  $\alpha$ -terpinene,  $\lambda$ -terpinene, (Z) - $\beta$ -ocymene, terpinolene, *n*-cymene, limonene,  $\beta$ -pellandrene, 1,8- cineole, cis-chrysanthenyl acetate, bornyl acetate,  $\alpha$ -terpinyl acetate, trans-sabinylyl acetate,  $\delta$ -elemene,  $\alpha$ -copaen,  $\beta$ -patchulene,  $\beta$ -bourbonene,  $\beta$ -elemene,  $\beta$ -caryofellen,  $\beta$ -copaen,  $\alpha$ -humulene, germacrene D,  $\beta$ -selenene, cingiberen, bicyclogermacrene, trans- $\beta$ -guayenne, (E, E) - $\alpha$ -farnesene,  $\beta$ -farnesene,  $\delta$ -cadinene, spatulol, caryofellene oxide, guayol [15, 16, 48].

In the aerial parts of *H. altaicus* (in flowers), the presence of diterpenoids and triterpenoids has been established. The first group includes trans-phytol, (-)-hardwickic and hautrivic acids, their derivatives – 12 $\alpha$ -(2-methylbutyryloxy) hardwickic, lactone 12 $\alpha$ -hydroxychautrivic-19, lactone 7 $\alpha$ 12 $\alpha$ -dihydroxychautriv-

ic-19, acids, 12 $\alpha$ -(2-methylbutyryloxy) strictic acid; and also (5R, 6S, 8aS)-5-[2-(3-furyl)ethyl-5,6,8a-trimethyl-4a,5,6,7,8,8a-hexahydro-1-naphthalenecarboxylic acid] (or heteratic acid) [16].

The second group (triterpenoids) is represented by Fridelin, epifridelanol, 2 $\beta$ , 3 $\beta$ , 16 $\alpha$ , 23-tetrahydroxyolean-12-ene-28-oic acid or polygalic acid [16, 49].

A quantitative assessment of some BACs groups of the aerial parts of *H. altaicus* growing on the territory of Western Transbaikalia, was carried out by Mazur L.V.

The composition of the herb was determined: 0.14% alkaloids, 0.76% flavonoids in terms of quercetin; 4.43% tannins and 0.88% ascorbic acid. In inflorescences, there are 0.05% alkaloids, 1.70% flavonoids in terms of quercetin, 5.92% tannins, 1.86% ascorbic acid. In the underground organs there are 0.08% flavonoids, 0.35% tannins. In addition, the study of the elemental composition revealed the following trace elements: Mn, Zn; Cu; Ni, Co, Cr [49].

In the available literature, the data on the study of *H. altaicus* in clinical medicine are insufficient; they touch on the period of 1997. The study results of the immunomodulatory and anti-inflammatory effects of triterpene saponins manifested by *Solidago virgaurea* and biennial species were presented [50]. Moreover, in folk medicine, *H. altaicus* inflorescences are prescribed for diseases of the gastrointestinal tract. The aerial part of the plant has antibacterial and protistocidal effects. In Tibetan and Mongolian medicine, the herb of this plant is used as an antipyretic, anti-inflammatory agent, for respiratory infections as an expectorant and antitussive remedy, as well as for stomach diseases (including a peptic ulcer disease [51]. The aerial organs are parts of the medicinal herbs mixtures prescribed for the treatment of measles and smallpox. In Chinese medicine, along with other plants, extracts from *H. altaicus* are used to treat sexual weakness in men, hemoptysis, and chronic bronchitis [21].

### *Solidago dahurica* Kitag.

According to "Flora of Central Siberia" and the Siberian Branch of the Russian Academy of Sciences [18, 19], on the territory of Eastern Siberia, the *Solidago* L. genus has one representative – *S. dahurica* L. (syn. *Solidago dahurica* Kitag. *S. gebleri* Juz. – *S. virgaurea* var. *alpestris* Krylov.non. DC.). In its turn, in "Flora of Siberia" [13] it is indicated that two species grow on the territory of Eastern Siberia – *S. dahurica* and *S. spireifolia* Fisch. ex Herder. The latter is common only in the Arctic floristic region (Sakha Yakutia). According to the information base of the EL SB RAS [19], *S. gebleri*, characteristic of the Altai flora, occurs in Eastern Siberia. At the same time, *S. canadensis* L., which is an officinal species, and *S. virgaurea* L. are found on the territory of Eastern Siberia. These species belong to the wild and naturalized, and, in practice, typical species of the flora of Eastern Siberia. This is due to their widespread use as cultivated species for landscaping city streets and garden plots, as

well as to the sufficient popularity of plants in the practice of traditional medicine [19, 21].

According to "The Plant List", *S. dahurica* is synonymous with *S. virgaurea* subsp. *dahurica* (Kitag.) Kitag., for which, in turn, the synonyms are *S. gebleri* Juz. and *S. gebleri* var. *gebleri* [11]. *S. dahurica* is usually a plain plant; its representatives are tall, up to 1 m, with a large panicle. The leaves are predominantly hairy along the veins. The plants from the Sayans and Stanovoe Highlands have a smaller habitus from 15 to 50 cm and have a simple racemose inflorescence, bare or almost bare leaves. Sometimes this species is distinguished as a special one – *S. gebleri* Juz. However, these differences are not constant and are not diagnostic signs [13, 18, 19].

*S. dahurica* is widespread in Eastern Siberia throughout the Central Siberian Plateau, in the Sayans regions along the Baikal Highlands. It does not form large thickets, but it has a massive habitus, a good supply of raw materials [52]. *S. dahurica* prefers to settle in thickets of shrubs, in forests, in clearings, along river valleys, on stony and gravelly slopes, pebble and open woodlands.

As a raw material for *S. dahurica*, the aerial parts are harvested during flowering. The found out flavonoids are astragalin, quercitrin, rutin, kaempferol, isorhamnetin, isoquercitrin. In addition, the presence of triterpene saponins, bitterness, tannins, resins, organic acids, essential oil, carotene, ascorbic and nicotinic acids, inulin, and alkaloids has been established [21].

The hydrolysis of the isolated triterpene saponins revealed eight aglycones, derivatives of virgureagenin, designated by letters A, B, C, D, I, F, G, H. The aglycone virgaureagenin A was identified as oleanolic acid, and virgaureagenin D – as a polygallic acid. The carbohydrate residue consists of glucose, rhamnose and xylose. The presence of glycosides of a polyphenolic nature, in particular, quercetin derivatives – isoquercitrin, has been established, the presence of saponins, tannins, catechins, flavones has been confirmed. The *S. dahurica* anethodium contains about 0.5% of essential oil, and about 0.7% in the leaves; the presence of saponins, catechins, tannins and flavones has been established [53].

In addition, the presence of organic acids (in particular, quinine), diterpenoids, polyacetylene compounds, phenolcarboxylic acids and their derivatives (caffeic, chlorogenic, hydroxycinnamic), coumarins (esculetin, esculin), and phytoecdysones has been revealed [53].

The chemical composition of the aerial organs ensures the use of *S. dahurica* as an expectorant, diuretic and hypoazotemic agent for the treatment of chronic nephritis and renal failure. In different countries, the *Solidago* species are used in a similar way. In particular, the herbs *S. dahurica*, *S. virgaurea* and *S. canadensis* have been long prescribed for the diseases of kidneys and bladder, for dissolving kidney and bladder stones, with a high protein content in urine, as a diuretic for dropsy, and also as effective remedies for rheumatism, gout, bronchial asthma, pulmonary tuberculosis, cholelithia-



sis and other diseases. A successful use of these types externally are for angina rinsing, in gum sponginess, for strengthening sensitive teeth, for purulent wounds applications and bone fractures [24].

From the aerial parts of *S. dahurica*, mixtures are made – ointments, anatriptics on the basis of cream, pork fat or butter. Such remedies are recommended for skin tuberculosis, dermatitis, burns, rheumatism, and leucorrhoea. The peoples of Komi and Siberia use *S. dahurica* extracts internally for ulcerative cystitis, hepatitis, prostate adenoma, impotence, frequent emissions and chronic prostatitis (mixed with other plants), as well as externally for rinsing and washing with acute laryngitis, eczema [54].

In the folk medicine of the Caucasus, alcoholic tincture from the underground parts of the plant is used as a wound healing agent [21, 54]. The herb *S. virgaurea* is included in the British Herbal Pharmacopoeia as a diaphoretic and antiseptic [55]. In homeopathy [56], the essence of fresh inflorescences is used for chronic inflammatory diseases of kidneys, accompanied by skin rashes, swelling of the glands, edema, catarrh and rheumatic pains.

***Leontopodium conglobatum* (Turcz.) Hand.-Mazz.**

*Leontopodium* R. Br. ex Cass. genus in the East Siberian flora is represented by 4 species:

*Leontopodium comesrte* (Ledeb) Hand., *Leontopodium conglobatum* (Turcz.) Hand.-Mazz, *Leontopodium leontopodioides* (Wild.) Beauv., *Leontopodium ochroleucum* Beauv. [23, 24]. The floristic summary “Flora of Siberia” [13] describes the following species: *Leontopodium comesrte* (Ledeb) Hand., *Leontopodium conglobatum* (Turcz.) Hand.-Mazz и *Leontopodium ochroleucum* Beauv. as *Leontopodium conglobatum subspecies*.

The Global *Compositae* Checklist database, which is an integrated database of nomenclature and taxonomic information of the *Asteraceae* family, included in the Catalog of Life: 2015 Annual Checklist [57] and “The Plant List” information base [11] indicate that the names *Leontopodium ochroleucum var. conglobatum* (Turcz.) Grubov and *Leontopodium sibiricum var. conglobatum* Turcz. are synonymous with the name *Leontopodium conglobatum* (Turcz.) Hand.-Mazz. The comparative analysis of indicators is presented in the table.

**Table – Comparative analysis of names, morphological characters, species distribution and intraspecific taxa *Leontopodium conglobatum* of Eastern Siberia**

Sources (database)	Indicators			
	Species name	Distribution	Morphological characters	Habitat
Flora of Central Siberia, vol. 2	<i>Leontopodium conglobatum</i> (Turcz.) Hand. -Mazz.	Central Siberian plateau in the East of the Irkutsk region (in the area of the Lena River basin), in the Sayan-Baikal region on the southern coast of Lake Baikal, the Irkut river, in the eastern and western parts of the Stanovoy Highlands, including the South of the North-Baikal Highlands, in the steppe regions of the Republic of Buryatia in the Selenga River basin, in Selenga and Dzhida districts	– Stems are usually single, less often they are several, and then in small tussocks, the leaves on the stem are numerous (up to 15).	Steppe dry and valley meadows, forest edges, dry forests, stony-gravelly steppes.
Flora of Siberia, vol. 13	<i>Leontopodium ochroleucum subsp. conglobatum</i> (Turcz.) V. Khan. stat. et comb. nov.	In the Irkutsk region – the Angara-Sayan floristic region; In the Republic of Buryatia – the North Buryat and South Buryat floristic regions	Floral bracts are ovate-lanceolate;	
Electronic Library, Siberian Branch of the Russian Academy of Sciences Synonym	<i>Leontopodium ochroleucum var. conglobatum</i> (Turcz.) Grub. <i>Leontopodium sibiricum var. conglobatum</i> Turcz. 1847 in Bull. Soc. Nat. Moscou, 20,3. <i>Leontopodium ochroleucum Beauverd conglobatum</i> (Turcz.) V. Khan.	Western Siberia: Altai. Central Siberia: Krasnoyarsk Territory, Republic of Khakassia, Republic of Tyva. Eastern Siberia: Irkutsk, Chita regions, Buryatia, Republic of Sakha (Yakutia)	lanceolate or oblong in the upper half with curled edges, sharply narrowed; twice-3 times longer than the inflorescence, the	
The Plant List Global <i>Compositae</i> checklist – Intra-species taxon, synonym	<i>Leontopodium ochroleucum var. conglobatum</i> (Turcz.) Grubov. <i>Leontopodium sibiricum var. conglobatum</i> Turcz.	30 – Siberia, Irkutsk (IRK), Irkutsk (IRK-OO); 31 – Russian Far East, Amur (AMU), Amur (AMU-OO); ... 31 – Russian Far East, Khabarovsk (KHA), Khabarovsk (KHA-OO); 30 – Siberia, Yakutskiya (YAK), Yakutskiya (YAK-OO); 3 – Asia-Temperate, 30 – Siberia, Chita (CTA), Chita (CTA-OO);	inflorescence is often branched in the form of a shield of several "stars", less often solitary.	

The data presented in the table makes it possible to conclude that an equivalent species is described under the accepted and synonymous names of *Leontopodium conglobatum*. At the same time, *Leontopodium conglobatum* has clearly pronounced morphological features, a fairly wide range on the territory of Eastern Siberia, and accessible habitats.

In the available literary sources, there is no information about clinical studies of this species. However, *Leontopodium conglobatum* (Turcz.) Hand.-Mazz. is included in the arsenal of medicinal plants of Tibetan medicine. For therapeutic purposes, the entire aerial part of the plant is used as a wound healing, expectorant, analgesic and sedative remedy; it is prescribed for cholelithiasis, as well as externally for cauterization during acupuncture [22]. The level of biological activity was studied according to the influence degree of the 1:20 infusion from *Leontopodium conglobatum* on the foaming reaction in a suspension of *Saccharomyces cerevisiae* [58]. No data on chemical composition has been found.

### Geranium Genus

The *Geranium* L. (*Geraniaceae*) genus includes more than 300 species represented by herbs and shrubs. The representatives of the *Geranium* genus are native to the world and are found in various climatic zones. They can grow in mountains and rocks. More than 20 species of *Geranium* are cultivated and are the material for the cultivation of highly decorative varieties. The representatives of the *Geranium* genus form radical leaf rosettes on long petioles. At the same time, the leaf blade is finger-dissected into lobes of various shapes – from rather wide to thin, almost filiform. In the representatives of the *Geranium* genus, the flowers are actinomorphic, saucer-shaped, usually large and beautiful, and consist of five almost round petals. The petals can grow together to form a flat or calyx shape. In this case, the petals are either bent towards the rim, or, conversely, bent towards the petiole. The color of geranium flowers can be white, purple, blue, violet, lilac of various shades. The fruit is a box of a specific shape with the remaining calyx petals. The shape of the fruit resembles the beak of a crane, hence the name of the genus and the family [60].

The representatives of the *Geranium* genus of the north-west European Russia flora, were studied by Razarenova K.N. on the basis of the “St. Petersburg State Chemical and Pharmaceutical Academy”. The objects of the research were: *Geranium pratense* L., *G. sylvaticum* L., *G. palustre* L., *G. sanguineum* L., *G. sibiricum* L., *G. robertianum* L., *G. pusillum* L. and a cultivated *G. lividum* species [59].

The floristic lists and identification guides describe a different number of the representatives of the *Geranium* genus inhabiting the Baikal region. In particular, in “Flora of Siberia” [61], 20 species are described. In “Flora of Central Siberia” [18], in the Program of the Siberian Branch of the Russian Academy of Sciences [19], there

is information about 10 species; a photo guide “Plants of the western coast of Lake Baikal” and a revision summary “Abstract of flora of the Irkutsk region (vascular plants)” [62] contains a description of 4 species.

There is information about the use of geraniums various types in folk medicine as a means of treating insomnia, epilepsy, fever, rheumatism, diarrhea, as a homeostatic in gynecological diseases. In Tibetan medicine, these types are prescribed for the treatment of eye diseases, including cataracts [21, 60].

Among the Baikal representatives of the *Geranium* genus, the most common species have been identified: *Geranium eriostemon* Fischer., *G. pratense* L., *G. wlassowianum* Fischer.

### Geranium eriostemon Fischer.

According to the information base [11], the name *G. eriostemon* is in the illegitimate status, i.e. the use of this name is not consistent with the rules of the International Code of Botanical Nomenclature. At the same time, the name *G. eriostemon* is synonymous with the *G. platyanthum* Duthie species. In the floristic summaries “Flora of Siberia” [61], “Flora of Central Siberia” [18], and the Siberian Branch of the Russian Academy of Sciences [19], the *G. eriostemon* species is described as independent.

The habitats are light forests, thickets of bushes, forest edges. The main areas of distribution are the western and southern regions of the Irkutsk region, the Central Siberian plateau, the southwestern outskirts of the Irkutsk region (Eastern Sayan), as well as the southern coast of Lake Baikal [18, 19, 61, 62].

Phytotechnological studies were carried out to obtain an extract containing the maximum amount of flavonoids of the *G. eriostemon* herb. Based on a comparison of the results obtained on a mathematically predictable model and experimental data, it was found out that the optimal conditions are the ratio “raw material : extractant” = 1 : 40, herewith the extractant was a 60% ethanol and the duration of the extraction was 35 min [63]. The content of tannides was determined by HPLC in some species of geraniums growing in China; the sum of these compounds in the *G. eriostemon* herb was 0.88% [64].

The component composition of *G. eriostemon* was studied by Du S. et al. established the presence of inositol derivatives – scillite  $\beta$ -sitosterol. The presence of polyphenols – phenolcarboxylic acids and flavonoids – was notified. In particular, the first group is represented by proto-catechic acid and gallic acid derivatives: 1,6-di-O-galloyl- $\alpha$ -L-glucose, 1,2,3,6-tetra-O-galloyl- $\beta$ -D-glucose, corilagin. The second group is flavonoids, which belong to flavonols – quercetin, myricetin, 7-O- $\alpha$ -L-arabinofuranoside and 3-O- $\alpha$ -L-arabinofuranoside kaempferol. Shikimic acid was found in the herb [64].

A phytochemical study of the methanol extract from the *G. eriostemon* aerial part showed the presence of oleanolic acid, three lignans – (-)-kobusin, (-) – eude-

smin, (+) – (+) – magnolin, lilac acid, and four flavonoids – quercetin, juglandin, juglalin and hyperin. Moreover, (+)-(+)-magnolin, lilac acid and quercetin showed a moderate cytotoxic activity against 4 human cancer cell lines *in vitro* [64].

The dynamics of tannins accumulation in the aerial and underground parts of *G. eriostemon*, growing on the territory of Buryatia, has been studied. The underground parts of this species are maximally rich in tannides, their content reached 4.14% [65].

A fairly high antimicrobial activity level of the sum of tannides isolated from underground *G. eriostemon* parts was experimentally established. The determination of bactericidal activity was carried out visually in Petri dishes according to the size of the growth inhibition zone of the most common representative of gram-positive bacteria, *Staphylococcus aureus*<sup>9</sup> [66].

### *G. pratense* L.

*G. pratense* has a common name in the World List of Plant Families (World Checklist of Selected Plant Families – WCSP) [12] and is represented by 24 synonyms of different status: *G. acknerianum* Schur., *G. alpinum* Kit. ex Kanitz., *G. batrachioides* Bubani., *G. caeruleum* Gilib. [Invalid], *G. coelestinum* Schur., *G. kemulariae* Kharadze, *G. mariae* Sennen, *G. napellifolium* Schur., *G. neapolitanum* Nyman., *G. pratense* var. *affine* (Ledeb.) C.C. Huang & L.R. Xu, *G. pratense* var. *albidum* Regel, *G. pratense* f. *albiflorum* Q.Zhu & J.Wang, *G. pratense* f. *leucanthemum* B.Boivin., *G. pratense* var. *litwinowii* Woronow, *G. pratense* var. *pallidum* Regel, *G. pratense* var. *parviflorum* Regel, *G. pratense* f. *pratense*, *G. pratense* var. *pratense*, *G. pratense* var. *pubescens* Regel, *G. pratense* var. *schmidii* Y.J.Nasir, *G. pratense* subsp. *sergievskajae* Peschkova, *G. pratense* subsp. *stewartianum* Y.J. Nasir, *G. pratense* var. *tenuisectum* Regel, *G. valde-pilosum* Schur ex Nyman.

In the Irkutsk region, the species prefers the following habitats – meadows, forest edges, clarified forests. It occurs in the Sayans, on the northern coast of Lake Baikal, on the territory of the Baikal-Lensky Nature Reserve [18, 19, 62].

In the *G. pratense* aerial part, phenolcarboxylic acids and their derivatives – geraniin and isoheraniin – were found, in the underground part there were caffeic, gallic, dehydrogallic, ellagic, chebulagic acids; methylgallate, 6-galloylglucose [64, 67, 68].

Among the compounds of the flavonoid structure, the presence of rutin, quercetin, and apigenin has been established [67]. Among other polyphenolic compounds in the aerial organs of *G. pratense*, the following were identified: myricetin 3-O-(2"-O-haloyl)- $\beta$ -D-glucopyranoside, 5 quercetin derivatives: 3-O- $\beta$ -D-glucopyranoside, 3-O- $\beta$ -D-galactopyranoside, 3-O-(2"-O-haloyl)- $\beta$ -D-glucopyranoside, 3-O-(2"-O-haloyl)- $\beta$ -D-galactopyranoside,

3-O- $\alpha$ -D-arabinopyranoside, as well as 3-O- $\beta$ -D-glucopyranoside kaempferol [67–68], as well as (-)-6-chloroepigallocatechin, methyl gallate and tryptophan. In the underground organs, there were (+)-catechin and (-)-Epicatechin. The isolated compounds were found to be effective against disorders of the endothelium-dependent relaxation in an isolated segment of the rat aorta [70].

The aerial parts of *G. pratense*, which grows in the western part of Russia, were examined for the amino acid composition. In particular, in the aerial parts of *G. pratense* harvested in the Republic of Bashkortostan, 20 amino acids were identified and their contents were determined [67, 68, 71].

The color of geranium flowers is provided by anthocyanin – malvidin diglycoside; leucoanthocyanidin is present in the seeds [68].

The Baikal species *G. pratense* is one of the first plant objects studied at the Department of Pharmacology of the Irkutsk State Medical Institute in the 60s of the last century. The studies were related to the effect study of the extract from this plant on the central nervous system and its toxicity [72]. At the same time, in the experiments on laboratory animals, the wound-healing effect of the polysaccharides sum of this plant has been studied. The effect of this group of compounds on the regeneration process of de-epilated animal skin, pretreated with a 20% potassium hydroxide solution, was studied. A noticeable decrease in the area of the wound surface, the acceleration of the regeneration processes and proliferation were found [73]. *G. pratense*, a species native to Mongolia, has a high antioxidant activity [74, 75]. In isolated plasma, methanol extracts inhibited the action of the  $\alpha$ -amylase enzymatic activity by more than 40% [74]. The prospect of using the sum of this type polyphenolic compounds against opportunistic microorganisms – strains *B. cereus*, *E. coli*, *P. aeruginosa*, *S. aureus* – was established [76].

Agrobiological studies of *G. pratense* were carried out. Was studied the antimicrobial activity of the dried powder from the roots of this plant after the ground application with a potato crop. This procedure reduced a further morbidity of the inoculum. It was found out that the fraction with geraniin exhibits the antimicrobial activity at its content of up to 15% of the dry weight of the root (HPLC method). The antimicrobial activity of this fraction corresponded to 1.25% of the streptomycin effect (a paper disk method). The results of the study indicate that the use of *G. pratense* as an organic supplement or an accompanying crop for controlling the microbial contamination of potatoes is promising [77].

### *Geranium wlassowianum* Fischer

According to the information database, *G. wlassowianum* Fischer. has no synonyms [11]. In the Irkutsk region, *G. wlassowianum* is found in the east and south of the region, more often in the Tulunsky region. It is also

<sup>9</sup> GOST 10444.2-94. Food products. Methods for detecting and quantifying *Staphylococcus aureus*. Russian

typical for the southern coast of Lake Baikal, is included in the list of vegetation of the Baikal-Lensky reserve, while it prefers habitats similar to the above-listed geraniums species [18, 19, 62].

Throughout the whole vegetation season, a consistently high content of tannides was noted in the underground and aerial parts of the *G. wlassowianum* species growing on the territory of Buryatia [69]. The bactericidal activity level of tannins of *G. wlassowianum* vegetative organs against *Staphylococcus aureus*, was determined [66].

### CONCLUSION

The data presented in the review show that species of the *Asteroidae* subfamily and the *Geranium* genus are sources of biologically active compounds of various groups – polyphenols, terpenoids, essential oil components, saturated and unsaturated fatty acids, trace elements, vitamins, etc. The presence of phenolcarboxylic acids, tannides is notified in all species. In folk medicine, the described plant objects are prescribed for the

treatment of various diseases. The effect on the central nervous system has been experimentally confirmed. The following types of pharmacological actions – homeostatic, diaphoretic, antiseptic, antioxidant, cytostatic, anti-influenza, antiherpetic, antiprotozoal, antimicrobial and anti-inflammatory – have been confirmed, too.

The ranges of the presented species cover almost all the continents of the globe. This indicates broad adaptive capabilities of the plant objects described. Many of the listed species are the bases for the introduction of varieties with special decorative, economic and biological characteristics into cultivation; the ones with purposefully improved pharmaceutical values have also been included there. In this regard, in relation to the Baikal species *Heteropappus altaicus*, *Solidago dahurica*, *Leucanthemum vulgare*, *Tripleurospermum inodorum*, *Antennaria dioica*, *Leontopodium conglobatum* and *Geranium eriostemon*, *G. pratense*, *G. wlassowianum*, it is advisable to conduct a deep complex phytochemical and pharmacological research in order to create medicines for the treatment of the most common diseases.

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### AUTHOR'S CONTRIBUTION

Elena G. Privalova – planning, collecting literature data, writing and editing the review.

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