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

E.G. Privalova

Irkutsk State Medical University
1, Krasnoye Vosstaniye St., Irkutsk, Russia, 664003

E-mail: eleprivalova@yandex.ru

Received 20 Juny 2020 After peer review 26 Oct 2021 Accepted 01 Nov 2021

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 subfamilies, 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, choleretic, 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 (eg, 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) ПРИБАЙКАЛЬЯ (ОБЗОР)

Е.Г. Привалова

Федеральное государственное бюджетное образовательное учреждение высшего образования «Иркутский государственный медицинский университет»
Министерства здравоохранения Российской Федерации
664003, Россия, г. Иркутск, ул. Красного Восстания, д. 1

E-mail: eleprivalova@yandex.ru

Получена 20.06.2020 После рецензирования 26.10.2021 Принята к печати 01.11.2021

For citation: Е.Г. Привалова. Некоторые представители подсемейства Asteroidae (Asteraceae) и рода Geranium (Geraniaceae) Прибайкалья (обзор). Фармация и фармакология. 2021;9(6):426-440. DOI: 10.19163/2307-9266-2021-9-6-426-440
© Е.Г. Привалова, 2021

Для цитирования: Е.Г. Привалова. Некоторые представители подсемейства Asteroidae (Asteraceae) и рода Geranium (Geraniaceae) Прибайкалья (обзор). Фармация и фармакология. 2021;9(6):426-440. DOI: 10.19163/2307-9266-2021-9-6-426-440
INTRODUCTION

According to the forecasts of the World Health Organization\(^1\), 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, choleretic, 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 dahuaria L., Leucanthemum vulgare Lam., Tripleurospermum inodorum (L.), Antennaria dioica (L.) Gaertn., Leontopodium conglabatrum (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”;...
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 (semiflrets and false – semiflrets, tubular and funnel-shaped). The anthodes are often grouped into complex aggregate inflorescences – spicas, racemes, panicles, cymoids or capitula. 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-semiflrets, the flowers are tubular, funnel-shaped;

– Lactucoideae L. (Liguliflorae) subfamily – in the inflorescence of the false-semiflrets, the flowers are tubular, funnel-shaped;

Many representatives of the Asteraceae family (the Asteroidae and Lactucoideae 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 [1-4].

Pharmacopoeial representatives of Asteraceae are used as vitamin and diaphoretic (Calendulae officinalis flores, Bidens tripartita subf. herba), choleretic and hepatoprotective (Tanaceti vulgares flores, Helichrysi arenarii flores, Siliquae marianae fructus, etc.), anti-inflammatory (Chamomillae recutita flores), diuretics and choleretic (Arcti radix), anti-inflammatory and expectorant (Tussilaginis 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 (Senecio platyphylloidis herba), etc. The main groups of biologically active compounds of these plants are vitamins, flavonoids, tannins, essential oils, alkaloids, polysaccharides.

The plants of the Asteroideae and Lactucoideae subfamilies are found in all areas of the Baikal region. The Asteroideae (Tubuliflorae) subfamily prevails: it comprises about 85% of all genera (or 61) of the Asteroideae 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. dahlurica, L. vulgare, T. inodorum, A. dioica, L. congobatum 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.) Graeth.

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. vilifera Boriss. A. fresiana (Trautv.) Ekman has been additionally included in the list of volume 13 “Flora of Siberia” [13].

The species A. dioica (L.) Graeth 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].
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′-apigenin glucoside, 7,4′-luteolin diglucoside, 7-O-β-D-glucoside and 4′-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 umberellifere 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 poultices for varicose veins, breast tumors and as a pain reliever for gout. Free 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 poultices for varicose veins, breast tumors and as a pain reliever for gout.

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. vulgaris, is an admixture to the official raw material of Chamomillae recutitae flores et Chamomillae suaveolentis flores. 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. ircutianum Turcz., C. lanceolatum Vest, C. lanceolatum Pers., C. leucanthemum L., C. leucanthemum var. boecheri 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. [Illegetimate], C. montanum var. heterophyllum (Willd.) Koch, C. prae cox (M.Bieb.) DC., C. pratense Salisb., C. sylvestre Willd., C. vulgaris (Lam.) Gaterau., C. vulgaris var. vulgaris, Leucanthemum atro var. heterophyllum (Willd.) Rouy, L. lanceolatum DC., L. leucanthemum (L.) Rydb. [Illegetimate], L. praecox (Horvatič) Villard, L. vulgaris subsp. heterophyllum (Willd.) Soó, L. vulgaris subsp. incisum Arcang., L. vulgaris var. pinnatifidum (Lecoq & Lamotte) Moldenke, L. vulgaris subsp. prae cox Horvatič, L. vulgaris var. vulgaris, L. vulgaris subsp. vulgaris, Matricaria leucanthemum (L.) Scop., M. leucanthemum (L.) Desr., Pontia heterophyllum (Willd.) Bubani, P. vulgaris Bubani, Pyrethrum leucanth emum (L.) Franch., Tanacetum leucanthemum (L.) Sch. Bip.

L. vulgaris 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 semiflowers show a unilateral coronet. Representatives with a unilateral coronet of achenes from the Irkutsk region are described for the L. ircutianum DC species and occur sporadically throughout the L. vulgaris range in all regions of Siberia. Moreover, the presence of this trait varies even within the population, which makes it possible to consider L. ircutianum as variety or L. vulgaris var. ircutianum (DC) Krylov. [13, 19].

The L. vulgaris 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,
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: hexadecacylbutol [1.2:3:4] bicyclooctene, 13-hexyloxyoctyltridec-10-en-2-one (aromatic component). Among the polynye 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-decanal, 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, isoamylisovalericate, 1-octenyl acetate, n-pentylisovalerianate, γ-palmitolactone [35]. The essential oil of *L. vulgare* inflorescences is in the amount not exceeding 0.5% and includes terpenoids – mono- and sesquiterpenes: sabinine, myrcene, n-cymene, limonene, (E) -β-ocymene, 1,8-cineole, terpinene-4-ol, α-terpinol, geranyl acetate, geraniol, α-bisabolol, α-copaen, (E) -β-caryophyllene, aromadendrene, α-humulene, (E) -β-farnesene, germacrene, α-amoren, α-muurelen, δ-cadinene, γ-cadinene, isofau-rinone, elemol, caryophyllene oxide, 1,2-humulene epoxide, γ-eudesmol, γ-cadinol, (Z) -lancelol, chamazulene, bisabolol A oxide, hexahydropharsylacetone, farnezo-lene, nerolidol, α-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 consisted mostly of (E)-β-farnesene (7.3%), hexadecahydrocyclobuta, dicyclocloctene (5.3%), decanoic acid (4.9%), γ-eudesmol (4.5%) [36].

The composition of the essential oil from the aerial parts of *L. vulgare* growing on the territory of the Ardebal province (Iran) has been studied. In its composition, 47 compounds were identified, among which caryophyllene oxide (21.2%), aromadendrene oxide (13.7%), cis-β-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, queretin, luteolin, isorhamnetin, 7-O-β-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 Asteroidae 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 Tetragonospermum. 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 inodora (L.) Vis., Ch. inodorum var. inodor, Chrysanthemum inodorum (L.) L., Ch. maritimum var. inodorum (L) Bech., Dibotherspermum agrestis 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. inodor, M. inodora var. pusilla Fiori, M. maritima var. agrestis (Knaf) Wilmott., M. maritima subsp. inodora (L) Soö., M. maritima subsp. inodora (L) Clapham., M. maritima var. inodora (L) Soö, M. perforata Mérat., M. pulmila Nyman., Pyrethrum elegans Pollini, P. inodorum (L) Moench., P. inodorum var. inodor, Rhytidospermum inodorum Sch.Bip. (permission not granted), Tripleurospermum maritimum var. agrestis (Weiss) Briq. & Cavill. T. maritimum subsp. inodora (L) Appleg., T. maritimum var. pusillum (Knaf) Briq. & Cavill., T. perforatum (Mérat) M.Inanz, 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-β-ocimene, artemisiaquatone, pinkarvone, geranium isobutanoate, β-caryophyllene, aromadendrene, α-humulene, E-β-farnesene, germacrene D, bicyclogermacrene, α-amanoflou, spathulenol, caryophyllene oxide, bisopoxide trans-α-trans-α, 2-α-bergamolot, y-eudesmol, y-cadinol, chamomillol, (2)-lancelol, bisabolol oxide A, bisabolol oxide B, bisabolone oxide A, aromadendrene oxide 2, alloaromadendrene epoxide, farnesyl acetate, hexylacahydropharenene.

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)-β-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-2,4а-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-hexylisovalerianate, γ-palmitolactone. From the group of phenylpropanoids, including polyphenolic compounds, the presence of isoeugenol was revealed, 8-methylcoumarin, cosinomal, and cinnaroside 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 absence of such a specialized group of chemically active natural compounds as polycacetenes. They are: trans-methyl-2-deceno-4,6,8-triionate; matricaria ether, (Z,Z) matricaria ether, dihydrolicamitrac ether, (Z)-lachnophylum methyl ether, (E)-lachnophylum methyl ether, (Z)-ene-in-bicycloether, (E)-ene-in-bicycloether, 2cis, 8cis-matrix triaether, 8cis-a, 8-dihydrmatricaria ester, 2Z, 8Z-matrix triaether, 8Z-2,3-dihydrmatricaria ester, (2E)-lachnothyllum ester, (2Z)-lachnophylum)-diE2)-matrixialacton [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 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 *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-[α-L-rhamnopyranosyl-(1→2)][-β-D-xylpyranosyl-(1→3)]-β-D-glucopyranoside of arjunic acid (*heteropappus*asin), as well as flavonoids – rutin, nicotiflorin, isorhamnetin 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 Burятия and Dauria. *H. altaicus* is a sun-loving xeromophyte, preferring riverbanks, lakes, including saline ones, as well as dry and steppe meadows and steppes [13, 18, 19]. *H. altaicus* (Willd.) Novopkr. (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., *Conya altaica* DC., *Galatella altaica* Tzvelév., *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* (Willidenow) Novopokrovsky, *Kalimeris altaica* (Willidenow) Nees, *K. altaica var. subincana* Avé-Lallemant are marked as synonymous. It is 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 monoterpenses and triterpenes. Most of them are occupied by germacrine D, caryophiline, β-pinene, β-felandrene, and limone (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, (-)-spatulenol, 1β 10α-caryophyllene epoxide, 4α7β-dihydroxy-10βH-guai-5-ene-1β8β-enoxide, 1β-methoxyacaril-9-one; α-thuyene, α-pinene, β-pinene, camphene, sabinen, myrcene, α-fellandrene, Δ3-carene, α-terpinene, λ-terpinene, (Z)-β-ocymene, terpinolene, n-cymene, limone, β-pellandrene, 1β- cineole, cis-chrysanthenyl acetate, bornyl acetate, α-terpinyl acetate, trans-sabinyl acetate, δ-elemene, α-copaen, β-patchulene, β-bourbonene, β-elemene, β-caryofellien, β-copaen, α-humulene, germacrene D , δ-selinene, cingiberen, bicyclogermacrene, trans-β-guaienene, (E, E)-α-farnesene, β-farnesene, δ-cadinene, spatulalen, caryofellene oxide, guayol [15, 16, 48].

In the aerial parts of *H. altaicus* (in flowers), the presence of diterpenes and triterpenes has been established. The first group includes trans-phytol, (−)-hardwickic and hauwric acids, their derivatives – 12α-(2-methylbutyryloxy) hardwickic, lactone 12α-hydroxyhauwric-19, lactone 7α12α-dihydroxyhauwric-
ic-19, acids, 12α-(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, epifridelinol, 2β, 3β, 16α, 23-tetrahydroxoylean-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 LV.

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 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. spirefolia 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 official 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 Stanovoy 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 gravely 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, isoqueritrin. 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 glycones, derivatives of virgureagenin, designated by letters A, B, C, D, I, F, G, H. The aglycone virgureagenin A was identified as oleanolic acid, and virgureagenin 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 – isoqueritrin, has been established, the presence of saponins, tannins, catechins, flavones has been confirmed. The S. dahurica anthocyanin 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 phytocedysone 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-
sic 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, alcholic 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 tincture from the underground parts of the plant is used 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.

### Table – Comparative analysis of names, morphological characters, species distribution and intraspecific taxa

| Sources (database) | Species name | Distribution | Morphological characters | Habitat |
|--------------------|--------------|--------------|--------------------------|---------|
| Flora of Central Siberia, vol. 2 | Leontopodium conglobatum (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 | Leontopodium ochroleucum var. conglobatum (Turcz.) Grubov. | In the Irkutsk region – the Angara-Sayan floristic region; In the Republic of Buryatia – the North Buryat and South Buryat floristic regions | | Flora bracts are ovate-lanceolate; lanceolate or oblong in the upper half with curled edges, sharply narrowed; twice-3 times longer than the inflorescence, the inflorescence is often branched in the form of a shield of several "stars", less often solitary. |
| Electronic Library, Siberian Branch of the Russian Academy of Sciences Synonym | Leontopodium ochroleucum subsp. conglobatum (Turcz.) V. Khan. | | | |
| The Plant List Global Compositae checklist – Intra-species taxon, synonym | Leontopodium ochroleucum var. conglobatum (Turcz.) Grubov. | 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, Yakutskiy (YAK), Yakutskiy (YAK-OO); 3 – Asia-Temperate, 30 – Siberia, Chita (CTA), Chita (CTA-OO); | | |
| The Plant List Global Compositae checklist – Intra-species taxon, synonym | Leontopodium ochroleucum var. conglobatum 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, Yakutskiy (YAK), Yakutskiy (YAK-OO); 3 – Asia-Temperate, 30 – Siberia, Chita (CTA), Chita (CTA-OO); | | |
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 chololithiasis, 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 hemostatic 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 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 β-sitosterol. The presence of polyphenols – phenolicarboxylic 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-α-L-glucose, 1,2,3,6-tetra-O-galloyl-β-D-glucose, corilagin. The second group is flavonoids, which belong to flavonols – quercetin, myricetin, 7-O-α-L-arabinofuranoside and 3-O-α-L-arabinofuranoside kaempferol. Shi-kimic 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 a [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 (Lede.) C.C. Huang & L.R. Xu, G. pratense var. albidum Regel, G. pratense f. albiflorum Q.Zhu & J.Wang, G. pratense f. leucanthemum B.Bovin., 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-galloylgucose [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]-β-D-glucopyranoside, 5 quercetin derivatives: 3-O-β-D-glucopyranoside, 3-O-β-D-galactopyranoside, 3-O-[2”-O-haloyl]-β-D-glu- copyranside, 3-O-[2”-O-haloyl]-β-D-galactopyranoside, 3-O-α-D-arabinopyranoside, as well as 3-O-β-D-glucopyranoside kaempferol [67–68], as well as (-)-6-chlo- roepigallocatechin, 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 content was determined [67, 68, 71].

The color of geranium flowers is provided by anthocyanin – malvidin diglycoside; leukoanthocyanidin 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 α-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 geraniine 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

---

\*GOST 10444.2-94. Food products. Methods for detecting and quantifying Staphylococcus aureus. Russian
ACKNOWLEDGMENTS

The author expresses gratitude to Irina Mikhailovna Semyonova, a senior lecturer at the Federal State Budgetary Educational Institution of Higher Education “Irkutsk State Medical University” of the Ministry of Health of the Russian Federation, for the linguistic assistance provided.

CONFLICT OF INTERESTS

The author declares no conflict of interest.

AUTHOR’S CONTRIBUTION

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

REFERENCES

1. Kurkin VA. Pharmacognosy as a methodological basis for evidence-based phytotherapy [Farmakognoziya kak metodologicheskaya osnova dokazatel’noj fitoterapii]. News of the Samara Scientific Center of the Russian Academy of Sci. 2015;17(5–2): 592–6. Russian

2. Nikolaev SM, Aseeva TA, Mondodoev AG, Shantanova LN, Razuavaeva YaG, Khobrakova VB, Khitrikheev VE, Malanov KZh, Ubeeva IP, Chukaev SA. A centuries-old experience of Buryat branch of the traditional medicine in Russia. Acta Biomedica Scientifica. 2017;2(3):101–5. DOI: 10.12737/article_59f036042cbb94.29099154. Russian

3. Sambukova TV, Ovchinnikov BV, Ganapolski VP. Prospects for phytopreparations (botanicals) use in modern pharmacology. Reviews on Clinical Pharmacology and Drug Therapy. 2017;15(2):56–63. DOI: 10.17816/RCF15256-63. Russian

4. Morozov SV, Tkacheva NI, Tkachev AV. Problems of comprehensive chemical profiling of medicinal plants. Chemistry of Plant raw material. 2018;4:5–28. DOI: 10.14258/JCPRM.2018044003. Russian

5. Teplova VV, Isakova EP, Klein OI, Dergacheva DI, Gessler NN, Deryabina Yul. Natural polyphenols: biological activity, pharmacological potential, metabolic engineering pathways (review) [Prirodnye polifenoly: biologicheskaya aktivnost’, farmakologicheskij potencial, puti metabolicheskoy inzhenerii (obzor)]. Applied Biochem and Microbiol. 2018; 54(3): 215–35. DOI: 10.7868/s0555109918030017. Russian

6. Perez-Vizcaino F, Fraga CG. Research trends in flavonoids and health. Arch Biochem Biophys. 2018 May 15;646:107–12. DOI: 10.1016/j.abb.2018.03.022.

7. Rodeiro I, Donato MT, Lahoz A, Garrido G, Delgado R, Gómez-Lechón MJ. Interactions of polyphenols with the P450 system: possible implications on human therapeutics. Mini Rev Med Chem. 2008 Feb;8(2):97–106. DOI: 10.2174/138955708783498131.

8. Tsydendambaev PB, Khshiktuev BS, Nikolaev SM. Biological effects of flavonoids [Biologicheskie effekty flavonoidov]. Bulletin of the East Siberian Scientific Center of the Siberian Branch of the Russian Academy of Medical Sci. 2006; 6: 22–23. Russian

9. Tutelyan VA, Lashneva NV. Biologically active substances of plant origin. Flavonols and flavones: prevalence, food sources, consumption [Biologicheski aktivnye veshchestva rasstitel’nogo proiskhzhdeniya. Flavonoly i flavony:
Identification of active substances of plant extracts with Kalinin EP, Boyarintsev DI, Buslaeva NN, Romadanova MA. Properties and Sources in Food. Molecules. 2019 Apr;24(7):1298. DOI: 10.3390/molecules24071298.

Huang H, Gao XJ, Liu J, Li S, Han YF, Zhou BC, Xia M. A new carylane sesquiterpene from Heteropappus altaicus (Willd.) Novopokr. Molecules. 2011 Jan 11;16(1):518–22. DOI: 10.3390/molecules16010518.

Radelov S. Yu. Everything about medicinal plants: At www-sbras.nsc.ru/win/elbib/atlas/list.dhtml?flora#menu

Merlichi AH. Constituents of Antennaria dioica. J of Natural Prod. 1983;46(6):941. DOI: 10.1021/np50030a026.

Slobodianiuk L, Budniak, L, Marchyshyn S, Basaraba R. Determination of amino acids and sugars content in Antennaria dioica crude oil phytoremediation. Int J Phytoremediation. 2018; 20 (13): 1292–9. DOI: 10.1080/15226514.2015.1045122.
41. Šibul F, Orčić D, Berežni S, Anačkov G, Mimica-Dukić N. HPLC–MS/MS profiling of wild-growing scentless Chamomile. Acta Chromatographica. 2020; 32 (2): 86-94. DOI:10.1556/1336.2019.00546.

42. Plant resources of Russia: Wild flowering plants, their component composition and biological activity. Vol.5. Family Asteraceae (Compositae). Part 2. Genus Echinops – Youngia. – Spb., M., 2013: 312 p. Russian

43. Torikov VE, Melnikova OV, Torikov VV. Mineral composition of the aboveground mass of weeds [Minerálnyj sostav nadzemnoj massy sornyh rastenii]. Bulletin of the Bryansk Agricultural Academy. 2015;4:10–14. Russian

44. Velikhanova ZR, Marakhova AI, Sorokina AA. The content of biologically active substances in the flowers of scentless mayweed (Tripleurospermum perforatum). Pharmacy. 2017; 66 (8): 9–12. Russian

45. Velikhanova ZR, Sorokina AA. Development of characteristics of authenticity of flowers of a three-ribbed perforated [Development of characteristics of authenticity of flowers of a three-ribbed perforated]. Ways and forms of perfection of pharmaceutical education. Creation of new physiologically active substances, Voronezh, 2016: 208. Russian

46. ZW, Chen X, Chen Y, Luc B, John CS. Tribe Asteraceae. Flora of China. Science Press & St. Louis. 2011; 20–21: 588. Chinese

47. Bader G, Tuja D, Wray V, Miller K. Flavonol glycosides from Heteropappus altaicus and H. biennis. Planta medica. 1993;59(03):284–5. DOI: 10.1055/s-2006-959675.

48. Tkachev AV, Korolyuk EA, Letchamo W. Chemical screening of volatile oil-bearing flora Siberia IX. Variations in chemical composition of the essential oil of Heteropappus altaicus Wild. (Novopokr.) growing wild at different altitudes of Altai region, Russia. J Essent Oil Res. 2006; 18(2): 149–51. DOI: 10.1080/10412905.2006.969904.

49. Mazur LV. Study of the chemical composition of the plant Heteropappus altaicus (Western Transbaikalia) [Issledovanie himicheskogo sostava rasteniya Heteropappus altaicus (Zapadnoe Zabajkal’e)]. Congress and conference were held with the financial support of the Russian Foundation for Basic Research (projects Ns. 18-04-20028 and No. 18-04-20023) and FANO of Russia. Tr. IV Congress and Conf. – Makhachkala: ALEF, 2018: 291. Russian

50. Toiu A, Vlase L, Vodnar DC, Gheldiu AM, Oniga I. Solidago grandiflora L. (Asteraceae) as a Valuable Source of Bioactive Polyphenols: HPLC Profile, In Vitro Antioxidant and Antimicrobial Potential. Molecules. 2019 Jul 23;24(14):2666. DOI: 10.3390/molecules24142666.

51. Goryachkina EG, Fedoseeva GM. Study of biologically active substances of the heteropappus of the Altai flora of Eastern Siberia [Izuchenie biologicheski aktivnyh veshchestv geteropappusa altaikskogo florы Vostochnoy Sibiri]. Biotechnology. Looking into the future: II International Scientific Internet; Kazan., 2013.: 69–73. Russian

52. Goryachkina E.G., Buinov M.V., Fedoseeva G.M. Resource studies of Daurian goldenrod growing in the Irkutsk region [Resursnye issledovaniya zolotarnika daurskogo, proizrastayushchego v Irkutskoy oblasti]. International research journal. 2013; 7(14): 85–86. Russian

53. Shen X, Zou ZR. [Review on research progress of chemical constituents and bioactivities of Solidago]. Zhongguo Zhong Yao Za Zhi. 2016 Dec;41(23):4303–13. DOI: 10.4268/cjcm20162303. Chinese

54. Ryzhikova NP. Medicinal plants: From A to Z. – Rostov-on-Don: Phoenix, 2006: 428 p. Russian

55. British Pharmacopoeia. TSO. 2018. Available from: https://www.pharmacopoeia.com/BP2018.

56. Nekratova AN, Kosmodemyanskii LV. A study of siberian medicinal plants used in homeopathy. Homeopathy. 2019;108 (1): 55–65. DOI: 10.1016/s0038-1675584.

57. Roskov Y, Kunze T, Paglinawan L, Orrell T, Nicolson D, Culham A. Biographical catalogues of life: 2000 & ITIS Catalogue of Life. 2015. Annual Checklist. Available from: www.catalogueoflife.org/annual-checklist/2015.

58. Zhadanova GO, Vyatchina OF, Bybin VA, Stom DJ, Fedoseeva GM. The use of Saccharomyces cerevisiae to assess the biological activity of drugs [Izuchenie Saccharomyces cerevisiae dlya ocenki biologicheskoy aktivnosti lekarstvennyh preparatov]. Siberian Medical Journal (Irkutsk). 2013;119 (4): 104–6. Russian

59. Razareonova KN, Zhokhova EV. Comparative assessment of the content of tannins in some species of the genus Geranium L. in the flora of the North-West [Sravnitel'naya ocenka soderzhania dubil'nyh veshchestv v nekotoryh vidah roda Geranium L. florly Severo-Zapadnoy]. Chemistry of vegetable raw materials. 2011; 4: 187–92. Russian

60. Graça VC, Ferreira ICFR, Santos PF. Bioactivity of the Geranium Genus: A Comprehensive Review. Curr Pharm Des. 2020;26(16):1838-1865. DOI: 10.2174/138161282666620011410323.

61. Flora of Siberia. Vol. 10: Geraniaceae ~ Cornaceae / Eds. G.A. Peschko. Siberian Publishers, Inc., 2006: 314 pp. Russian

62. Chepinoga VV, Stepanovska N V, Grebenuykov A. Abstract of the flora of the Irkutsk region (vascular plants). – Irkutsk, 2008: 327 p. Russian

63. Liu J, Tan H. Optimization of Extraction Technology for Total Flavonoids in Geranium eriostemon Fisch. ex DC. by Spherical Symmetric Design. J of Anhui Agricultural Sci. 2014; 17: 20. Russian

64. Chang SW, Kim KH, Lee IK, Choi SU, Lee KR. Phytochemical constituents of Geranium eriostemon. Nat Prod Sci. 2009;15(3): 151–5. Russian

65. Ilyina LP, Antsupova TP. The accumulation of tannins in geranium species depending on the growing season [Na-koplenie dubil'nyh veshchestv v vidah geranii v zavisimosti ot fazy vegetacii]. Bulletin of the Buryat State Agricultural Academy. BP Filippov. 2009;15(3): 151–5. Russian

66. Ilyina LP, Tsdyvyp VTS, Alekseeva SM. Antimicrobial activity of tannins of plants of the Geraniaceae family of Buryatia [Antimikrobnaya aktivnost' dubil'nyh veshchestv rastenii semejstva Geraniaceae Buryatii]. Bulletin of the Buryat State Agricultural Academy. BP Filippov. 2017; 3: 95–100. Russian

67. Nikitina VS, Shendel GV. The content of phenolic compounds and amino acids in the aerial parts of Geranium pratense and G. sibiricum (Geraniaceae) [Soderzhanie fenol'nyh soedinenij i aminokislot v nadzemnoj chasti Geraniaceae –Apiaceae; SPb.; M. 2010: 601 p. Russian

68. Plant resources of Russia: Wild flowering plants, their component composition and biological activity. T.3. Families Fabaceae –Apiaceae; SPb.; M. 2010: 601 p. Russian

69. Akdemir ZS, Tatli II, Saracoğlu I, Ismailoğlu UB, Sahin-Erdemli I, Caliş I. Polyphenolic compounds from Geranium Genus: A Comprehensive Review. Curr Pharm Des. 2020;26(16):1838-1865. DOI: 10.2174/138161282666620011410323.
70. Küpeli E, Tatlı II, Akdemir ZS, Yesilada E. Estimation of antinociceptive and anti-inflammatory activity on Geranium pratense subsp. finitimum and its phenolic compounds. J Ethnopharmacol. 2007 Nov 1;114(2):234–40. DOI: 10.1016/j.jep.2007.08.005.

71. Razarenova KN, Zakharova AM, Protasova ID, Zhokhova EV. Amino acid composition of the aboveground part of Geranium pratense L., Geranium sylvaticum L., Geranium palustre L. [Aminokislotnyj sostav nadzemnoj chastii Geranium pratense L., Geranium sylvaticum L., Geranium palustre L.]. Butlerov Communications. 2012; 31(8):73–8. Russian

72. Leventa AI, Gvozdeva PV, Baturina VA. Siberian scientist Sergei Romanovich Semenov [Sibirskij uchenyj Sergej Romanovich Semenov]. News of the laboratory of ancient technologies. 2014; 2 (11):109–13. Russian

73. Churilov GI, Ivanycheva YuN. Study of the monosaccharide composition of water-soluble polysaccharides of meadow geranium [Issledovanie monosaharidnogo sostava vodorastvorimyh polysaharidov gerani lugovoj]. Materials of the annual scientific conference of the Ryazan State Medical University named after acad. IP Pavlova. 2006: 16–18. Russian

74. Kobayashi K, Baba E, Fushiya S, Takano F, Batkhuu J, Dash T, Sanchir C, Yoshizaki F. Screening of Mongolian plants for influence on amylase activity in mouse plasma and gastrointestinal tube. Biol Pharm Bull. 2003 Jul;26(7):1045–8. DOI: 10.1248/bpb.26.1045.

75. Khairullina VR, Garifullina GG, Gerchikov AYa. Antioxidant activity of plant extracts from family Geraniaceae, Rosaceae on the example of a model reaction of isopropyl alcohol oxidation [Antiokislitel’naya aktivnost’ ekstraktov rastenij sem. Geraniaceae, Rosaceae na primere mod- el’noj reakcii okisleniya izopropilovogo spirta]. Chemical and Pharmaceutical Journal. 2005; 39 (3): 28–30. DOI: 10.30906/0023-1134-2005-39-3-28-30.

76. Nikitina VS, Kuzmina Lyu, Melent’ev AI, Shendel GV. Antibacterial activity of polyphenolic compounds isolated from plants of the families Geraniaceae and Rosaceae [Antibakterial’naya aktivnost’ polifenol’nyh soedinenij, vydelennyh iz rastenij semejstv Geraniaceae i Rosaceae]. Applied Biochemistry and Microbiology. 2007; 43 (6): 705–12. Russian

77. Ushiki J, Tahara S, Hayakawa Y, Tadano T. Suppressive effect of Geranium pratense L. on common scab of potato and identification of the active compound. Soil Science and Plant Nutrition. 1998; 44(2):157–65.

AUTHOR

Elena G. Privalova – Candidate of Sciences (Pharmacy), Associate Professor, Associate Professor of the Department of Pharmacognosy and Pharmaceutical Technology, Irkutsk State Medical University. ORCID ID: 0000-0002-9878-1372. E-mail: eleprivalova@yandex.ru