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Study of *Hedysarum theinum* (Fabaceae Lindl.) in the flora of Kazakhstan

Abstract. Analysis of historical data on the distribution of *Hedysarum theinum* Krasnob. in Kazakhstan presented in this paper is based on herbarium collections kept at the Institute of Botany and Phytointroduction, Almaty and the Digital Herbarium of Moscow State University, Moscow, as well as a list of species of *Hedysarum theinum* on the Ivanovsky Ridge, Kazakhstani Altai with specimens collected as a result of expedition trips to the study area. The cenoflora includes 176 species from 120 genera and 41 families. The hierarchical order of the leading families is as follows: Asteraceae Dumort, Poaceae Barnhart, Ranunculaceae Juss., Rosaceae Juss. Comparative analysis of life forms shows that short rhizomatous plants prevail – 33%, taproot plants – 24% and tussock plants – 11%. The basis of communities in relation to temperature, moisture and substrate structure are the following ecological groups of plants: mesophytes – 30%, in a smaller proportion are mesohygrophytes – 19%, mesoxerophytes – 20% and mesopsychophytes – 18%.

Key words: *Hedysarum theinum*, herbarium collections, Kazakhstani Altai, cenoflora.

Introduction

The genus *Hedysarum* (H.) L. (Fabaceae) comprises about 285 species. Some of its representatives are known for their medicinal properties, while other are valuable forage and ornamental plants [1]. *H. theinum* is an endemic for Central Asian-South Siberian area [2], which is also present in Kazakhstani Altai (Figure 1).

Biological features of the species (slow growth, irregular fruiting, narrow ecological plasticity) and anthropogenic impact (intensive logging, deforestation and grazing) led the species to the threat of extinction [3]. *H. theinum* as an independent species, which differs from *H. neglectum* by the

structure and chemical constitution of the root, inflorescences, pedicels, flowers and fruits [4]. In earlier works, *H. theinum* was referred to *H. obscurum* and *H. austrosibiricum* [5].

The study of the *H. theinum* cenopopulation was carried out by Russian botanists in the highlands of the Russian and Kazakhstani Altai at an altitude of 1600-2100 m above sea level [6]. In Eastern Europe and Siberia major research was performed by M.S. Knyazev [7]. The scientists S.Y. Syeva, N.A. Karnaukhova, O.V. Dorogina; T.P. Sviridova, N.S. Zinner and Sh.M. Zubairova made a special contribution to the study of cultivation, ecological and biological features, introduction, reintroduction and ontogenesis of *H. theinum* [8-10].



Figure 1 – In nature: A – community involving *H. theinum*,
B – generative individual of *H. theinum*

The above-ground part of *H. theinum* contains monosaccharides, disaccharides, tannins, vitamin C, carotene, substances of xanthone nature mangiferin and isomangiferin. Such compounds as polyphenols, alkaloids, saponins, coumarins, carbohydrates, and vitamin C are present in the under-the-ground part [11-13].

A number of works are focused on anatomy [14], phytochemistry [15-18], introduction [19-22], genetics [23-25], and microclonal reproduction of *H. theinum* [26, 27]. At the same time, geobotanical studies have been conducted insufficiently both throughout the range [28-31] and in Kazakhstan, in particular [32]. At the present time, clarification of the geographical distribution of the species in nature and the inventory of species of the *H. theinum* cenoflora in a comparative aspect with previous floristic studies in the Kazakhstani Altai is an important and relevant direction.

Our goal was to study the actual distribution of *H. theinum* on the basis of historical herbarium finds and our own expeditionary data, as well as to identify the floristic composition of communities associated with *H. theinum* in Kazakhstani Altai.

Materials and methods

Creation of inventory of herbarium material stored in the Institute of Botany and Phytointroduction Herbarium (AA) – more than 50 documented sheets, and the Digital Herbarium of Moscow State University (MW) – 3 herbarium sheets, was aimed at added clarification of the composition and distribution of *H. theinum*. Herbarium specimens from different places

in Kazakhstan and other neighboring regions cover the period of 1843-2000.

Statistical processing of the results was performed in STATISTICA 10.0. The Latin names are given according to the “WCSP” [33] and according to the electronic resource “Plant list” [34]. Families were structured according to A.L. Takhtajian [35]. Species and genera in the families were arranged alphabetically. The names of floristic regions were given according to the “Flora of Kazakhstan” [36].

The floristic composition of communities associated with *H. theinum* on the territory of Kazakhstani Altai was studied in natural habitats of the Ivanovsky Ridge in the Southwestern Altai. The eastern part, as the highest (about 2800 m above sea level), begins at the eastern border of Kazakhstan, at the sources of the Belaya and Chernaya Uba and stretches westward to the Gromatukha River valley, in the vicinity of the town of Ridder. In the south, it borders with the Ulbinskiy range, and in the northwest, the Gromatukha River separates it from the Ubinskiy range. The elevation ranges from 2000-2800 m above sea level [37].

Results and discussion

To establish the historical locations of *H. theinum* in Kazakhstan, an inventory of AA and MW was conducted. The actual distribution sites in three floristic regions were identified: 22 in Altai, 24 in Dzungar Alatau, and 25 in Trans-Ili Kungei Alatau (Figure 2).

Table 1 shows the collections of *H. theinum* stored in AA, MW and collected mainly by Krasnoborov I.M., who discovered the species.

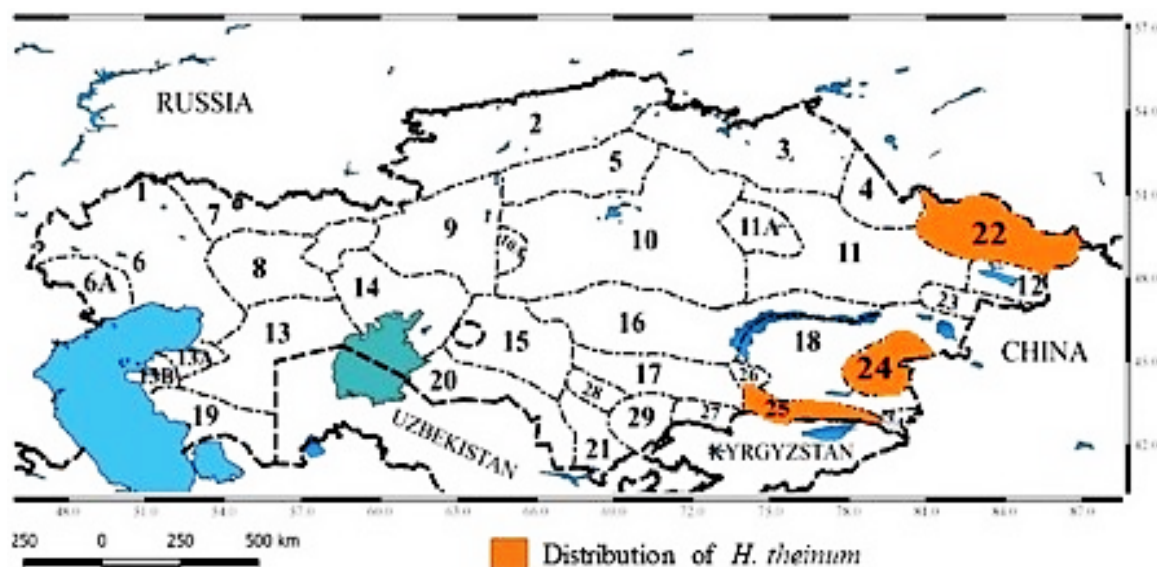


Figure 2 – Distribution of *H. theinum* in floristic regions of Kazakhstan, where: 1. Spurs of the common Syrt; 2. Tobol-Ishim; 3. Irtysh; 4. Semipalatinskiy boar; 5. Kokchetav; 6. Precaspian; 6a. Bukey; 7. Aktobe; 7a. Mugodzhaz; 8. Embi; 9. Turgay; 10. Western shallow hills; 10a. Ultau; 11. Eastern cretaceous; 11a. Karkaraly; 12. Zaisan; 13. Northern Ust-Urt; 13a. Buzachi; 13b. Mangyshlak; 14. Priaralskiy; 15. Kzyl-Orda; 16. Betpak-dala; 17. Muyun-Kum; 18. Balkhash-Alakul; 19. South Ust-Urt; 20. Kzyl-Kum; 21. Turkestan; 22. Altai; 23. Tarbagatai; 24. Dzungarian Alatau; 25. Trans-Ili Kungei Alatau; 25a. Ketmen-Terskey Alatau; 26. Chu-Ili Mountains; 27. Kyrgyz Alatau; 28. Karatau; 29. Western Tien Shan.

Table 1 – Collections of *H. theinum* in AA and MW

Floristic Area	Region	Location	Date	Identifier
Altai	Western Altai	Western Altai. Golukha Mountain. Northwest of Ridder. On the northern slope of Golukha Mountain, in a fir forest at an altitude of 1600 m	27.07.1947	Krasnoborov I.M. (AA)
Altai	Western Altai	Altai. Ridder. The surroundings of Ridder. The outskirts of the Botanical Gardens. On top of the hill 820 m	29.06.1926	Krasnoborov I.M. (AA)
Altai	Southern Altai	Altai, Sarymsakty ridge, the headwaters of the Ush-Kungei River	19.08.1958	Krasnoborov I.M. (AA)
Dzungarian Alatau	Northern part	Lepsinsk. Glinovka. Meadow near the snow on the top of the mountain Abl-tau close to Glinovskii village	07.07.1928	Krasnoborov I.M. (AA)
Trans-Ili Kungei Alatau	Trans-Ili Alatau	Trans-Ili Alatau. Kaz. state reserve. Sarsai, the height above the sea 2200 m	1932	Krasnoborov I.M. (AA)
Trans-Ili Kungei Alatau	Trans-Ili Alatau	Trans-Ili Alatau, the right bank of the Middle Talgar River, rocky slopes near the Semenov glacier of the Eastern peak	19.07.1935	Krasnoborov I.M. (AA)
Dzungarian Alatau		Kazakhstan, Taldy-Kurgan region, Sarkand district, vicinity of Pokatilovo village, Dzungarian Alatau, valley of the Baskan river, granite kurums, shrub thickets	20.07.1995	Krasnoborov I.M. (AA)
Dzungarian Alatau	Southwestern spurs	Altyn-Emel, Mantai mountains. Itmurun river gorge. Along the northern meadow slopes near the peaks	26.06.1926	Goloskov V.P. Krasnoborov I.M. (MW)
Dzungarian Alatau	Northern part	Lepsi. A meadow near the snow, on top of Abyl-Tau Mountain, in the vicinity of the village of Glinovka	7.07.1928	Lipshits S., Krasnoborov I.M. (MW)
Altai	Southern Altai	In the subalpine Tarbagatai near the Cheshak Assu brook, as well as in the Narym Alps	1840	Karelin et Kirilloff, Krasnoborov I.M. (MW)

Based on the inventory of historical summaries, the route of expeditionary research was laid on the Ivanovsky Ridge as the most typical habitat of the species in the Kazakhstani Altai. The community with *H. theinum* occupies an area up to 35 km² in the upper reaches of the Bolshaya Poperechka River on

the northwestern slope. Coordinates are 50° 19' 02" N, 83° 52' 32" E, elevation 1860 m above sea level [32].

According to the results, the studied cenoflora includes 176 species belonging to 120 genera from 40 families (Table 2).

Table 2 – Cenoflora of *H. theinum* in Kazakhstani Altai (Ivanovsky Ridge)

Names of species	Family	Life forms (Raunkiaer 1934)	Ecological groups
<i>Achillea ledebourii</i> Heimerl (<i>Ptarmica ledebourii</i> (Heimerl) Klok.)	Asteraceae	Tp	M
<i>Achillea millefolium</i> L.	Asteraceae	Lrp	M
<i>Antennaria dioica</i> (L.) Gaertn.	Asteraceae	Tp	MX
<i>Aster alpinus</i> L.	Asteraceae	Tp	MP
<i>Crepis chrysantha</i> (Ledeb.) Turcz.	Asteraceae	Srp	M
<i>Crepis sibirica</i> L.	Asteraceae	Srp	M
<i>Doronicum altaicum</i> Pall.	Asteraceae	Lrp	GM
<i>Erigeron speciosus</i> (Lindl.) DC.	Asteraceae	Tp	M
<i>Leuzea carthamoides</i> (Willd.) DC. (<i>Stemmacantha chartamoides</i> (Willd.) M. Dittrich)	Asteraceae	Srp	MP
<i>Ligularia glauca</i> (L.) O.Hoffm.	Asteraceae	Tp	M
<i>Omalotheca sylvatica</i> (L.) Sch.Bip. & F.W.Schultz	Asteraceae	Tp	M
<i>Saussurea frolowii</i> Ledeb.	Asteraceae	Srp	MP
<i>Saussurea latifolia</i> Ledeb.	Asteraceae	Srp	MP
<i>Saussurea parviflora</i> (Poir.) DC.	Asteraceae	Srp	M
<i>Saussurea schanginiana</i> (Wydler) Fisch. ex Herder	Asteraceae	Srp	M
<i>Senecio nemorensis</i> L.	Asteraceae	Srp	M
<i>Serratula coronata</i> L.	Asteraceae	Srp	MP
<i>Solidago dahurica</i> (Kitag.) Kitag. ex Juz.	Asteraceae	Srp	MP
<i>Solidago virgaurea</i> L.	Asteraceae	Brp	M
<i>Taraxacum ceratophorum</i> (Ledeb.) DC.	Asteraceae	Brp	M
<i>Tragopogon pratensis</i> L.	Asteraceae	Tp	MX
<i>Tripleurospermum inodorum</i> (L.) Sch.Bip. (<i>Tripleurospermum perforatum</i> ((Mérat) M.Lainz)	Asteraceae	Tp	MX
<i>Aconitum anthora</i> L. (<i>Aconitum anthoroideum</i> DC.)	Ranunculaceae	Bbp	MX
<i>Aconitum glandulosum</i> Rapaics (<i>Aconitum altaicum</i> Steinb.)	Ranunculaceae	Lrp	M
<i>Aconitum leucostomum</i> Vorosch.	Ranunculaceae	Srp	M
<i>Aconitum monticola</i> Steinb.	Ranunculaceae	Srp	M
<i>Aconitum septentrionale</i> Koelle	Ranunculaceae	Srp	GM
<i>Anemonastrum crinitum</i> (Juz.) Holub	Ranunculaceae	Brp	M
<i>Anemonastrum narcissiflorum</i> (L.)	Ranunculaceae	Brp	M
<i>Anemonoides caerulea</i> (DC.) Holub (<i>Anemone caerulea</i> DC.)	Ranunculaceae	Brp	M
<i>Aquilegia glandulosa</i> Fisch. ex Link.	Ranunculaceae	Tp	GM

Table continuation

Names of species	Family	Life forms (Raunkiaer 1934)	Ecological groups
<i>Clematis alpina</i> subsp. <i>sibirica</i> (L.) Kuntze (<i>Atragene sibirica</i> L.)	Ranunculaceae	Srp	GM
<i>Delphinium elatum</i> L.	Ranunculaceae	Srp	GM
<i>Thalictrum alpinum</i> L.	Ranunculaceae	Tp	GM
<i>Thalictrum flavum</i> L.	Ranunculaceae	Tp	M
<i>Trollius altaicus</i> C.A.Mey.	Ranunculaceae	Srp	GM
<i>Ranunculus grandifolius</i> C.A. Mey.	Ranunculaceae	Srp	GM
<i>Ranunculus monophyllus</i> Ovcz. (<i>Ranunculus krylovii</i> Ovcz.)	Ranunculaceae	Lrp	GM
<i>Callianthemum alatavicum</i> Freyn	Ranunculaceae	Srp	M
<i>Aegopodium alpestre</i> Ledeb.	Apiaceae	Srp	M
<i>Angelica decurrens</i> (Ledeb.) B.Fedtsch.	Apiaceae	Lrp	GM
<i>Bupleurum longifolium</i> ssp. <i>aureum</i> (Fisch. ex Hoffm.) Soó	Apiaceae	Tp	MX
<i>Neogaya simplex</i> (L.) Meisn. (<i>Pachypleurum alpinum</i> Ledeb.)	Apiaceae	Srp	M
<i>Pachypleurum alpinum</i> Ledeb.	Apiaceae	Srp	GM
<i>Schulzia crinita</i> (Pall.) Spreng.	Apiaceae	Tp	GM
<i>Seseli condensatum</i> (L.) Rchb.f.	Apiaceae	Bbp	M
<i>Agrostis gigantea</i> Roth	Poaceae	Tsp	MX
<i>Alopecurus pratensis</i> L.	Poaceae	Tsp	MX
<i>Anthoxanthum monticola</i> (Bigelow) Veldkamp (<i>Hierochloe alpina</i> (Sw. ex Willd.) Roem. & Schult.)	Poaceae	Tp	MX
<i>Anthoxanthum nipponicum</i> Honda (<i>Anthoxanthum alpinum</i> Á.Löve & D.Löve)	Poaceae	Tp	MX
<i>Calamagrostis arundinacea</i> (L.) Roth	Poaceae	Tsp	MX
<i>Calamagrostis epigejos</i> (L.) Roth	Poaceae	Tsp	X
<i>Calamagrostis obtusata</i> Trin.	Poaceae	Tsp	X
<i>Dactylis glomerata</i> L.	Poaceae	Tsp	M
<i>Elymus mutabilis</i> (Drobow) Tzvelev	Poaceae	Tp	M
<i>Deschampsia cespitosa</i> (L.) P. Beauv.	Poaceae	Tp	M
<i>Festuca altaica</i> Trin.	Poaceae	Tsp	MX
<i>Festuca borissii</i> Reverd.	Poaceae	Tp	MP
<i>Festuca kryloviana</i> Reverd.	Poaceae	Tp	MX
<i>Festuca rubra</i> L.	Poaceae	Tp	MX
<i>Koeleria altaica</i> (Domin) Krylov	Poaceae	Tp	MX
<i>Milium effusum</i> L.	Poaceae	Tsp	MX
<i>Phleum alpinum</i> L.	Poaceae	Tsp	MX
<i>Phleum phleoides</i> (L.) H.Karst.	Poaceae	Tsp	MX
<i>Poa alpigena</i> Lindm.	Poaceae	Tp	MX
<i>Poa attenuata</i> Trin.	Poaceae	Tp	M
<i>Poa pratensis</i> L.	Poaceae	Tp	GM
<i>Poa sibirica</i> Roshev.	Poaceae	Tsp	MP

Table continuation

Names of species	Family	Life forms (Raunkiaer 1934)	Ecological groups
<i>Helictochloa versicolor</i> (Vill.) Romero Zarco (<i>Helictotrichon versicolor</i> (Vill.) Pilg.)	Poaceae	Tp	MX
<i>Deschampsia cespitosa</i> (L.) P. Beauv.	Poaceae	Tp	MX
<i>Alchemilla altaica</i> Juz.	Rosaceae	Srp	MP
<i>Alchemilla vulgaris</i> L. (<i>Alchemilla acutiloba</i> Opiz)	Rosaceae	Srp	MP
<i>Alchemilla xanthochlora</i> Rothm.	Rosaceae	Srp	MP
<i>Cotoneaster uniflorus</i> Bunge	Rosaceae	C	MPt
<i>Dasiphora ruticose</i> (L.) Rydb. (<i>Pentaphylloides ruticose</i> (L.) O.Schwarz)	Rosaceae	C	M
<i>Potentilla chrysantha</i> Trevir.	Rosaceae	Srp	M
<i>Rosa acicularis</i> Lindl.	Rosaceae	C	M
<i>Rosa spinosissima</i> var. <i>spinosissima</i> (<i>Rosa pimpinellifolia</i> L.)	Rosaceae	C	M
<i>Rubus idaeus</i> L.	Rosaceae	C	GM
<i>Sibbaldia procumbens</i> L.	Rosaceae	Srp	GM
<i>Sanguisorba alpina</i> Bunge	Rosaceae	Srp	GM
<i>Sibiraea laevigata</i> (L.) Maxim.	Rosaceae	Srp	GM
<i>Spiraea chamaedryfolia</i> L.	Rosaceae	C	M
<i>Spiraea media</i> Schmidt	Rosaceae	C	MX
<i>Allium altaicum</i> Pall.	Amaryllidaceae (Alliaceae)	Bp	MPt
<i>Allium flavidum</i> Ledeb.	Amaryllidaceae (Alliaceae)	Bp	MX
<i>Allium schoenoprasum</i> L.	Amaryllidaceae (Alliaceae)	Bp	GM
<i>Bistorta elliptica</i> (Willd. ex Spreng.)	Polygonaceae	Srp	MP
<i>Koenigia alpina</i> (All.) T.M.Schust. & Reveal (<i>Aconogonon alpinum</i> (All.) Schur)	Polygonaceae	Srp	MP
<i>Rheum compactum</i> L.	Polygonaceae	Srp	MP
<i>Rumex acetosa</i> L.	Polygonaceae	Srp	MX
<i>Rumex acetosella</i> L.	Polygonaceae	Srp	M
<i>Campanula cervicaria</i> L.	Campanulaceae	Tp	M
<i>Campanula stevenii</i> subsp. <i>altaica</i> (Ledeb.) Fed. (<i>Campanula altaica</i> Ledeb.)	Campanulaceae	Tp	M
<i>Carex aterrima</i> Hoppe	Cyperaceae	Tsp	GM
<i>Carex capillaris</i> L.	Cyperaceae	Tsp	GM
<i>Carex glomerata</i> Thunb.	Cyperaceae	Tsp	M
<i>Carex melanocarpa</i> Cham. ex Trautv.	Cyperaceae	Tsp	M
<i>Carex pediformis</i> var. <i>macroura</i> (Meinsh.) Kük. (<i>Carex macroura</i> Meinsh.)	Cyperaceae	Tsp	M
<i>Berberis sibirica</i> Pall.	Berberidaceae	C	M
<i>Saxifraga sibirica</i> L.	Saxifragaceae	Srp	MPt
<i>Bergenia crassifolia</i> (L.) Fritsch	Saxifragaceae	Lrp	MP
<i>Micranthes punctata</i> (L.) Losinsk. (<i>Saxifraga punctata</i> L.)	Saxifragaceae	Srp	MPt

Table continuation

Names of species	Family	Life forms (Raunkiaer 1934)	Ecological groups
<i>Betula rotundifolia</i> Spach	Betulaceae	T	P
<i>Cerastium pauciflorum</i> Steven ex Ser.	Caryophyllaceae	Tp	MX
<i>Dianthus superbus</i> L.	Caryophyllaceae	Tp	MX
<i>Dichodon cerastoides</i> (L.) Rchb.	Caryophyllaceae	Tp	M
<i>Silene repens</i> Patrin	Caryophyllaceae	Tp	GM
<i>Silene vulgaris</i> (Moench) Garcke (<i>Oberna behen</i> (L.) Ikonn.)	Caryophyllaceae	Tp	M
<i>Corydalis bracteata</i> (Stephan ex Willd.) Pers.	Papaveraceae	Tp	GM
<i>Papaver nudicaule</i> L.	Papaveraceae	Tp	M
<i>Dracocephalum grandiflorum</i> L.	Lamiaceae	Srp	MX
<i>Dracocephalum nutans</i> L.	Lamiaceae	Srp	MX
<i>Dracocephalum ruyschiana</i> L.	Lamiaceae	Tp	X
<i>Lamium album</i> L.	Lamiaceae	Tp	MX
<i>Origanum vulgare</i> L.	Lamiaceae	Srp	M
<i>Phlomis alpina</i> (Pall.) Adylov, Kamelin & Makhm.	Lamiaceae	Srp	MP
<i>Epilobium angustifolium</i> L. (<i>Chamaenerion angustifolium</i> (L.) Scop.)	Onagraceae	Srp	MP
<i>Erythronium sibiricum</i> (Fisch. & C.A.Mey.) Krylov	Liliaceae	Bbp	MP
<i>Lloydia serotina</i> (L.) Rchb.	Liliaceae	Bbp	M
<i>Euphorbia pilosa</i> L.	Euphorbiaceae	Bbp	MPt
<i>Galium boreale</i> L.	Rubiaceae	Tp	MP
<i>Galium verum</i> L.	Rubiaceae	Tp	MX
<i>Gentiana algida</i> Pall.	Gentianaceae	Bbp	MP
<i>Gentiana decumbens</i> L.f.	Gentianaceae	Bbp	MP
<i>Gentiana uniflora</i> Georgi	Gentianaceae	Bbp	MP
<i>Gentianella amarella</i> (L.) Börner	Gentianaceae	Bbp	MP
<i>Gentianopsis barbata</i> (Froel.) Ma	Gentianaceae	Bbp	M
<i>Swertia obtusa</i> Ledeb.	Gentianaceae	Tp	GM
<i>Geranium albiflorum</i> Ledeb.	Geraniaceae	Srp	GM
<i>Geranium collinum</i> Stephan ex Willd.	Geraniaceae	Srp	GM
<i>Hedysarum neglectum</i> Ledeb.	Fabaceae	Lrp	MP
<i>Lathyrus gmelinii</i> (Fisch. ex Ser.) Fritsch	Fabaceae	Lrp	MP
<i>Lathyrus vernus</i> (L.) Bernh.	Fabaceae	Lrp	M
<i>Thermopsis alpina</i> (Pall.) Ledeb.	Fabaceae	Srp	MP
<i>Vicia cracca</i> L.	Fabaceae	Lrp	M
<i>Trifolium lupinaster</i> L. (<i>Lupinaster pentaphyllus</i> Moench)	Fabaceae	Srp	GM
<i>Oxytropis alpina</i> Bunge	Fabaceae	Srp	GM
<i>Hylotelephium ewersii</i> (Ledeb.) H.Ohba (<i>Sedum ewersii</i> Ledeb.)	Crassulaceae	Srp	GM
<i>Rhodiola algida</i> (Ledeb.) Fisch. & C.A.Mey.	Crassulaceae	Srp	MPt
<i>Rhodiola rosea</i> L.	Crassulaceae	Srp	MPt
<i>Iris ruthenica</i> Ker Gawl.	Iridaceae	Srp	MX
<i>Juniperus communis</i> var. <i>saxatilis</i> Pall. (<i>Juniperus sibirica</i> Burgsd.)	Cupressaceae	C	MPt

Table continuation

Names of species	Family	Life forms (Raunkiaer 1934)	Ecological groups
<i>Lagotis globosa</i> Hook.f.	Plantaginaceae	Brp	MX
<i>Veronica krylovii</i> Schischk.	Plantaginaceae	Srp	MX
<i>Larix sibirica</i> Ledeb.	Pinaceae	T	MP
<i>Picea obovata</i> Ledeb.	Pinaceae	T	P
<i>Pinus sibirica</i> Du Tour	Pinaceae	T	P
<i>Lonicera caerulea</i> subsp. <i>altaica</i> (Pall.) Gladkova (<i>Lonicera altaica</i> (Pall.))	Caprifoliaceae	C	MP
<i>Lonicera hispida</i> Pall. ex Schult.	Caprifoliaceae	C	MP
<i>Patrinia sibirica</i> (L.) Juss.	Caprifoliaceae	Srp	MX
<i>Valeriana pratensis</i> Dierb. (<i>Valeriana collina</i> Wallr.)	Caprifoliaceae	Bbp	M
<i>Veronica krylovii</i> Schischk.	Plantaginaceae	Srp	M
<i>Macropodium nivale</i> (Pall.) W.T.Aiton	Brassicaceae	Srp	MPt
<i>Myosotis scorpioides</i> subsp. <i>Scorpioides</i> (<i>Myosotis palustris</i> (L.) Hill)	Boraginaceae	Srp	GM
<i>Paeonia anomala</i> L.	Paeoniaceae	Brp	M
<i>Pedicularis condensata</i> M.Bieb.	Orobanchaceae	Srp	MX
<i>Pedicularis elata</i> Willd.	Orobanchaceae	Srp	MX
<i>Pedicularis oederi</i> Vahl	Orobanchaceae	Srp	MX
<i>Polemonium caeruleum</i> L.	Polemoniaceae	Tp	M
<i>Polygala sibirica</i> L.	Polygalaceae	Tp	MP
<i>Primula nivalis</i> Pall.	Primulaceae	Tsp	MP
<i>Primula pallasii</i> Lehm.	Primulaceae	Srp	M
<i>Ribes atropurpureum</i> C.A.Mey.	Grossulariaceae	C	M
<i>Ribes rubrum</i> L.	Grossulariaceae	C	M
<i>Salix lanata</i> L.	Salicaceae	T	GM
<i>Salix nummularia</i> Andersson	Salicaceae	T	GM
<i>Salix rectijulis</i> Ledeb. ex Trautv.	Salicaceae	T	GM
<i>Thesium repens</i> Ledeb.	Santalaceae	Ds	MP
<i>Vaccinium myrtillus</i> L.	Ericaceae	Hs	GM
<i>Vaccinium vitis-idaea</i> L.	Ericaceae	Hs	GM
<i>Veratrum lobelianum</i> Bernh.	Melanthiaceae	Srp	MP
<i>Viola altaica</i> Ker Gawl.	Violaceae	Tsp	M
<i>Viola biflora</i> L.	Violaceae	Tsp	M
<i>Viola disjuncta</i> W.Becker	Violaceae	Tsp	M

* Life forms according to Raunkiaer (1934): M – Mesophanerophytes, N – Nanophanerophytes, Ch – Chamaephytes, H – Hemicryptophytes, C – Cryptophytes. Life forms according to Serebryakov, (1962): T – tree; S – shrub; Hs – half-shrub; Ds – dwarfshrub; Lrp – long rhizomatous plant; Srp – short rhizomatous plants; Bbp – bulbotuberiferous plants; Bp – bulbous plants; Tp – taproot plants; Brp – brushy root plants; Tsp – tussock plants; Cm – club-moss. Ecological groups of plants in relation to the temperature, moisture and ston nature of the substrate: H – hygrophytes, HP – hygropsychophytes, GM – hygromesophytes, M – mesophytes, MX – mesoxerophytes, MP – mesopsychophytes, X – xerophytes, XPt – xeropetrophyte, P – psychophytes, MPt – mesopetrophytes [38]

The most numerous are representatives of the following families: Poaceae Barnhart (13.7%), Asteraceae Dumort. (12.6%), Ranunculaceae Juss. (9.7%), Rosaceae Juss. (8%), which account for 44% of the total (Figure 3).

In the aspect of life forms, short rhizomatous plants prevail – 33%, taproot plants – 24% and tussock plants – 11% (Figure 4).

Regarding the composition of life forms in relation to temperature, moisture and substrate structure, the basis of phytocenoses are ecological groups of plants: mesophytes – 30%, in a smaller proportion are mesohygrophytes – 19%, mesoxerophytes – 20% and mesopsychrophytes – 18% (Figure 5).

The results of comparisons of *H. theinum* cenoflora on the Ivanovsky Ridge with data on the species composition of the flora of the Kazakhstani Altai show that the families Fabaceae Lindl., Ranunculaceae Juss., Rosaceae Juss., Gentianaceae Juss. differ significantly in the proportion of participation in the formation of the floral composition (Table 3). This is associated with the low number of xeromesophytic species and the predominant number of mesophytic species typical of dark coniferous forests and subalpine meadows. The Spearman rank correlation coefficient is 0.615, and the relationship is moderate and direct.

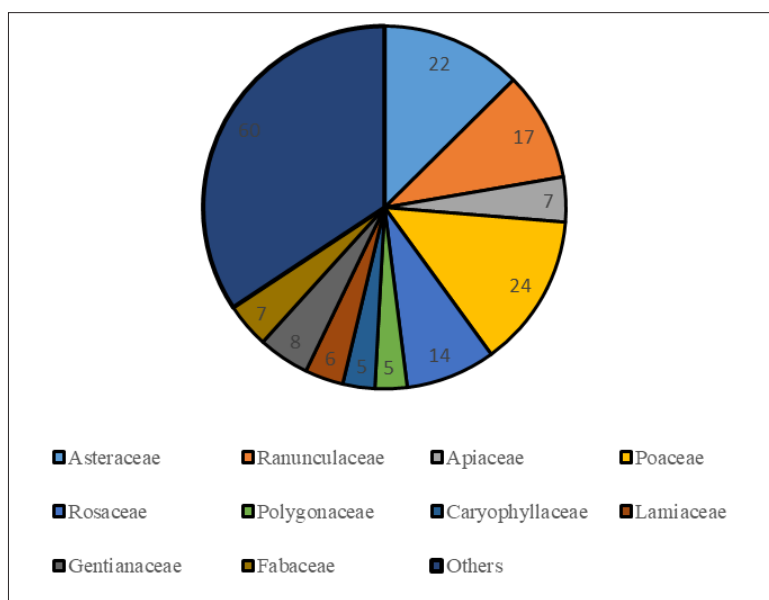


Figure 3 – Spectrum of the leading families

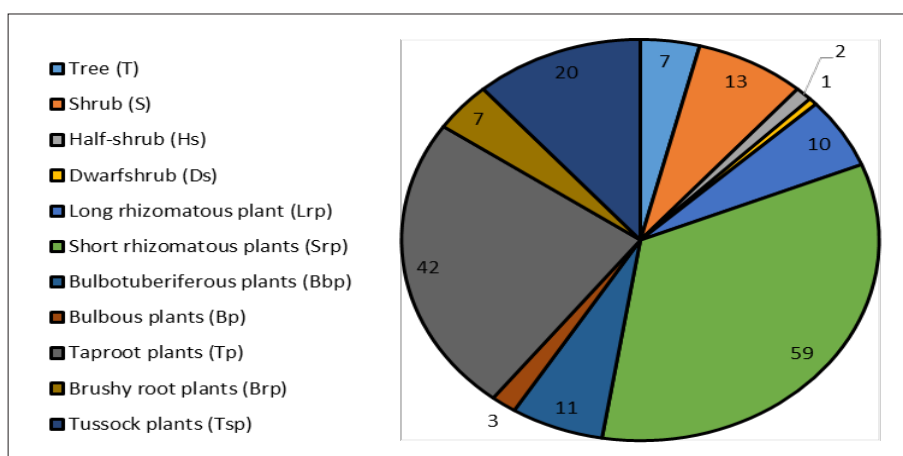


Figure 4 – Life forms according to Serebryakov (1962)

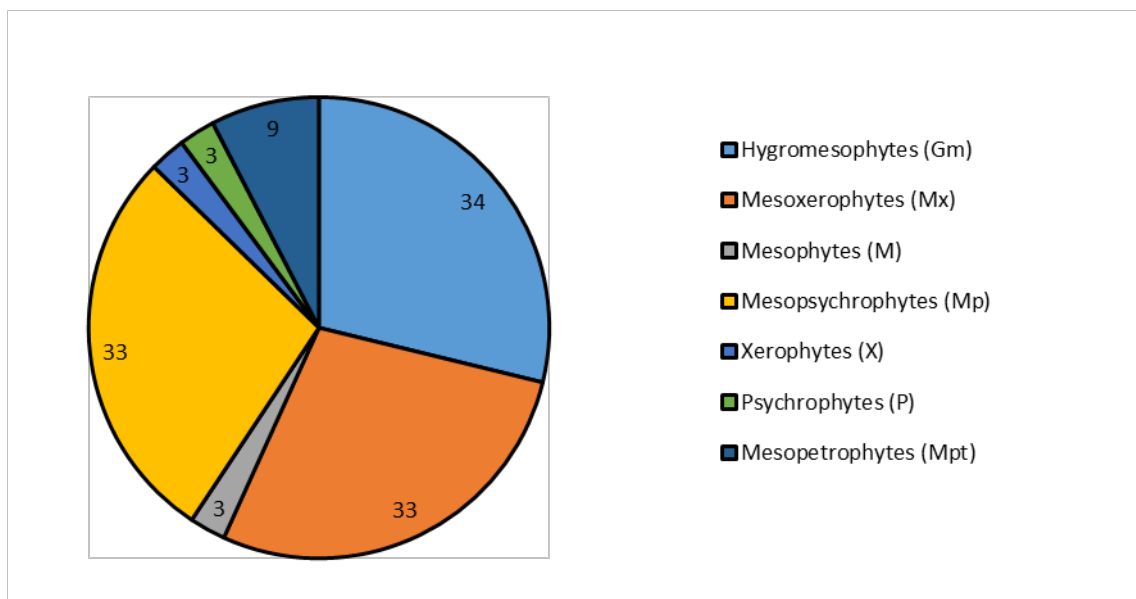


Figure 5 – Ecological groups of plants

Table 3 – Leading families of the flora of *H. theinum* populations by the number of species

Family	Cenoflora of <i>H. theinum</i> populations, Ivanovo Ridge		Flora of Kazakhstani Altai
	Number of genera, % of total number	Number of species, % of total number	Number of species, % of total number
Apiaceae Lindl.	7/6	7/4	71/2,9
Asteraceae Dumort.	16/13	22/12	324/13,3
Caryophyllaceae Juss.	4/3	5/3	81/3,3
Fabaceae Lindl.	6/5	7/4	183/7,5
Lamiaceae Martinov	4/3	6/3	77/3,2
Gentianaceae Juss.	4/3	8/5	29/1,2
Poaceae Barnhart	14/12	24/14	308/12,6
Ranunculaceae Juss.	10/8	17/10	10/4,2
Rosaceae Juss.	9/7	14/8	109/4,5
Caryophyllaceae Juss.	4/3	5/3	81/3,3
Total	78/65	115/66	1256/51,8

According to the spectrum of the 10 leading families, the flora of associated species for *H. theinum* is significantly similar to the flora of the entire Kazakhstani Altai. The high percentage of species falling within the main ten families – 66% – indicates a high degree of anthropogenic pressure and transformation of the flora, which is much higher than the overall figures for the Kazakhstani Altai – 51.8%. Weed species in the cenoflora: *Crepis sibirica*, *Poa pratensis*, *Lamium album* also confirm the presence of anthropogenic pressure on *H. theinum* communities.

Conclusion

The study of the current state of rare and economically valuable *H. theinum* in Kazakhstan should have a comprehensive character. The first stage in the study was an inventory of historical herbarium materials of the main repositories: the herbarium fund of the Institute of Botany (AA) and the herbarium fund of the Moscow State University (MW). Establishment of the actual places of growth served as the basis for the construction of expedition routes. The second stage of the study was the analysis

of the *H. theinum* cenoflora in the Kazakhstani Altai, the natural habitat of the species. The study of *H. theinum* cenoflora showed a high similarity of species ratio with the whole flora of Kazakhstani Altai. The high number of mesophytic species influenced the predominance of such families as Asteraceae Dumort., Poaceae Barnhart, Ranunculaceae Juss. and Rosaceae Juss. At the same time the high percentage of species falling on the leading families and the presence of weed species confirms the high anthropogenic load on the *H. theinum* communities. The species requires further detailed study with the purpose of preservation and protection.

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