

Formation of the Ranges of Invasive Plant Species in the Altai Republic: Results of the Centennial Naturalization

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Abstract—Currently, 10–15% of invasive plant species are recorded in alien floras of all inhabited regions of the world, and their proportion is constantly growing. A particular problem is naturalization of alien species in the regions with high levels of endemism and species diversity, such as the Altai Republic. We have been studying the alien flora of the Altai Republic since the beginning of the 21st century. The ranges of 67 invasive species belonging to 57 genera and 20 families have been identified. Most of the species have been known on the territory of the Altai Republic since the 20th century; ten species have penetrated here in the 21st century. The main method of penetration (vector) is accidental introduction. In all areas, at least singly, there are five species: *Amaranthus retroflexus*, *Bunias orientalis*, *Matricaria discoidea*, *Melilotus officinalis*, *Tripleurospermum inodorum*. The orographic and climatic features of the area predetermine a greater susceptibility to invasions for the northern regions and a lesser one for the southeastern regions. Eighteen species are distributed only in the northern regions. Almost all species are found Gorno-Altaysk, Maima district; the least number of species are found in Kosh-Agach district, which is characterized by the most severe climatic conditions. Thirty-five species are invasive in Siberia; 11 species are among the hundred most aggressive species in Russia. On the basis of our own long-term research, taking into account the analysis of available publications and stock materials (Herbarium of the Central Siberian Botanical Garden of the Siberian Branch of the Russian Academy of Sciences and Gorno-Altaysk State University), as well as other available data (iNaturalist, GBIF), maps of the ranges of invasive plants of the Altai Republic were compiled. For each species, all known localities are given, indicating administrative regions, settlements, river valleys, etc.; the time of discovery is noted, and links to the source are indicated.

Keywords: alien flora, annotated list, range maps, invasive species, naturalization history, the Altai Republic

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INTRODUCTION

Invasions of alien species are a global problem that is growing in the 21st century (Tittensor et al., 2014; Early et al., 2016). To date, about 14000 adventitious species (4% of the world flora) have been registered in the world, naturalized in at least one region of the planet (Global..., 2015; van Kleunen et al., 2019). In 42% of the continental regions of the world, the number of naturalized (forming self-sustaining populations) adventids is 10–40% of the total number of species, and these numbers are steadily growing (Pergl et al., 2017). The share of invasive species in some regions reaches 10–15 (20)%, often these are the same species in many regions. It is known that, in 45 Russian regions, occupying 83% of the Russian territory, 354 invasive species have been registered (Vinogradova et al., 2018). Naturalization of new species often leads to a decrease in the reproductive capacity of native species and a reduction in their numbers and habitats; therefore, invasions of species are rightfully considered one of the most serious threats to biologi-

cal diversity (Williamson, 1996; *Biologicheskie...*, 2004; Olmstead, 2006). Naturalized alien species reduce the uniqueness of regional floras throughout the world, as demonstrated by a recent study of native and adventive floras of 658 regions from 110 countries, covering 65.7% of the world's land mass. The natural decline in floristic similarity with increasing geographic distance was found to be attenuated by naturalized species. Floristic homogenization is higher in regions with similar climates, as well as between regions with historical or modern relationships characterized by intense trade and transport exchanges (Yang et al., 2021). The high degree of naturalization is also due to the level of regional development: the higher the level, the more actively species are introduced that have decorative and economic value in combination with high adaptation to a disturbed environment (Pouteau et al., 2021). The continued rate of unification of floras can lead to the fact that even the most remote regions will lose their floristic uniqueness. A particular problem is the naturalization of alien

species in regions with high levels of endemism and species diversity (Early et al., 2016), such as the Altai Republic.

The Altai Republic is located within the Russian part of the Altai mountainous country and, along with other mountainous territories of Southern Siberia, belongs to the Altai-Sayan ecoregion, recognized as one of the 200 world centers of species diversity (Olson and Dinerstein, 2002).

The republic has a relatively small area of 92900 km² and ranks 35th among Russian regions in terms of this indicator, while it is included in the five regions with the lowest population (210000 in 2023) and in the ten regions with the lowest population density (2.27 people per 1 km²). In the south of the territory of the republic there is the state border of Russia with Mongolia and China; in the southwest, there is the border with the Republic of Kazakhstan, with a total length of about 800 km. The Altai Republic borders Altai Territory on the northwest, Kemerovo Region and the Republic of Khakassia on the northeast, and the Republic of Tyva on the east.

The Altai Republic is a region unique in its biodiversity; 17.5% of its territory was included in the UNESCO World Heritage List in 1998 under the name “Golden Mountains of Altai.” Until the end of the 20th century, the territory of the Altai Republic could have been considered relatively free from phytinvasions. This was facilitated by the sparse population of the region and, accordingly, the low level of economic activity and a small proportion of disturbed territories. According to *Flora of Siberia (Flora Sibiri, 1988–2003)*, by the beginning of the 21st century 82 species of adventive plants were registered on the territory of the republic.

From the end of the 20th century, the situation has been changing dramatically: the tourism industry in the region is actively developing. The flow of tourists is growing; since 2017, more than 2 million people annually visit the Altai Republic (*Godovoi doklad...*, 2022), the number of territories being developed for tourist camps, bases, and recreation areas is increasing by an order of magnitude. If ten years ago the bulk of tourists did not cross the borders of the Chermal district (Fig. 1), located in the northern part of the republic, now central and southeastern Altai, which are places of concentration of rare and endemic species of the Altai Republic and the Altai-Sayan mountain region, are actively being developed generally. Visits to the territories that make up the Golden Mountains of Altai entity are becoming widespread.

Self-dispersal of alien species occurs along several transport routes, often in the forward direction, less often in the opposite direction. The longest route crossing the Altai Republic from north to southeast and connecting the region with Mongolia is the Chusky tract and its branches to Ust-Koksa and Ulagan.

Another route is from Gorno-Altaysk east to Turochak and Lake Teletskoye.

The first information about alien species on the territory of the Altai Republic is contained in “Flora of Altai and Tomsk Province” (Krylov, 1901–1914) and “Flora of Western Siberia” (Krylov, 1927–1949), but special interest in studying the alien flora of the region arose later, at the end of the 20th to beginning of the 21st centuries. The adventitious flora of the Altai Nature Reserve (ANR) is being studied (Zolotukhin, 1983); fragmentary information about the distribution of adventive species appears in works on the study of floras of individual ridges, valleys of large rivers, and interfluves (Danilov, 1990; Artemov, 1993; Silant'yeva, 1994; Pshenichnaya, 1997; Studenikina, 1999; Achimova, 2004; Khmeleva, 2005), as well as in isolated publications on floristic finds.

The purpose of our study is to study the distribution of invasive plant species in the Altai Republic, analyze the routes and methods of introduction into the region, and compile habitat maps in order to identify areas of the republic most susceptible to plant invasions.

MATERIALS AND METHODS

Since 2000, we have been studying the alien flora of the Altai Republic. In 2015, a summary of the adventive flora was published, including 230 species (Zykova, 2015a), and to date, the alien flora of the region includes more than 300 species (Zykova, 2016–2022; etc.). Sixty-seven of them are invasive species, naturalizing and actively settling in disturbed habitats and penetrating natural habitats (Zykova and Ebel, 2022).

On the basis of our own long-term observations and analysis of the author's herbarium collections and collections stored in the holdings of the Central Siberian Botanical Garden (NS, NSK) and Gorno-Altaysk State University (GASU), taking into account existing publications, data from the portals iNaturalist (2023) and GBIF (2023), as well as generalizing floristic reports (Krylov, 1901–1914, 1927–1949; *Flora Sibiri, 1988–2003*; Ilyin and Fedotkina, 2008; *Opre-delitel'...*, 2012), all information on the distribution of invasive species in the Altai Republic has been collected and analyzed. Range maps have been compiled, where for each species the first known location is marked (black circles and year of discovery), and the distribution in the 20th century (gray circles) and 21st century (open circles) is indicated (Figs. 2–6).

For each species, the text provides all available information on its distribution in the Altai Republic, indicating the administrative regions; the first mention of the region is in bold. An asterisk (*) indicates the author's unpublished collections after 2015. Links to publications are provided, stock specimens are marked in parentheses with the herbarium acronym

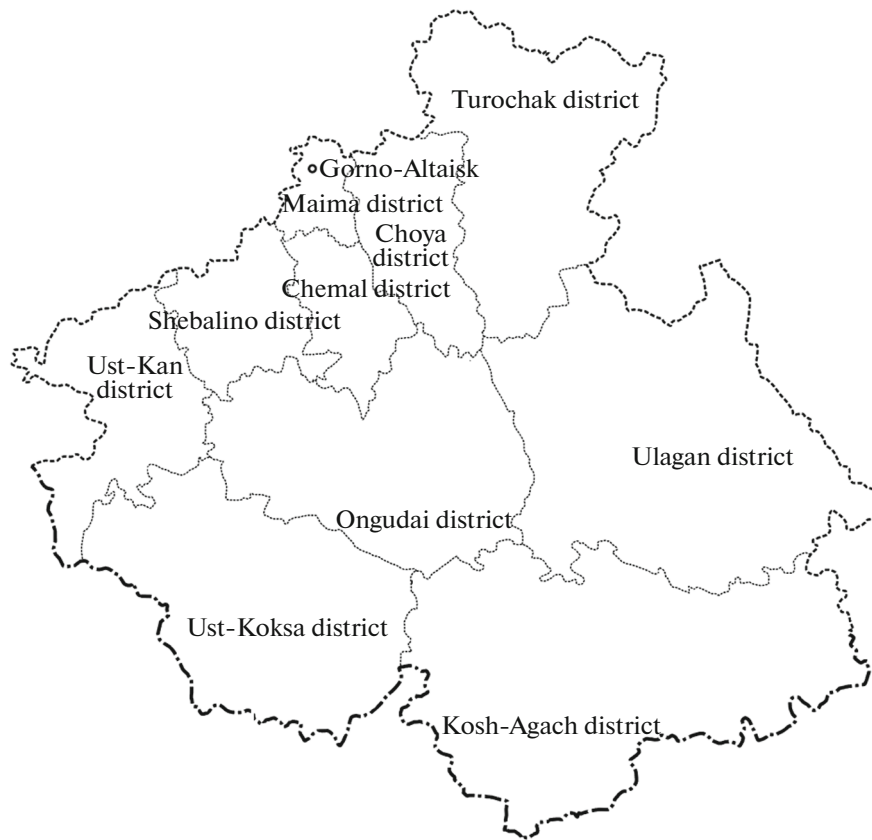


Fig. 1. Administrative districts of the Altai Republic.

and a unique number (NS0028538), and a link to the location posted on the iNaturalist portal (iNat90043998) is also provided. The description of the villages is omitted; only the names are given. Accepted abbreviations: administrative districts: G—city of Gorno-Altaysk, M—Maima district, Ch—Choya district, T—Turochak district, Chm—Chemal district, Sh—Shebalino district, O—Ongudai district, Ukn—Ust-Kan district, Uks—Ust-Koksa district, U—Ulagan district, K—Kosh-Agach district. The families are arranged alphabetically, as are the species within the family. Species names are given in accordance with the “Catalogue of Life Checklist” (Banki et al., 2023).

RESULTS

AMARANTHACEAE

Amaranthus retroflexus L.: xenophyte; a common ruderal and segetal plant, the most widespread invasive species in the Altai Republic. 1909—T: Kibezen; U: Bashkaus River mouth, Chulyshman River valley near Kutu-Yaryk (Krylov, 1909). 1930s—M: Ust-Muny; T: in the valley of the Lebed River between the mouths of the Tavoloka and Salazan rivers; Chm: Anos, Elekmonar, Chemal; O: Kayancha, lower

reaches of the Chuya River (Krylov, 1930); T: Yailyu (Khomutova et al., 1938). 1961—G, 1976—O: Maly Yaloman (GASU herbarium). 1980s—Sh: Marchela River valley (Pshenichnaya, 1997); Uks: valleys of the Multa and Kuragan rivers (Artemov, 1993); Tyungur (NS0048578), Yustik (NS0048579), Ust-Koksa (NS0048577); U: the foot of Mount Belkenek (Danilov, 1990). 1990s—Ch: Uymen; T: Novotroitsk, Churya, Ust-Pyzha (Silantieva, 1994); Ch: Paspaul (Studenikina, 1999); U: Aktash (NS0048576). 2000s—2010s—O: widely (Achimova, 2004; Vaganov, 2004); Ukn: Yabogansky Pass*; K: Chuya River valley—from the mouth to the upper reaches (Ilyin and Fedotkina, 2008); widely settled in all other districts (Ilyin and Fedotkina, 2008; Zykova, 2015a; iNaturalist, 2023).

Bassia scoparia (L.) A.J. Scott: xenophyte; near roads, in fields, in populated areas; noted for all areas with the exception of K (Lomonosova, 2012); however, there are no collections or publications confirming such a wide distribution of the species; to date, it is reliably known from four regions of the Altai Republic. 1930—U: in the Chulyshman River valley between Kumurtuk and the mouth of the Chulcha River (Krylov, 1930). 1990s—Chm: Chemal (NS0028538), Elekmonar (Lomonosova, 1992). 2010s—G*, O: Inya (Zykova, 2015a).

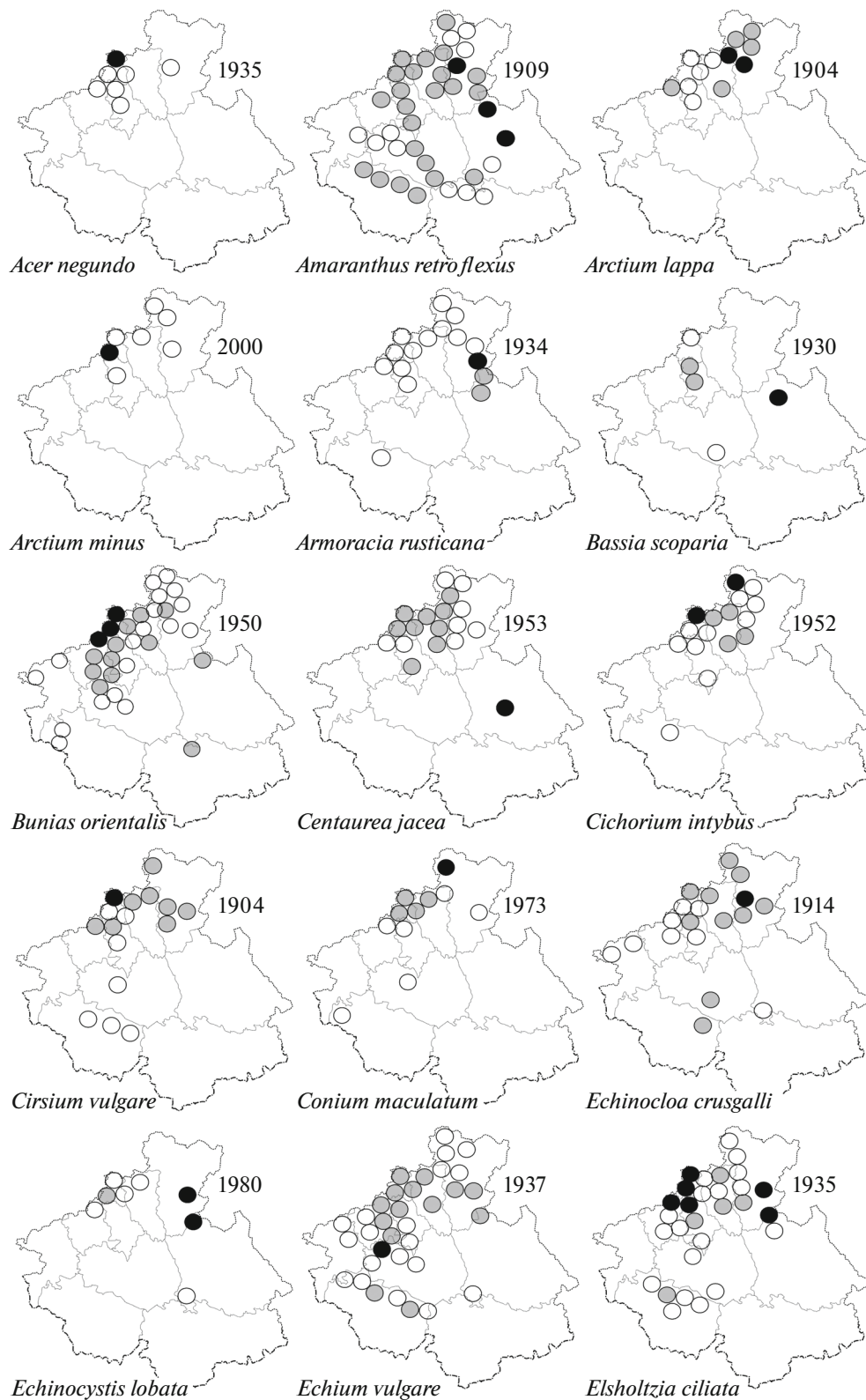


Fig. 2. Schematic maps of ranges, where for each species the first known location is marked (black circles and year of discovery), and distribution in the 20th century (gray circles) and 21st century (uncolored circles).

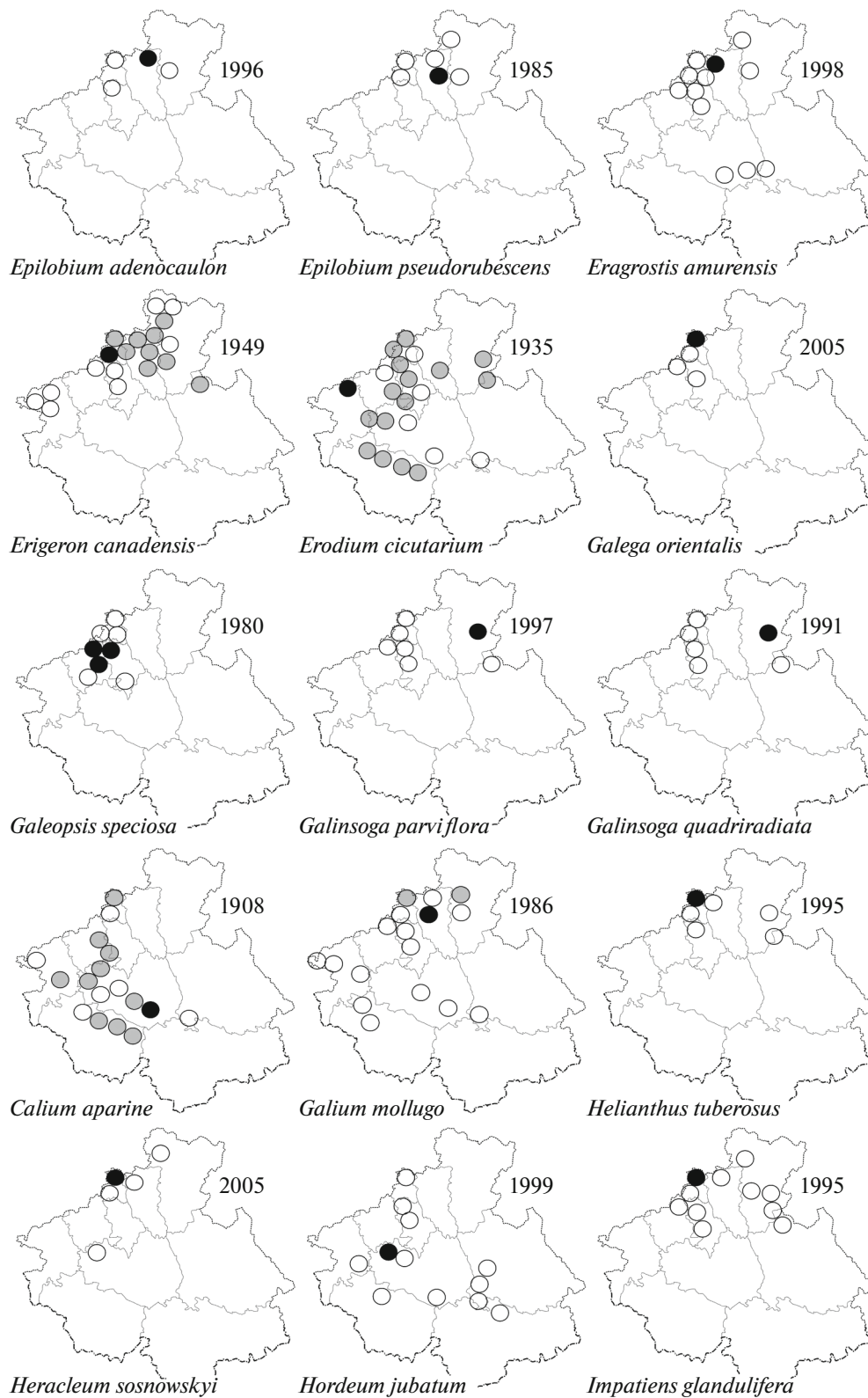


Fig. 3. Schematic maps of species ranges (for symbols, see Fig. 2).

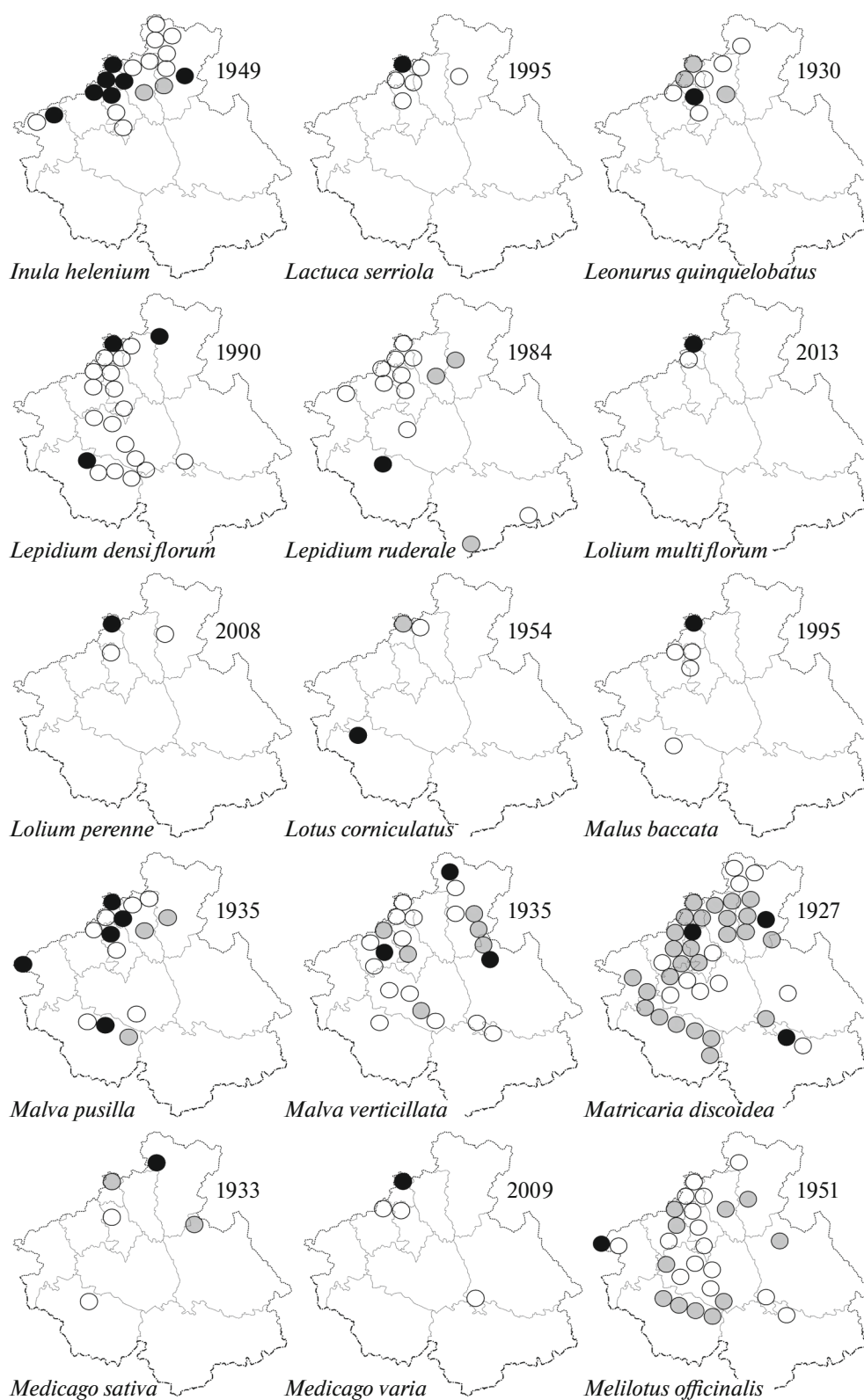


Fig. 4. Schematic maps of species ranges (for symbols, see Fig. 2).

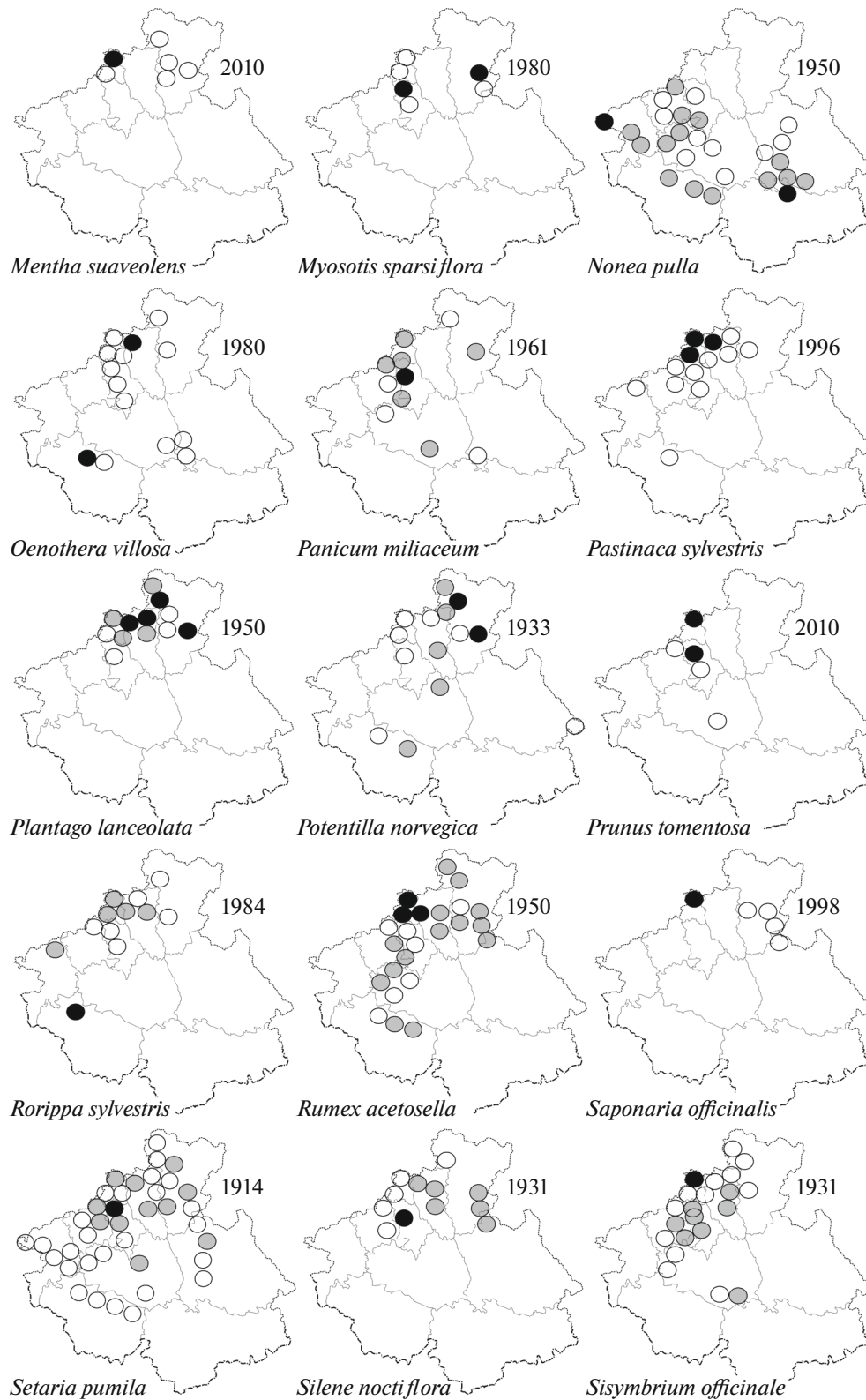


Fig. 5. Schematic maps of species ranges (for symbols, see Fig. 2).

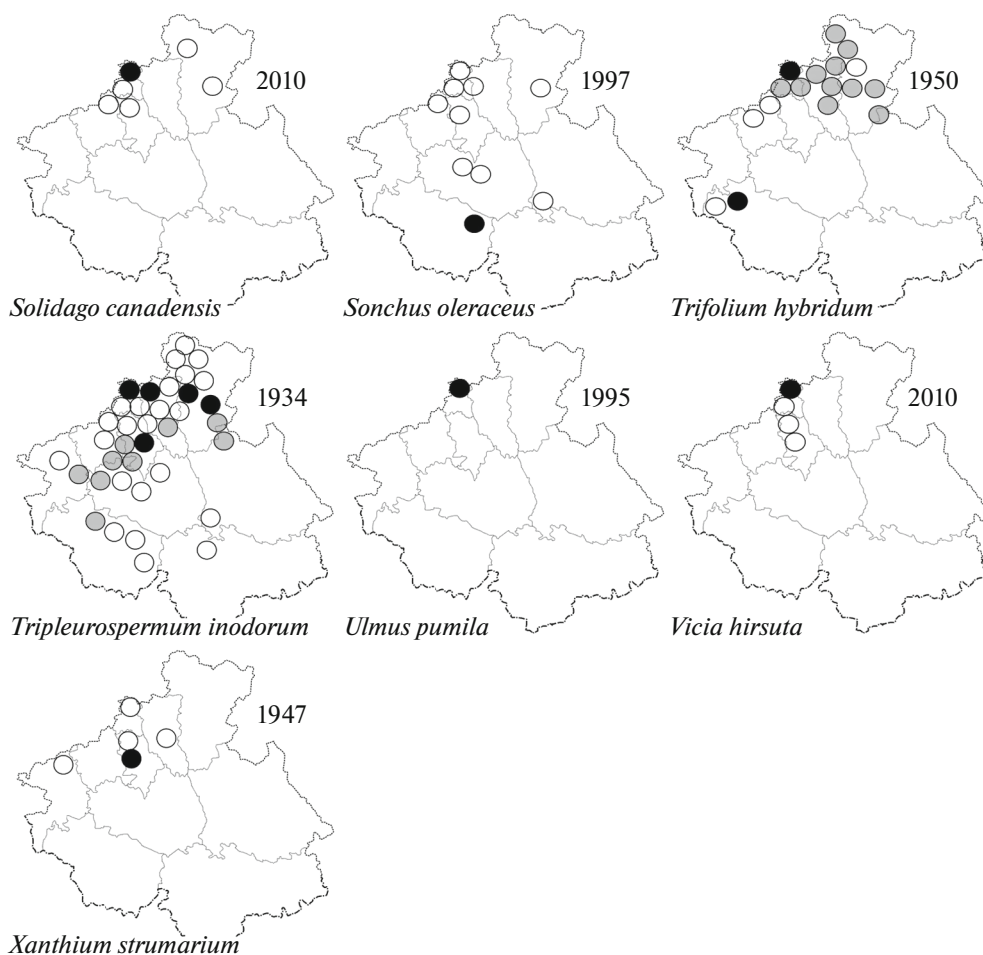


Fig. 6. Schematic maps of species ranges (for symbols, see Fig. 2).

APIACEAE

Conium maculatum L.: xenophyte; forms thickets in gardens, vegetable gardens, near roads and housing, in wastelands, fallow lands, landfills, along the banks. 1973—T: Lake Kureevo (Rostovtseva, 1976). 1990s—G, M, Sh (Nikiforov, 1989); Ch: Paspaul (Studenikina, 1999). 2000s—O: Shashikman, Ongudai (Achimova, 2004). 2010s—Ch: Choya, Kiska, Verkh-Pyankovo (Ilyin and Fedotkina, 2008). 2020s—Ch: Sugul*; T: Yailyu (Zykova, 2020b); Chm: Uznezya (iNat120139044); Sh: Cherga (iNat90043998); Uks: between Karagay and Banny (iNat128099316).

Heracleum sosnowskyi Manden.: xenophyte; forms thickets in ravines, along banks, in fields, fallow lands, wastelands, near roads and in populated areas, and enters light forests. 2005—M: from the border along the Chuisky tract to Karlushka (Silantieva et al., 2005). 2010s—G and M (along the Chuisky tract to Izvestkovoye); Ch: along the highway between Paspaul and Levinka; T: near the mouth of the Lebed River near a rock with Lenin bas-relief; O: along the ascent to the Seminsky Pass (Zykova, 2015a).

Pastinaca sativa var. *sylvestris* (Mill.) DC.: xenophyte; common near roads and in fallow lands, penetrates into dry meadows and pine forests. 1996—G, M: Alexandrovka, Ch: Paspaul (Studenikina, 1999). 2010s—Ch: widely (Ilyin and Fedotkina, 2008); M: everywhere; Chm: Chemal; Uks: Ust-Koksa (Zykova, 2015a); T: Artybash (Zykova, 2022). 2020s—Chm: Elanda (iNat55237195), Elekmonar (iNat71071435); Sh: Kamlak (iNat132230294), Cherga (iNat90043999), Myyuta (iNat87855515); Ukn: Black Anui (iNat30738317); Uks: Bashtala (iNat102811312).

ASTERACEAE

Arctium lappa L.: xenophyte; common near roads and in built-up areas, in vacant lots, along shores. 1904—between T: Kibezen and Ch: Pyankovo (Krylov, 1904). 1949—T: Lebed River valley; Sh: Cherga (Krylov, 1949). 1990s—Ch: Uymen (Silantieva, 1994). 2000s—M: Maima; Ch: Choya; Chm: Ust-Sema, Anos, Chemal (Ilyin and Fedotkina, 2008). 2010s—G, M: Karlushka, Kyzyl-Ozyok (Zykova, 2020b); Ch: Levinka, T: Turochak-Artybash highway

(Zykova, 2015a); **Chm**: Cheposh (Zykova and Ankova, 2017).

Arctium minus (Hill) Bernh.: xenophyte; near roads, in vacant lots, along the banks, in populated areas; it forms thickets. 2000—**M**: Souzga, Manzhherok (Pyak et al., 2000). 2010s—**G**, **M**: Kyzyl-Ozyok (Zykova, 2014b); **Ch**: Choya (Zykova and Ankova, 2017); **T**: Turochak, mouth of the Lebed River (Zykova, 2015a), Artybash (Zykova, 2022). 2020s—**Chm**: Chemal (iNat128417652).

Centaurea jacea L.: ergasiophyte; sown as a honey plant, common near roads and housing, along the banks, in meadows, wastelands, fallow lands, in light forests; forms extended populations and provides background during flowering. 1953—**U**: Bolshoi Aragal River Valley (Zykova, 2016). 1975—**Ch**: Choya (NS0048570). 1980s—**Chm**: Elanda (Pshenichnaya, 1997). 1990s—**G**, **M**: Maima, Kyzyl-Ozyok; **Ch**: Paspaul; **T**: Daibovo (Studenikina, 1999); **Ch**: Uyemen (Silantieva, 1994). 2000s—2010s—**M**, **Ch**: everywhere; **T**: Ust-Lebed, Turochak, Artybash, Yogach, Yailyu (Zykova, 2015a); **T**: along the Biya River valley (Ilyin and Fedotkina, 2008). 2020s—**Sh**: Cherga (iNat90057822), **Chm**: Ust-Sema (iNat89075871).

Cichorium intybus L.: ergasiophyte; cultivated as a medicinal and melliferous plant, found along roads, in populated areas, in meadows, fallow lands, wastelands, along banks, and forest edges. 1952—**M**: Podgornoye (NS0048561); **T**: Lake Kureevo (NS0048569). 1990s—**Ch**: Uyemen; **T**: Ust-Pyzha, Obogo tract (Silantieva, 1994); **G**, **Ch**: Choya (Studenikina, 1999). 2000s—2010s—**T**: Turochak, Artybash, Ust-Lebed; **M**: widely (Zykova, 2015a). 2020s—**Sh**: Cherga (iNat90057826); **Chm**: Chemal (iNat128416230), Kuyus (iNat53450653), **Uks**: Upper Uimon (iNat58221854).

Cirsium vulgare (Savi) Ten.: xenophyte; near roads, on fallow lands, wastelands, in populated areas, in ravines, on forest edges, disturbed meadows. 1904—**M**: Karasuk (Krylov, 1904). 1940s—**Sh**: Cherga (NS0048566); **Chm**: Beshpeltir; **T**: Pyzha River valley, Kibezhen, Artybash (Krylov, 1949). 1980s—**T**: Yailyu, Karatash cordon (Zolotukhin, 1983). 1990s—**Ch**: Choya, Paspaul; **T**: Daibovo (Studenikina, 1999). 2000s—**G**, **M**: everywhere; **Chm**: Ust-Sema (Zykova, 2015a). 2020s—**O**: Ongudai (iNat40075283); **Uks**: Ust-Koksa (iNat96040820), Bashtala (iNat64523166), Multa (iNat101750105), Tyungur (iNat64159128).

Erigeron canadensis L.: xenophyte; near roads, in fields, fallow lands, wastelands, in populated areas, along the banks, in dry meadows, in light forests. 1949—**M**: Ust-Muny (Krylov, 1949). 1980s—**U**: Chiri cordon (Zolotukhin, 1983). 1990s—**Ch**: Uyemen; **T**: Novotroitsk (Silantieva, 1994); **G**, **Ch**: Choya, Paspaul, Sarakoksha River valley; **T**: Turochak; **M**: widely (Studenikina, 1999). 2000—2010s—**Ch**: Sugul; **T**: Artybash, Yogach, Ust-Lebed, Yailyu; **Chm**: Ust-

Sema, Chemal, Elekmonar, Anos; **Sh**: Kamlak, Cherga (Zykova, 2015a); **Ukn**: valleys of the Charysh and Anui rivers (Ilyin and Fedotkina, 2008).

Galinsoga parviflora Cav.: xenophyte; near housing, weeds in flower beds, landfills, and vegetable gardens. 1997—**T**: Baygazan cordon (Zolotukhin, 1997). 2000—2010s—**G**, **Sh**: Kamlak (Ebel, 2008); **U**: Chiri cordon (Zolotukhin, 2012); **Chm**: Anos (Zykova, 2014b); **M**: Manzhherok (Zykova, 2015a). 2020s—**Sh**: Cherga (iNat90050455); **Chm**: Chemal (iNat96058390), Ust-Sema (iNat89069968).

Galinsoga quadriradiata Ruiz & Pav.: xenophyte; in vegetable gardens, on arable land, flower beds, lawns, in weedy places, near roads and housing, more abundant than the previous type, a malicious garden weed. 1991—**T**: Yailyu, Baigazan cordon (Zolotukhin, 1997). 2010s—**G** (Zykova and Erst, 2012); **U**: Chiri cordon (Zolotukhin, 2012); **Chm**: Uznezya, Anos (Zykova, 2014a). 2020s—**M**: Barangol (iNat88523372).

Helianthus tuberosus L.: ergasiophyte; it is cultivated as forage and food and forms extensive thickets in garden plots and beyond, near roads, in fallow lands, and wastelands. 1995—**G**, **M**: Maima (Studenikina, 1999). 2000s—**ANR** (**T** and **U**) (Zolotukhin, 2012); **M**: Izvestkovy (Zykova, 2014a); **Ch**: Sugul (Zykova, 2015a); **Chm**: Cheposh (iNat28157883).

Inula helenium L.: ergasiophyte; grown as a medicinal and ornamental plant, found near homes, roads, meadows, fallow lands, forests, and along the banks. 1949—between **G** and **Sh**: Cherga; **M**: Alexandrovka; **Chm**: Anos, **Ukn**: Black Anui (Krylov, 1949); 1952—**T**: Guryanovka (NS0050054). 1990s—**Ch**: lower reaches of the Uyemen River; **T**: lower reaches of the Pyzha River (Silantieva, 1994); widely in **G**, **M** (Studenikina, 1999). 2000s—**Ukn**: valleys of the Charysh and Anui rivers; **Chm**: Ust-Sema; **Ch**: upper reaches of the Isha River and its tributaries; **T**: in the valley of the Biya River and its tributaries—Uimen, Lebed, Tondoshka (Ilyin and Fedotkina, 2008). 2010s—**T**: Yailyu*. 2020s—**Chm**: Kuyus (iNat53453488).

Lactuca serriola L.: xenophyte; near roads and housing, in fallow lands, vacant lots, landfills, fields, and vegetable gardens. 1995—**G** (Studenikina, 1999). 2000—2010s—**M**: Karlushka, Cheremshanka; **Ch**: Sugul (Zykova, 2012); **M**: widely (Zykova, 2015a); **Chm**: Chemal; **T**: Artybash (Zykova, 2019a).

Matricaria discoidea DC.: xenophyte; near roads and housing, in vacant lots, vegetable gardens, along the banks, in degraded meadows; more widespread than most invasive species, rising to elevations of 2000 m above sea level. 1927—**T**: Yailyu; **Chm**: Beshpeltir; **K**: Kurai steppe in the Tyuty River valley (Krylov, 1949). 1960s—**Chm**: Chemal (NS0048538); **T**: Artybash (NS0048534). 1980s—**U**: Aktash (Danilov, 1990), **ANR** cordons (Zolotukhin, 1983); Seminsky Ridge (**Chm**, **Sh**, **O**): everywhere (Pshenichnaya, 1997); **Ukn**: Ust-Kan (NS0048541), Kayarlyk (NS0048536),

Yabogansky Pass (NS0048540); **Uks**: northern macroslope of the Katunsky Ridge and the Zaychikha River valley (Artemov, 1993), Ust-Koksa (NS0048530), Yustik (NS0048528). **1990s**—valleys of the Uymen River (**Ch**) and Pyzha River (**T**) (Silantieva, 1994); **G, M**: Maima, Dubrovka; **Ch**: Karasuk, Sarakoksha River valley (Studenikina, 1999). **2000s**—widely in **G, M, Ch, Chm, T, O, Uks** (Ilyin and Fedotkina, 2008).

Solidago canadensis L.: ergasiophyte; cultivated as an ornamental, found in wastelands, fallow lands, landfills, near roads, penetrates into meadows, banks, and forms extensive thickets. **2010**—**M**: Maima (Zykova, 2012). **2010s**—**G** (Zolotukhin, 2012; Zykova, 2015a); **Chm**: Uznezya; **T**: Turochak; **Sh**: Cherga (Ebel et al., 2016), **T**: Baigazan* cordon; **M**: Manzherok*, Ust-Muny*.

Sonchus oleraceus L.: xenophyte; in vegetable gardens, orchards, near roads and housing, in vacant lots. **1995**—**G** (Studenikina, 1999). **1997**—**Uks**: Kuragan River (Lomonosova, 1997). **2010s**—**M**: Manzherok; **O**: Khabarovka; **U**: Aktash (Zykova, 2015a); **Sh**: Kamalak; **Chm**: Chemal (Zykova and Ankova, 2017); **T**: Karatash* cordon. **2020s**—**O**: Ongudai (iNat112956466).

Tripleurospermum inodorum (L.) Sch.-Bip.: xenophyte; in populated areas, near roads, in fields, fallow lands, wastelands, along the banks, one of the most widespread invasive species. **1934**—**T**: Yailyu (Khomutova et al., 1938). **1948**—**M**: Maima (NS0048523); **Ch**: Choya (NS0048519). **1949**—**G, T**: Kibezhen; **O**: Karakol River (Krylov, 1949). **1980s**—**Uks**: Ust-Koksa (NS0048521); **Ukn**: Yabogan Pass (NS0048524); Seminsky Ridge (**Chm, Sh, O**): everywhere (Pshenichnaya, 1997); **U**: ANR cordons (Zolotukhin, 1983). **1990s**—**Ch**: Uymen (Silantieva, 1994), **M**: widely, **Ch**: Karasuk, Sovetskoe, **T**: Turochak (Studenikina, 1999). **2000s–2010s**—widely in **M, Ch, T** and **Chm, Sh**: Kaspia River, **O**: Sumulta River, Ursul River and its tributaries, **K**: upper reaches of the Ak-Tru River near the Maly Ak-Tru glacier (Ilyin and Fedotkina, 2008); **U**: Aktash (Zykova, 2014b); **T**: Artybash, Ust-Lebed; **Sh**: Kamalak; **Chm**: Uznezya (Zykova, 2015a). **2020s**—**Uks**: Uimon Valley (iNat64520282, iNat132580188, etc.); **Ukn**: Tyudrala (iNat64304324), Korgon (iNat130335995); **Sh**: Mukhor-Cherga (iNat128271095), Myyuta (iNat36728120), Cherga (iNat90048831); **T**: Novotroitsk (iNat91934146).

Xanthium strumarium L.: xenophyte; forms thickets along the banks of reservoirs, near roads, and in wastelands. **1947**—**Chm**: Chemal (NS0048512). **1949**—**Ukn**: Black Anui (Krylov, 1949). **1961**—**M**: Maima (NS0048511). **1990s**—**Ch**: Uymen (Silantieva, 1994); **G** (Studenikina, 1999). **2000s**—**Chm**: Uznezya (Zykova, 2014a), **M**: Kyzyl-Ozyok, Podgornoye, Karlushka (Zykova, 2015a).

BALSAMINACEAE

Impatiens glandulifera Royle: ergasiophyte; it is cultivated as an ornamental plant, found along the banks of reservoirs, in ditches, ravines, in landfills, damp roadsides, in overgrown parks, in garden plots, and often forms thickets. **1995**—**G** (Studenikina, 1999). **2000s–2010s**—**Chm**: Anos; **T**: Iogach (Zykova, 2014b); **M**: Maima, Ust-Muny, Manzherok, Kyzyl-Ozyok, **Ch**: Choya; **T**: Turochak (Zykova, 2015a); **T**: Yailyu; **U**: cordons Bele, Chelyush (Zykova, 2019b). **2020s**—**Sh**: Cherga (iNat90050452); **T**: Artybash (iNat90256775), **Chm**: Chemal (iNat132160844), Ust-Sema (iNat91484117).

BORAGINACEAE

Echium vulgare L.: ergasiophyte; grown as a honey plant, found along roads, in wastelands, fallow lands, dry meadows, pastures, along the banks, in populated areas. **1937**—**O**: Seminsky Pass (Krylov, 1937). **1950s–1960s**—widely in the regions of Northern Altai (Kuminova, 1960); **G** (NS0048499); **M**: Maima (NS0048498), Manzherok (NS0048517). **1980s**—**T**: Yailyu; **U**: cordons Chelyush, Bele, and Chiri (Zolotukhin, 1983); **Uks**: Kuragan River valley (Artemov, 1993), Ust-Koksa (NS0048495); valleys of the Anos River (**Chm**), Sema, Marcela, Sarlyk rivers (**Sh**) (Pshenichnaya, 1997). **1990s**—**Ch**: Uymen; **T**: Novotroitsk, Churya (Silantieva, 1994); **Ch**: Choya; **M**: everywhere (Studenikina, 1999). **2000s–2010s**—**O**: Khabarovka, Tabata River valley (Achimova, 2004); Chuya River valley (**O, U**) (Vaganov, 2004); **U**: Aktash (Zykova, 2015a); everywhere in **G, M, Ch, T, Sh, Chm** (Ilyin and Fedotkina, 2008; Zykova, 2015a). **2020s**—**Ukn**: Black Anui (iNat130226609).

Myosotis sparsiflora Pohl: xenophyte; a malicious garden weed that forms thickets on abandoned estates, arable lands, along the banks, and enters forests. **1980s**—**T**: Yailyu (Zolotukhin, 1990). **1985**—**Chm**: Anos River valley (Pshenichnaya, 1997). **2000s–2010s**—**M**: at the Arzhan-Suu spring (Ebel, 2008); **U**: Chelyush cordon, **T**: cordons Baigazan, Karatash, Kokshi (Zolotukhin, 2012; Zykova, 2019b); **Chm**: Uznezya, Anos (Zykova, 2014b), Chemal (iNat51944522); **G** (Zykova, 2015a).

Nonea rossica Stev. *Nonea pulla* subsp. *pulla*: xenophyte; near roads, in wastelands, fallow lands, in crops, in dry meadows, in the steppes. **1951**—**Ukn**: Korgon (NS0048488), **1953**—**K**: Tütö River valley (NS0048489). **1970s**—**Sh**: Cherga (NS0048487); **Chm**: Elanda (herbarium of GASU). **1980s**—**Uks**: valleys of the rivers Kuragan, Ak-Kem (Artemov, 1993), Ust-Koksa (NS0048500), Tyungur (NS0048502); **O**: valleys of the rivers Kurata, Tabatoi, Verkh-Koksa, Tenginskoye Lake; **Sh**: valley of the Sarlyk River (Pshenichnaya, 1997); **U**: Aktash (NS0048486), Kurai Range, Bashkaus River basin and its tributaries (Danilov, 1990); **Ukn**: Ust-Kan (NS0048504), Kyrlyk

(NS0048503). 2000s–2010s—O: Bolshoi Yaloman, Khabarovka, Shashikman, Kulada (Achimova, 2004); mouth of the river Chuya (Vaganov, 2004); Chm: Chemal; O: Tuekta (Zykova, 2015a), in the valley of the Sema River and its tributaries, in the basin of the Anos, Kaspá, Ursul, Chuya (Sh, Chm, O, U) rivers (Ilyin and Fedotkina, 2008). 2020s—U: Koo (iNat84949494), Balyktuyul (iNat86118182).

BRASSICACEAE

Armoracia rusticana P. Gaertn., B. Mey. & Scherb.: ergasiophyte; grown as a spicy food, found in abandoned garden plots, vegetable gardens, landfills, near fences, along roads, along the banks of water bodies, and forms thickets. 1934—T: Yailyu (Zolotukhin, 1983). 1980s—U: cordons Bele, Chiri, Chelyush, T: Baigazan cordon (Zolotukhin, 1983). 2000s—northern, western, and central regions (Ilyin and Fedotkina, 2008). 2013—M: Manzherok (Zykova, 2014b). 2015—G, Ch: Choya, Paspaul; T: Turochak; Chm: Chemal; Sh: Kamlak; Uks: Ust-Koksa (Zykova, 2015a).

Bunias orientalis L.: ergasiophyte; sown as a melliferous plant, found near roads, in fields, fallow lands, near housing, along the banks, abundant in meadows, and provides a background during flowering. 1950s—Northern Altai (Kuminova, 1960). 1976—Sh: Cherga (Doronkin, 1994). 1979—U: bank of Kyga River 3 km from the mouth (Zolotukhin, 1983). 1980s—G, M (Nikiforov, 1989); valleys of the Anos River (Chm), Sema, Marcela, Sarlyk, Kaspá rivers (Sh) (Pshenichnaya, 1997). 1990s—K: North Chuisky Ridge, Eshtykel tract (the southernmost location of the species); along the Chuisky tract to the Seminsky Pass (O) (Ebel, 1997); M: Maima, Alferovo; T: Verkh-Biysk; Ch: Choya (Studenikina, 1999), Uymen (Silantieva, 1994). 2000s—settlement in G, M, Ch, T, Chm, Sh, O (Ilyin and Fedotkina, 2008). 2020s—Ukn: Black Anui (iNat130210800), Ust-Kumir (iNat130209505); Uks: Souzar (iNat1280993610), Bannoye (iNat128099168).

Lepidium densiflorum Schrad.: xenophyte; near roads and housing, in fields, wastelands, fallow lands, on dry slopes, along pebbles; it forms thickets. When defining, they were often mixed with *L. apetalum* Willd.; therefore, information about the distribution of the species in the Altai Republic, which is not confirmed by critically reviewed herbarium material, needs to be clarified. 1990s—along the Chuya tract to the lower reaches of the Chuya River (Ebel, 1997); G, T: Verkh-Biysk (Studenikina, 1999); Uks: Ust-Koksa (NS0048476). 2000s–2010s—O: Shashikman, Inya, Inegen, Tenga (Achimova, 2004); M: Izvestkovy, Manzherok, Cheremshanka, Karlushka, Souza, Rybalka, Ch: Paspaul; Chm: Chemal, Elekmonar, Ust-Sema, Chepush, Anos; Sh: Shebalino, Kamlak, Myyuta, Uks: Tyungur, Upper Uimon; U: Aktash; O: Maly Yaloman (Zykova, 2015a). 2020s—Uks: Katanda (iNat88348485); Chm: Edigan (iNat54406272).

Lepidium rudera L.: xenophyte; near roads and housing, in wastelands, on pebbles, in the steppes. 1984—Uks: Ust-Koksa (Artemov and Korolyuk, 1999). 1990s—Ch: Uymen; T: Novotroitsk (Silantieva, 1994); K: Ukok Plateau (Dyachenko, 1995). 2000s—K: Bayan-Chagan River basin (Ilyin and Fedotkina, 2008). 2010s—M: Maima, Souza, Rybalka; Chm: Chemal; Sh: Myyuta; O: Ongudai (Zykova, 2015a); G*. 2020s—Ukn: Black Anui (iNat130226604), Sh: Cherga (iNat90050446).

Rorippa sylvestris (L.) Besser: xenophyte; in roadside ditches, along the banks of reservoirs, in damp meadows, near roads and housing, in vegetable gardens, in wastelands and fallow lands; it forms thickets. 1984—Uks: Justik (NS0048475). 1990s—Ukn: by Anuy River (Dorofeev, 1996); M: from Maima (Studenikina, 1999) to Manzherok; G, Ch: Veselaya Seika, Krasnoselskoe (Ebel, 2000). 2000s–2010s—T: Turochak, Yogach, Artybash (Zykova, 2015a, 2020a); Chm: Ust-Sema*, Uznezya*, Chemal*. 2020s—Sh: Kamlak (iNat127628221), Cherga (iNat90043981).

Sisymbrium officinale (L.) Scop.: xenophyte; near roads, in populated areas, in vacant lots, along the banks; it forms thickets. 1931—G (Krylov, 1931). 1980s—Seminsky Ridge (Sh, Chm) (Pshenichnaya, 1997). 1990s—Chm: Elekmonar (Ovchinnikova, 1994); Ch: Uymen (Silantieva, 1994); M: Maima (Studenikina, 1999); Sh: Shebalino; O: Iodro, Ch: Ynyrga, Krasnoselskoe; Chm: Anos (Pyak et al., 2000), Seminsky Ridge (O) (Achimova, 2004). 2000–2010s—T: Daibovo, Artybash, Yogach, Turochak; M: Manzherok, Dubrovka; Chm: Uznezya, Ust-Sema, Chemal; Ch: Choya; Sh: Kamlak; O: Inya, Maly Yaloman (Zykova, 2012, 2015), the valleys of the Sema (Sh) and Ursul (O) rivers (Ilyin and Fedotkina, 2008).

CARYOPHYLLACEAE

Saponaria officinalis L.: ergasiophyte; cultivated as an ornamental plant, found in landfills, wastelands, abandoned gardens, near homes, and forms thickets. 1998—G (Studenikina, 1999). 2000s–2010s—M: Maima, Kyzyl-Ozyok, Podgornoye (Zykova, 2015a); ANR (T, U) (Zolotukhin, 2012); T: Artybash*, Yailyu*.

Silene noctiflora L.: xenophyte; in vacant lots, near roads and housing, in crops. 1931—Chm: Elekmonar, Chemal (Krylov, 1931). 1980s—T: Yailyu, cordons Baigazan, Kokshi; U: cordons Chiri, Bele, Chelyush (Zolotukhin, 1983); Chm: Anos River valley (Pshenichnaya, 1997). 1990s—Ch: Ynyrga (Zuev, 1993), Uymen (Silantieva, 1994), Paspaul (Studenikina, 2000). 2000s—G, M: Maima, Manzherok, Cheremshanka; Chm: Uznezya; Sh: Shebalino (Shaulo et al., 2010). 2010s—M: Karlushka, Dubrovka, Souza, Rybalka; T: mouth of the Lebed River; Sh: Kamlak, Cherga (Zykova, 2015a).

CUCURBITACEAE

Echinocystis lobata (Michx.) Torr. & A. Gray: ergasiophyte; it is bred as an ornamental plant, found in weedy places, near homes, in damp ravines and along riverbanks, and forms thickets. 1980—T: Yailyu; U: Bele cordon (Zolotukhin, 1983). 1996—M: Manzherok (Kamelin et al., 1999). 2000s—2010s—G, M: Maima, Kyzyl-Ozyok, Dubrovka; U: Aktash; Ch: Choya (Shaulo et al., 2010; Zykova, 2014b, 2015a). 2020s—M: Ust-Muny (iNat133232067); Sh: Kamlak (iNat37337870), Cherga (iNat68206922).

FABACEAE

Galega orientalis Lam.: xenophyte; along roads, in fields, fallow lands, in ravines, near housing, penetrates into communities of floodplain meadows, and forms thickets. 2005—M: between Maima and Souzga (Silantieva et al., 2005). 2000s—M: Izvestkovy, Manzherok, near the bridge over the Katun River to Platovo (Shaulo et al., 2010); G (Zykova and Ankova, 2017). 2020s—Chm: Chermal (iNat127708996); Sh: Kamlak (iNat127634155).

Lotus corniculatus L.: xenophyte; along the banks of reservoirs, near roads, on fallow lands, in populated areas. 1954—Uks: Amur (NS0036086), in crops, was not observed later. 1997—M: Kyzyl-Ozyok (Zykova, 2014a). 2010s—G (Zykova, 2019a); Ch: Sugul (Zykova et al., 2019).

Medicago sativa L.: ergasiophyte; grown as fodder, found near housing, in fields, fallow lands, near roads, in meadows, in light forests. 1933—T: Lebed River basin at the mouth of the Tibe River (Krylov, 1933). 1950s—U: Balykcha (NS0021022), Chiri cordon (Zolotukhin, 1983). 1990s—G, M: Maima (Studenikina, 1999). 2000s—2010s—Chm: Anos (Zykova, 2015a). 2020s—Uks: Ust-Koksa (iNat102811794).

Medicago varia Martyn: xenophyte; near roads, in populated areas, in vacant lots, fallow lands, in crops. 2009—G (Zykova, 2015a). 2010s—M: Karlushka, Dubrovka, Maima (Zykova, 2015a); U: Aktash (Ebel et al., 2016). 2020s—Chm: Ust-Sema (iNat89075883); Sh: Cherga (iNat90057588).

Melilotus officinalis (L.) Pall.: ergasiophyte; it is cultivated as a forage and melliferous plant, found near roads, in fields, meadows, fallow lands, and in populated areas. 1951—Ukn: Korgon (Kurbatsky, 1994). 1980s—Sh: Marcela River basin, mouth of the Sema River; O: Tabatoy River basin (Pshenichnaya, 1997); U: middle course of the Chulyshman River; O: mouth of the Chuya River (Kurbatsky, 1994); Uks: valleys of the Multa, Kucherla, Kuragan, Ak-Kem, Zaychikha rivers (Artemov, 1993), Ust-Koksa (NS0048466). 1990s—Ch: Uymen; T: Novotroitsk (Silantieva, 1994). 2000—2010s—O: Khabarovka, Shashikman, Kulada (Achimova, 2004); G, M: everywhere; Chm: Ust-Sema; Sh: Kamlak, Cherga, Shebalino, and others; O: Ursul River valley (Ilyin and Fedotkina, 2008); Chuya

River valley (O, U) (Vaganov, 2004); T: Artybash, Ust-Lebed; Chm: Chermal; O: Cheke-Taman Pass, Tuekta; K: Kurai (Zykova, 2015a). 2020s—U: Aktash (iNat112822794).

Trifolium hybridum L.: ergasiophyte; it is cultivated as a fodder and melliferous plant, found near roads, in wastelands, fallow lands, along the banks, in meadows, and in light forests. 1950s—G (NS0048451); M: Kyzyl-Ozyok (NS0048452); Uks: Amur (NS0048453), Abay (NS0048454). 1960—1970s—Ch: between Choya and Sugul (Krylov and Sergievskaya, 1964); T: Dmitrievka (NS0048463), Yailyu, and all ANR cordons (T, U) (Zolotukhin, 1983). 1990s—Ch: Uymen; T: Novotroitsk (Silantieva, 1994); widely in G, M, Ch, T (Studenikina, 1999). 2000s—Ch: Yugala, Ynyrga; T: Artybash (Ilyin and Fedotkina, 2008). 2020s—Sh: Cherga (iNat90043986), Mukhorcherga (iNat128271106), Uks: Bannoe (iNat128099347).

Vicia hirsuta (L.) Gray: xenophyte; near roads, in fields, fallow lands, embankments, penetrates into meadows, and forms thickets. 2010—M: Maima (Zykova, 2012). 2010s—Chm: Anos (Zykova, 2015a); G (Zykova et al., 2020); M: Dubrovka*, Karlushka*, Souzga*, Rybalka*. 2020s—Chm: Chermal (iNat54527606).

GERANIACEAE

Erodium cicutarium (L.) L'Her.: xenophyte; in fields, fallow lands, wastelands, near roads. 1935—Ukn: Black Anui (Krylov, 1935). 1953—O: Tenga (NS0022470). 1961—Chm: Chermal (NS0022467). 1980s—Uks: valleys of the Multa and Kuragan rivers (Artemov, 1993), Ust-Koksa (NS0022463), Yustik (NS0022465); valleys of the rivers Kurata, Tabatoi (O), Kaspas (Sh), Anos (Chm) (Pshenichnaya, 1997); T: Baygazan cordon; U: Bele cordon (Zolotukhin, 1983). 1990s—Ch: Uymen (Silantieva, 1994); G, M: Maima, Souzga (Studenikina, 1999). 2000s—Chuya River valley from the mouth to Chibit (Vaganov, 2004); O: Ongudai, Inya, Maly Yaloman, Ursul River valley; U: Aktash; Chm: Elekmonar, Elanda; M: Manzherok, Kyzyl-Ozyok; Sh: Sema River valley and its tributaries (Ilyin and Fedotkina, 2008; Zykova, 2015a).

LAMIACEAE

Elsholtzia ciliata (Thunb.) Hyl.: xenophyte; near roads, in fields, in vegetable gardens, near housing. 1935—T: Yailyu (Khomutova et al., 1938). 1937—G, M: Ust-Muna; Chm: Elekmonar; Sh: Cherga (Krylov, 1937). 1947—Chm: Chermal (NS0048395). 1952—T: Guryanovka (NS0048393). 1978—Ch: Choya (NS0048394). 1984—Uks: Ust-Koksa (NS0048392). 1990s—Ch: Uymen; T: Churya (Silantieva, 1994). 2000s—2010s—M: Dubrovka, Manzherok; Ch: Paspaul; T: Turochak; O: Maly Yaloman (Zykova, 2015a); M: everywhere; Uks: Tyungur, Katanda,

Nizhny Uimon, Berezovka, Ognevka, Kaitanak; Sh: Kamlak, Shebalino, Kumalyr, Topuchaya; Ch: Sugul, Verkh-Pyankovo, Kiska, Karakoksha, Ynyrga, Uskuch; T: Lake Kureevo, Dmitrievka, Udalovka, Sankin Ail, Tondoshka, Kibezhen; U: lower reaches of the Chulyshman River (Ilyin and Fedotkina, 2008). 2020s—O: Ongudai (iNat104513803), Chm: Kuyus (iNat133640945).

Galeopsis speciosa Mill.: xenophyte; near roads, in crops, on fallow lands, wastelands, near housing. 1980s—Sh: Sema River mouth, Marcela River basin; Chm: Anos River valley (Pshenichnaya, 1997). 2000s—G, M: Maima, Aleksandrovka, Izvestkovy, Manzherok, Kyzyl-Ozyok, Biryulya; Sh: Sema River basin from the mouth to Topuchaya (Ilyin and Fedotkina, 2008; Zykova and Erst, 2012; Zykova, 2015a). 2020s—Chm: Kuyus (iNat133641721).

Leonurus quinquelobatus Gilib.: xenophyte; near roads, in vacant lots, fallow lands, along the banks, near housing. 1937—Chm: Anos (Krylov, 1937). 1990s—Ch: Uymen (Silantieva, 1994), M: Rybalka (Krestovskaya, 1997); G (Studenikina, 1999). 2010s—M: everywhere; Ch: Choya; Chm: Uznezya, Cheposh (Zykova, 2015a); T: Turochak*. 2020s—Sh: Cherga (iNat90043971), Kamlak (iNat127634149); Chm: Ust-Sema (iNat89119951).

Mentha suaveolens Ehrh.: ergasiophyte; grown as a medicinal and essential oil plant, found along the streets and near roads. 2010—G (Zykova, 2014a). 2010s—M: Karasuk (Zykova, 2014a), Manzherok (Zykova, 2017), Dubrovka*, Kyzyl-Ozyok*; T: Artybash (Zykova, 2015b), Turochak, Kibezhen (Zykova, 2017), Iogach*, Yailyu*.

MALVACEAE

Malva pusilla Sm.: xenophyte; in gardens, vacant lots, near roads. 1935—G, M: Alexandrovka; Chm: Chemal; Uks: Upper Uimon; Ukn: Korgon (Krylov, 1935). 1983—Uks: Tyungur (NS0048427). 1990s—Ch: Uymen; T: Novotroitsk, Churya (Silantieva, 1994). 2000s—2010s—Sh: Katun River basin (Khmel'eva, 2005); M: everywhere; Ch: Paspaul, Choya; Chm: Uznezya, Askat, Anos; Uks: Ust-Koksa; O: Maly Yaloman, Inya (Zykova, 2015a).

Malva verticillata L.: xenophyte; near roads, in garbage areas, vacant lots, in vegetable gardens, near housing, a malicious weed. 1935—U: Bashkaus River mouth; Sh: Shebalino; T: Lebed River valley between the mouths of the Tavoloka and Salazan rivers (Krylov, 1935). 1950—O: Bolshoi Yaloman (Vlasova, 1996). 1980s—Sh: Marcela River basin, mouth of the Sema River; Chm: Elanda (Pshenichnaya, 1997); ANR (T, U) (Zolotukhin, 1983). 2000s—O: Inya, Boochi (Pyak and Ebel, 2001), Bely Bom (Vaganov, 2004); G, M: Cheremshanka, Maima; Chm: Chemal (Shaulo et al., 2010); U: Aktash (Zykova, 2014a); Sh: Myyuta, Kumalyr (Ilyin and Fedotkina, 2008).

2010s—M: everywhere; T: Turochak; O: Maly Yaloman, Ongudai; Uks: Ust-Koksa; K: Kurai (Zykova, 2015a); Ch: Sugul*. 2020s—T: Ust-Pyzha (iNat141597174).

ONAGRACEAE

Epilobium adenocaulon Hausskn.: xenophyte; near roads, on fallow lands, in populated areas. 1996—Ch: Choya (Zykova, 2015a). 2000s—G, T: Artybash (Zykova, 2015a); M: Kyzyl-Ozyok (Zykova, 2020b). 2020s—Chm: Ust-Sema (iNat132970150).

Epilobium pseudorubescens A.K. Skvortsov: xenophyte; along the banks in populated areas, near roads and housing, in wastelands and fallow lands. 1985—Ch: Veselaya Seika (Ebel, 2013). 2010s—M: Karlushka; T: Iogach (Zykova, 2014b); G, M: Kyzyl-Ozyok (Zykova, 2015a); Ch: Choya; T: Turochak (Zykova et al., 2019). 2020s—M: Manzherok (iNat149908029).

Oenothera villosa Thunb.: xenophyte; near roads, in meadows, wastelands, in populated areas, along riverbanks. 1983—Uks: Ust-Koksa. 1985—Ch: between Sugul and Paspaul. 2000—U: Chibit, Chuya River valley between the mouths of the Boki River (O) and Belgebash River (U) (Ebel, 2008). 2000s—2010s—G, M: Maima, Cheremshanka (Shaulo et al., 2010), Maima*, Rybalka*, Cheremshanka*, Manzherok*; Chm: Chemal (Zykova, 2014a), Cheposh*, Anos*; T: Lebed River mouth (Zykova, 2015a), Iogach (Zykova, 2020a); U: Aktash (Zykova, 2017). 2020s—Uks: Verkhniy Uimon (iNat101812585); Chm: Edigan (iNat54400058), Ust-Sema (iNat89068491).

PLANTAGINACEAE

Plantago lanceolata L.: xenophyte; near roads, housing, along the banks, in wastelands, fields, fallow lands, meadows, in light forests. 1952—T: Guryanovka (NS0048404). 1956—T: Turochak (Krylov and Sergievskaya, 1964). 1960s—Ch: Isha River valley between Choya and Sugul (Krylov and Sergievskaya, 1964). 1981—T: Yailyu (Zolotukhin, 1983). 1987—Ch: Veselaya Seika (NS0013271). 1990s—G (Zykova, 2002); M: Maima, Kyzyl-Ozyok, Alferovo, Dubrovka; T: Daibovo (Studenikina, 1999, 2000). 2000s—M: Souzga, Karlushka, Manzherok; T: Artybash, Iogach, Ust-Lebed, Verkh-Biysk (Zykova, 2015a); M: everywhere; Ch: Verkh-Pyankovo, Karakoksha; T: Lake Kureevo, Dmitrievka, Udalovka, Sankin Ail, Tondoshka, Kibezhen, in the valleys of the Tuloy and Pyzha rivers (Ilyin and Fedotkina, 2008). 2020s—Chm: Chemal (iNat128416563).

POACEAE

Echinochloa crus-galli (L.) P. Beauv.: xenophyte; in crops, on fallow lands, near roads, in populated areas, along the banks, in meadows. 1914—T: Kibezhen (Kry-

lov, 1914). 1928—**Chm**: Uznezya (Krylov, 1928). 1934—**T**: Yailyu (Khomutova et al., 1938). 1948—**Ch**: Choya (NS0048442). 1952—**M**: Podgornoye (NS0048445); **T**: Ainka (NS0048444). 1983—**Uks**: Tyungur (NS0048443). 1990s—**Ch**: Uymen; **T**: Novotroitsk, Churya (Silantieva, 1994); **G**, **M**: Maima; **Ch**: Paspaul; **T**: Daibovo (Studenikina, 1999); **O**: Bolshoi Yaloman River mouth (Pyak et al., 2000). 2000s—**U**: Chibit (Pyak and Ebel, 2001); **Ukn**: valleys of the Charysh and Anui rivers (Ilyin and Fedotkina, 2008); **M**: Dubrovka, Souzga, Karlushka, Manzherok, Rybalka, Kyzyl-Ozyok; **Chm**: Anos; **T**: Turochak, Yogach; **Sh**: Myyuta, Kamlak (Zykova, 2015a).

Eragrostis amurensis Prob.: xenophyte; near roads, on sand and pebbles. 1998—**Ch**: Paspaul (Studenikina, 1999). 2000s—2010s—between **O**: Boki River and **U**: R. Belgebash River (Pyak and Ebel, 2001); **G**, **M**: Souzga (Shaulo et al., 2010); **Chm**: Chemal; **O**: Inya (Zykova, 2014a); **T**: Turochak, Ust-Lebed; **M**: widely; **Ch**: Sugul, Choya; **Chm**: Anos, Cheposh; **O**: Maly Yaloman (Zykova, 2015a); **Sh**: Cherga (Zykova, 2017); **T**: Artybash (Zykova, 2022).

Hordeum jubatum L.: xenophyte; near roads, in vacant lots, in populated areas, steppes, on pebbles. 1999—**O**: Seminsky Ridge (Pyak et al., 2000). 2000s—**U**: Chuya River valley at the mouth of the Belgebash River (Pyak and Ebel, 2001), Aktash (Ebel, 2008), Ulagan, Balyktuyul (Zykova, 2015a), **O**: Tenga, mouth of the Chuya River (Ilyin and Fedotkina, 2008), Tuekta (Shaulo et al., 2010), Chui-Oozy Park (Zykova, 2017); **G** (Zykova, 2014b); **M**: Kyzyl-Ozyok, Mayma; **Chm**: Ust-Sema, Chemal; **Uks**: Ust-Koksa (Zykova, 2015a); **K**: highway Chegan-Uzun-Aktash*. 2020s—**Ukn**: highway Yelo-Jabogan (iNat30933917).

Lolium multiflorum Lam.: ergasiophyte; grown as part of lawn grass mixtures; it is often found near roads, in populated areas, in wastelands, disturbed meadows, and along banks. 2013—**M**: between Dubrovka and Karlushka (Zykova, 2014b). 2017—**M**: Manzherok (Zykova et al., 2019). 2019—**G** (Zykova, 2021).

Lolium perenne L.: xenophyte; near roads, housing, in fields, wastelands, on pebbles. 2008—**G** (Zykova et al., 2019). 2010s—**T**: Iogach; **Chm**: Uznezya (Zykova et al., 2019); **M**: Kyzyl-Ozyok (Zykova, 2020b).

Panicum miliaceum L. s. l.: ergasiophyte; in crops, on fallow lands, near roads. 1961—**Chm**: Chemal (Nikiforova, 1990). 1979—**T**: Baigazan cordon (Zolotukhin, 1983). 1980s—**Chm**: Anos River basin; **Sh**: Sema River mouth, Kaspia River basin (Pshenichnaya, 1997); **O**: Bolshoi Yaloman River mouth (Pyak et al., 2000). 1990s—**G** (Studenikina, 1999). 2000s—2010s—**U**: Chibit (Pyak and Ebel, 2001); **O**: Seminsky Ridge (Achimova, 2004), **M**: Maima (Shaulo et al., 2010), Karlushka*, Podgornoe*; **Sh**: Myyuta (Zykova,

2014a); **T**: Turochak (Zykova, 2017), **O**: Seminsky Pass*.

Setaria pumila (Poir.) Roem. & Schult.: xenophyte; near roads, in populated areas, in fields, wastelands, fallow lands, on pebbles. 1914—**Chm**: Anos (Krylov, 1914), Uznezya (NS0048431). 1928—**Chm**: Chemal; **Sh**: Myyuta; **O**: lower reaches of the Sumulta River (Krylov, 1928). 1934—**T**: Yailyu (Khomutova et al., 1938). 1948—**Ch**: Choya (NS0048436). 1952—**T**: Ainka (NS0048435), Tyutelga (NS0048432); **Chm**: Elekmonar (NS0048437); **U**: Koo (NS0048434). 1990s—**Ch**: Uymen; **T**: lower reaches of the Pyzha River (Silantieva, 1994); **G**, **M**: Maima, Cheremshanka; **Ch**: Paspaul (Studenikina, 1999). 2000s—2010s—**M**: Manzherok*, Dubrovka*; **Chm**: Ust-Sema*; **Sh**: Kamlak*; **O**: Maly Yaloman*; **M**: everywhere; **Chm**: everywhere; **Sh**: from the mouth of the Sema River to its origins; **Ukn**: Charysh River valley (Korgon, Tyudrala, Ust-Kan) and its tributaries; **O**: Ursul River basin; **Uks**: valleys of the rivers Tyungur, Kucherla, Katanda, Uimon Steppe; **Ch**: Ishi River valley and its tributaries; **T**: Biya River basin and its tributaries, shores of Lake Teletskoye; **U**: Chulyshman River valley, Bashkaus River basin (Ulagan, Balyktuyul, Paspaul) (Ilyin and Fedotkina, 2008).

POLYGONACEAE

Rumex acetosella L.: xenophyte; near roads, in populated areas, in wastelands, fallow lands, along the banks, in dry meadows, in light forests. 1950s—northern and central regions (Kuminova, 1960). 1980s—cordons ANR and Yailyu, lower reaches of the Kyga River, pebbles of Lake Teletskoye (**T**, **U**) (Zolotukhin, 1983); Seminsky Ridge—everywhere (**Sh**, **Chm**, **O**) (Pshenichnaya, 1997); **Uks**: valleys of the Kuragan and Zaychikha rivers (Artemov, 1993), the mouth of the Multa River (Kashina, 1992). 1990s—**Ch**: lower reaches of the Uymen River; **T**: Pyzha River (Silantieva, 1994); **G**, **M**: Maima; **Ch**: Sarakoksha River valley; **T**: Turochak, Daibovo (Studenikina, 1999). 2000s—**O**: Shashikman, Kulada, Ongudai (Achimova, 2004); **T**: Artybash*, Yogach*, Yailyu*; **M**: everywhere (Ilyin and Fedotkina, 2008). 2020s—**Uks**: Ust-Koksa (iNat64162867); **Chm**: Chemal (iNat123811635).

ROSACEAE

Malus baccata (L.) Borkh.: ergasiophyte; grown for landscaping and as a fruit tree, found in light forests, bushes, along the banks, in ravines, and near roads. 1995—**G**, **M**: Dubrovka (Studenikina, 1999). 2010s—**Chm**: Uznezya (Zykova, 2015a). 2020s—**Chm**: Chemal (iNat132160856); **Sh**: Cherga (iNat115387939); **Uks**: Upper Uimon (iNat101866670).

Potentilla norvegica L.: xenophyte; near roads, in vacant lots, in populated areas, in meadows. 1933—**T**: Turochak (Krylov, 1933). 1936—**T**: Yailyu (Khomutova et al., 1938). 1986—**Uks**: Multa River valley

(Artemov, 1993). 1990s—**O**: Bolshaya Sumulta River valley; **Ch**: Uymen (Silantieva, 1994); **T**: Verkh-Biysk, Daibovo (Studenikina, 1999). 2000s—**U**: Lake Dzhu-lukul (Ilyin and Fedotkina, 2008). 2010s—**M**: Maima (Zykova, 2015a), Rybalka, Kyzyl-Ozyok (Zykova, 2017); **Ch**: Sovetskoe*; **T**: Artybash*, Ust-Lebed*, Yogach*. 2020s—**G** (Zykova, 2021); **Ch**: Uskuch (iNat153023014); **M**: Manzherok (iNat91128903); **Chm**: Chemal (iNat132462760); **Uks**: Ust-Koksa (iNat30933167).

Prunus tomentosa Thunb.: ergasiophyte; grown as a fruit plant; it grows in abandoned areas and near roads. 2015—**G**, **M**: Maima, Kyzyl-Ozyok; **Chm**: Uznezya (Zykova, 2015a). 2020s—**Chm**: Elanda (iNat54123303), Chemal (iNat135346338); **Sh**: Cherga (iNat79762170); **O**: Kupchegen (iNat114718212).

RUBIACEAE

Galium aparine L.: xenophyte; in crops, along the edges of fields, near roads, near housing, along banks. 1908—**O**: Akbom (NS0046016). 1948—**O**: Inya (NS0046018). 1980s—**Uks**: Tyungur (NS0043699); valleys of the Ak-Kem, Multa, and Zaychikha rivers (Artemov, 1993); **Ukn**: Kyrlyk (NS0043698); Seminsky Ridge (**Chm**, **Sh**, **O**): everywhere (Pshenichnaya, 1997). 1990s—**G** (Studenikina, 1999). 2000s—**O**: Shashikman, Kulada, Elo (Achimova, 2004). 2010s—2020s—**M**: Maima, Izvestkovy; **U**: Aktash, **Uks**: Ust-Koksa; **O**: confluence of the Chuya and Katun rivers (Zykova, 2015a); **Ukn**: Ust-Kumir (iNat130209357).

Galium mollugo L.: xenophyte; near roads, in fields, fallow lands, penetrates into meadows. 1986—**Ch**: Karakoksha (NS0013332). 1990s—**Ch**: Sarakoksha River valley; **T**: Verkh-Biysk (Studenikina, 1999); **G** (Zykova, 2002). 2000s—**U**: Chibit; **O**: Akbom (Pyak and Ebel, 2001); **Ch**: Choya; **M**: Kyzyl-Ozyok, Dubrovka, Maima, Cheremshanka, Izvestkovy; **T**: Artybash; **Chm**: Ust-Sema; **Ukn**: Yabogansky Pass (Zykova, 2015a). 2020s—**Sh**: Cherga (iNat79744125); **Chm**: Chemal (iNat132462761), Uznezya (iNat85119239); **O**: Khabarovka (iNat90523879); **Ukn**: Yabogan (iNat127959973), Ust-Kumir (iNat130209386), Korgon (iNat130335894); **Uks**: Sugash (iNat64110923), Kaitanak (iNat64520450).

SAPINDACEAE

Acer negundo L.: ergasiophyte; used in landscaping, common along roads, in populated areas, along the banks of water bodies, in ravines, floodplain forests, and forms thickets. Introduced into culture in the Altai Republic in 1935 (Ebel, 2001); it was then, apparently, that it began to run wild. I did not intend to become a collector. First collections—from 1990s—**G** (Studenikina, 1999). 2000s—**M**: Manzherok, Maima, Souzga, Rybalka, Alferovo; **Chm**: Chemal, Anos (Zykova, 2015a). 2020s—**Ch**: Sugul*; **T**: Kebezen

(iNat78435525); **Chm**: Ust-Sema (iNat94538938); **Sh**: Cherga (iNat115385241), Barlak (iNat132279362).

ULMACEAE

Ulmus pumila L.: ergasiophyte; used in landscaping, found near roads, in vacant lots, along banks, in light forests. 1995—**G**, **M**: Dubrovka (Studenikina, 1999). 2010s—there is active settlement in **G**.

DISCUSSION

The largest number of invasive species is found in the northern regions of the republic, which are characterized by warm and humid summers and mild winters, have developed agricultural sectors, and receive the bulk of the tourist flow. The central and southeastern regions are much less susceptible to plant invasions: here, when alien, mainly mesophytic, species are introduced into the flora, the limiting factor is the harsh sharply continental climate due to both the location of the territory within the continent and the orographic features of the terrain, characterized by mid- and high-mountainous relief type (Modina, 1997).

To date, the largest number of invasive species are in Gorno-Altaysk (66) and Maima district (65), located in the north; there are slightly fewer in Chemal (58) and Turochak (51) districts, even fewer in Shebalino (46) and Choya (45) districts, and significantly fewer in the central and southeastern districts—in Ulagan (35 species, 13 of them are found only in the cordons of the reserve), Ust-Koksa (32), Ongudai (29), and Ust-Kan (20). In the Kosh-Agach district, which in terms of natural and climatic conditions is equal to the regions of the Far North (*Postanovlenie...*, 2021), only nine species have been recorded: *Amaranthus retroflexus*, *Bunias orientalis*, *Hordeum jubatum*, *Lepidium ruderales*, *Malva verticillata*, *Matricaria discoidea*, *Melilotus officinalis*, *Nonea rossica*, *Tripleurospermum inodorum*. Moreover, they are found relatively rarely and only in disturbed habitats; without posing a significant threat to the biodiversity of southeastern Altai, the majority act here as colonophytes.

The first currently invasive species recorded on the territory of the Altai Republic at the beginning of the 19th century were *Amaranthus retroflexus*, *Arctium lappa*, *Cirsium vulgare*, *Echinochloa crus-galli*, *Galium aparine*, and *Setaria pumila*. By the middle of the 20th century, another 26 species entered the Altai Mountains: *Acer negundo*, *Armoracia rusticana*, *Bassia scoparia*, *Bunias orientalis*, *Centaurea jacea*, *Cichorium intybus*, *Echium vulgare*, *Elsholtzia ciliata*, *Erigeron canadensis*, *Erodium cicutarium*, *Inula helenium*, *Leonurus quinquelobatus*, *Malva pusila*, *M. verticillata*, *Matricaria discoidea*, *Medicago sativa*, *Melilotus officinalis*, *Nonea rossica*, *Plantago lanceolata*, *Potentilla norvegica*, *Rumex acetosella*, *Silene noctiflora*, *Sisymbrium officinale*, *Trifolium hybridum*, *Tripleuros-*

permum inodorum, *Xanthium strumarium*. In the 21st century, of the significant number of alien species that have entered the territory of the Altai Republic, the spread of ten has acquired an invasive character: *Heracleum sosnowskyi*, *Arctium minus*, *Solidago canadensis*, *Galega orientalis*, *Medicago varia*, *Vicia hirsuta*, *Mentha suaveolens*, *Lolium multiflorum*, *L. perenne*, *Prunus tomentosa*.

The vast majority of species were first recorded in the north of the republic; only a few species were first discovered in the southeast of the Altai Republic: *Centaurea jacea* (in the Ulagansky district, individually, apparently escaped from sowing, but did not naturalize), *Galium aparine*, *Nonea rossica*, *Matricaria discoidea*. Xeromesophytic species *Nonea rossica* is not registered in northern areas with high levels of moisture.

When analyzing the temporary introduction of species into the regions of the Altai Republic, it was revealed that most of the first locations of species were found in northern Gorno-Altaysk and Maima and Turochak districts (17 species each); the least were located in the center and southeast of the Altai Republic in Kosh-Agach (1), Ongudai and Shebalino (3 each), and Ust-Kan and Ulagan (5 each) districts. In the 20th century the most species settled in the northern Gorno-Altaysk (36) and Turochak (35), Choya (34), and Maima (31) districts; the fewest species are in the southeastern Kosh-Agach (4) and southwestern Ust-Kan (8) districts.

The most widespread species found in disturbed areas in all districts of the Altai Republic (in some places often and abundantly, in others only sporadically) are *Amaranthus retroflexus*, *Bunias orientalis*, *Matricaria discoidea*, *Melilotus officinalis*, and *Tripleurospermum inodorum*. In ten administrative districts out of eleven, there are *Echium vulgare*, *Erodium cicutarium*, *Galium mollugo*, *Lepidium ruderales*, *Malva verticillata*, and *Setaria pumila*; known in nine districts are *Echinochloa crus-galli*, *Elsholtzia ciliata*, *Lepidium densiflorum*, *Malva pusilla*, and *Rumex acetosella*.

The main methods of penetration are the accidental introduction of diaspores of weeds with seed and planting material and through transport (46 xenophytes), as well as the deliberate introduction of species as ornamental, melliferous, forage, and medicinal plants and their subsequent escape from cultivation (21 ergasiophytes). The proportion of ergasiophytes in the invasive flora of the Altai Republic (31%) is less than in the invasive flora of Siberia as a whole (43%) (Chernaya..., 2016), which is explained by the relatively smaller role of representatives of the families Rosaceae, Ulmaceae, etc., in the studied region, as well as changes method of penetration in a number of species. For example, *Heracleum sosnowskyi*, *Galega orientalis*, and *Lotus corniculatus*, which are tested or grown in some regions of Siberia as forage plants and “run wild” from the crop, entered the Altai Republic accidentally.

Invasive species of the Altai Republic make up 11 of the 29 plant species included in the “Top 100 invasive species of Russia” (Samye..., 2018): *Acer negundo*, *Amaranthus retroflexus*, *Echinocystis lobata*, *Epilobium adenocaulon*, *Erigeron canadensis*, *Galinsoga parviflora*, *G. quadriradiata*, *Heracleum sosnowskyi*, *Hordeum jubatum*, *Impatiens glandulifera*, *Solidago canadensis*. Most of the alien species included in the Black Book of the Flora of Siberia (Chernaya... 2016) are found on the territory of the Altai Republic; 35 of them are invasive in the region under study; the spread of others has not yet become aggressive.

Most species are usually found in disturbed habitats—near roads, in fields, wastelands and fallow lands, in populated areas, and along the banks of water bodies subject to high anthropogenic pressure. The most active “edificator species” forming vast, often monodominant populations and penetrating natural habitats (forests, meadows, steppes) invasive in Siberia as a whole (Chernaya..., 2016) are *Acer negundo*, *Centaurea jacea*, *Echinocystis lobata*, *Erigeron canadensis*, *Helianthus tuberosus*, *Heracleum sosnowskyi*, *Impatiens glandulifera*, *Pastinaca sativa* var. *sylvestris*, *Solidago canadensis*, and *Trifolium hybridum*, as well as those not included in the Black Book of the Flora of Siberia (Chernaya..., 2016) *Bunias orientalis*, *Cirsium vulgare*, *Cichorium intybus*, *Galega orientalis*, *Galium mollugo*, *Inula helenium*, and *Rumex acetosella*.

The spectrum of life forms is dominated by juveniles—38 species; among them are 23 annuals (35%) and 29 perennials: 25 herbaceous plants (37%) and 4 shrubs (6%). In the invasive flora of Siberia, a similar ratio is observed: annuals—38%, perennial grasses—31%, trees and shrubs—10% (Chernaya..., 2016). The invasive flora of Russia, for example, includes 41% perennial grasses, 28% annual plants, and 15% shrubs, while, compared to Siberia, the participation of shrubs is increased in European Russia, and the participation of perennial grasses is increased in the Far East (Vinogradova et al., 2018).

Among the invasive species in the Altai Republic is *Sonchus oleraceus*, which is the most widespread alien species in the world. It is found in 48% of regions, which cover 42% of the world’s terrestrial area. Among species with invasive status, *Sonchus oleraceus* ranks fourth, occurring in 108 regions out of 349 (Pyšek et al., 2017). Among the 11 most widespread alien species in the world (Pyšek et al., 2017) is also *Echinochloa crus-galli*.

The largest number of invasive species is contained in the families Asteraceae (15) and Poaceae and Fabaceae (7 each); these three families, as established (Pyšek et al., 2017), make the greatest contribution to the unification of the world flora.

CONCLUSIONS

In the Altai Republic, there are currently 67 invasive species contained in 57 genera and 20 families. The largest number of species is found in the northern

regions; the natural conditions of the southeastern regions are a limiting factor in the penetration and naturalization of alien species. The main method of penetration is self-dispersal (46 species). The first localities of 63 species to penetrate into the territory of the Altai Republic were found in the northern districts, and four species were found in the southeastern districts. In all regions, five species are found, at least singly; 18 species are so far distributed only in the northern districts of the Altai Republic. At the beginning of the 20th century, six currently invasive species were discovered for the first time; by the middle of the 20th century, 26 more were registered; in the 21st century, ten species were registered. Among the invasive species of the Altai Republic, 11 are among the most dangerous alien species in Russia; 35 are among the invasive species in Siberia. There are more invasive species in the Altai Republic than the average for Russian regions (27 ± 17) (Vinogradova et al., 2018); more than 20% of species of alien flora of the Altai Republic display an aggressive character. This is explained by the favorable climate in the northern districts, active economic activity in recent decades, the exponentially growing flow of tourists (according to the increase in the area of disturbed territories and the increase in the number of passing vehicles), and intensely developing trade relations with neighboring regions.

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ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This work does not contain any studies involving human and animal subjects.

CONFLICT OF INTEREST

The author of this work declares that she has no conflicts of interest.

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