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ALIEN FLORAS AND FAUNAS 25

Alien flora of Mongolia: species richness, introduction dynamics and spatial patterns

Gundegmaa Vanjil · Alessandra Kortz · Bernd Lenzner · Javzandolgor Chuluunbat · Suvdtsetseg Chuluunbat · Urgamal Magsar · Khongorzul Tsagaan · Munguntulga Erdenechuluun · Dashmaa Tsogtbayar · Davaa Bayarmagnai · Enkhchimeg Sanjaajav · Khulan Batbayar · Franz Essl · Petr Pyšek

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Abstract We present the updated checklist of the alien flora of Mongolia, with information on species status, taxonomy, distribution, habitats, and economic use. In total, we recorded 154 taxa of alien plants, of which 33 are naturalized and 121 are casual. The alien flora belongs to 32 families, with Amaranthaceae, Fabaceae, and Brassicaceae containing most of the naturalized species and Asteraceae and Poaceae being the richest in casuals. Annuals (101 species) and perennials (27 species) are the most common life forms among the alien species of Mongolia, while woody and aquatic are only represented by two species and parasitic by one species. The majority of Mongolian alien plants originate from temperate Asia (81 species), Europe (72 species), and Africa (53 species). Alien species are restricted to a relatively narrow range of habitats, all heavily transformed by humans, with 42.2% of all species recorded in agricultural habitats. Regarding economic use, food plants dominate, while those used as fodder show the greatest naturalization success. The 29 most widespread naturalized alien species were recorded in all 22 provinces. Compared to other countries in temperate Asia, the Mongolian alien flora is relatively poor, which can be attributed to harsh climatic conditions and the country's isolation in the past. Our study provides the first step toward a science-based

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G. Vanjil · S. Chuluunbat · K. Tsagaan · M. Erdenechuluun · D. Tsogtbayar · D. Bayarmagnai · E. Sanjaajav
Department of Biology, School of Mathematics and Natural Sciences, Mongolian State University of Education, Baga Toiruu-14, Ulaanbaatar 14191, Mongolia

A. Kortz (✉) · P. Pyšek
Institute of Botany, Department of Invasion Ecology, Czech Academy of Sciences, 25243 Průhonice, Czech Republic
e-mail: alessandrakortz@gmail.com

B. Lenzner · F. Essl
Division of BioInvasions, Global Change and Macroecology, University of Vienna, 1030 Vienna, Austria

J. Chuluunbat · U. Magsar
Laboratory of Plant Systematic and Phylogeny, Botanic Garden and Research Institute, Mongolian Academy of Sciences, Ulaanbaatar 13330, Mongolia

K. Batbayar
Department of Biology, School of Arts and Sciences, National University of Mongolia, Ulaanbaatar 14200, Mongolia

P. Pyšek
Department of Ecology, Faculty of Science, Charles University, Viničná 7, 12844 Prague, Czech Republic

approach to plant invasions by policymakers, authorities, and managers in Mongolia.

Keywords Alien species · Asia · Checklist · Distribution · Inventory · Plant invasions · Vascular plants

Introduction

Biological invasions have long been recognized as a major driver of global biodiversity loss, with diverse impacts on invaded species, communities, and ecosystems (Brondizio et al. 2019; Pyšek et al. 2020; IPBES 2023). Alien plants represent one of the best-studied taxonomic groups (Pyšek et al. 2008); in the last decade, the knowledge of their distribution has dramatically improved globally (van Kleunen et al. 2015, 2019; Pyšek et al. 2017), including analyses of invasion dynamics (Seebens et al. 2017), but the lack of data from certain parts of the world like Central Asia pertains (Pyšek et al. 2008, 2017). The standardization of the terminology reflecting stages of the invasion process allowed assigning species to clear categories based on their level of invasion and contributed to the improved understanding of biological invasions over the last 20 years (Richardson et al. 2000; Pyšek et al. 2004; Blackburn et al. 2011; Essl et al. 2018). This, hand in hand with raised awareness and increasing interest in biological invasions, allowed for standardized compilation of alien plant species distribution data for regions of the world that suffered from the lack of data until not long ago (Latombe et al. 2017); this research yielded many checklists from previously understudied regions (e.g. Inderjit et al. 2018; Ansong et al. 2019; Dorjee et al. 2020; Borokini et al. 2023; Holmes et al. 2023; Sohrabi et al. 2023) and contributed to global analyses of invasion patterns, mechanisms and historical legacies (e.g. Essl et al. 2019; Lenzner et al. 2022; Fristoe et al. 2023; Pyšek et al. 2023).

In many countries, invasive alien species negatively impact regional floras and faunas, and their spread is attributed to climate change and human factors, especially trade and land use (Montagnani et al. 2022). Among reported impacts are changes in vegetation cover or even ecosystem functioning, causing soil erosion, change in their physical and chemical composition and irreversible desertification (Brooks et al. 2006), and resulting in the reduction of biological diversity (Vilà et al. 2011; Pyšek et al. 2012, 2020; Shiferaw et al. 2018; IPBES 2023).

Until now, Mongolia belonged to such understudied regions with regard to the completeness of information on the country's alien flora, despite recently raised awareness of biosecurity issues. Alien plants have increased rapidly in Mongolia over the past 30 years, and the recent research yielded a total of 51 species (M. Urgamal, unpublished data); more recently, 62 were reported in the Global Naturalized Alien Floras (GloNAF) database (van Kleunen et al. 2019). The biosecurity in Mongolia has only recently started to be debated, and there is a lack of information at the national level about alien species and their harmful effects. In 2010, when the term "alien plant" was first included in the national law (https://legalinfo.mn/en), invasions became an issue for science and policy, and propositions were made to restrict the cultivation of imported and introduced species in nature.

This study aims to improve the knowledge of plant invasions in Mongolia. We present the most comprehensive checklist to date, with information on the taxonomic structure of the alien flora, the geographical distribution of the recorded species, and analysis of their invasion status, origin, and life history.

Methods

Study area

Mongolia is the second-largest landlocked country worldwide, surrounded by Russia to the north and China to the south, with an area of about 1,564,116 km^2. The western and northern regions are dominated by mountainous terrain, while the eastern and southern areas are flat steppe and deserts. The climate is highly continental, with pronounced differences between warm to hot summers and very cold winters. The average annual temperature is 8.5 °C in the Gobi region, and reaches –7.8 °C in the high-mountain areas. Forests are widespread in the mountains of the north, grasslands prevail in the eastern part of the country, and rocky and desert areas occupy large areas in the south and in the depression of the Great Lakes (Yembuu 2020).

The native flora of Mongolia is rather rich due to the large land area and diverse habitats, ranging from the northern taiga forest to the southern Gobi Desert; the most recent checklist reports 3,041 vascular plant taxa (Baasanmunkh et al. 2022). In Mongolia, there are 16 phytogeographical regions defined based on differences in plant species distributions (Grubov and Yunatov 1952) and 22 administrative political units (provinces; Table 1), including capital city Ulaanbaatar. While most plant taxonomists follow the phytogeographical division for their research, studies on alien or invasive species usually use administrative units to determine their distribution areas (Liu et al. 2005; Vinogradova et al. 2018; Qian et al. 2022), probably because of the close association of alien plant's occurrence with human activities that can be then expressed by proxies related to economy and demography. Here, to obtain insight into the effect of natural and human-related factors, we considered both categories and compiled a list of alien vascular plant species for each administrative unit and phytogeographical region (Supplementary Information 1). For each administrative unit, we obtained information on the human population size (National Statistics Office of Mongolia 2024).

Compilation of data on alien flora

The list of alien plant species occurring in Mongolia was compiled based on books and journal articles (Grubov 1955, 1982; Gubanov 1996; Ulziikhutag 1984, 2003; Javzan and Ochgerel 2010; Manibazar 2010; Urgamal et al. 2013, 2014; Urgamal and Sanchir 2014; Munkhnast et al. 2020; Baasanmunkh et al. 2022; Undruul et al. 2023). The latest compilation (Baasanmunkh et al. 2022) reported 3041 species of vascular plants in Mongolia, of which 24 were alien. As a basis of our checklist, we used the data of M. Urgamal (unpublished), who registered 51 alien plants from 48 genera and 23 families; this figure

Table 1 Twenty two administrative units of Mongolia, including the capital city Ulaanbaatar, with information on human population size and density, and alien plant species numbers

No	Region	Population size	Area (km^2)	Population density (per km^2)	Number of alien species	Number of naturalized alien species	Number of casual alien species
1	Arhangai	94,205	55,314	1.7	66	13	53
2	Bayan-Ulgii	113,806	45,705	2.5	44	9	35
3	Baynkhongor	89,043	115,978	0.8	49	12	37
4	Bulgan	61,943	48,733	1.3	67	13	54
5	Gobi-Altai	57,458	141,448	0.4	52	12	40
6	Gobisumber	18,079	5542	3.3	43	9	34
7	Darkhan-Uul	107,751	3275	32.9	130	24	106
8	Dornogovi	71,457	123,359	0.6	43	13	30
9	Dornod	83,757	123,597	0.7	46	14	32
10	Dundgobi	46,654	74,690	0.6	39	7	32
11	Zavkhan	72,731	82,456	0.9	58	12	46
12	Orkhon	108,713	844	128.8	79	17	62
13	Uvurkhangai	115,732	62,895	1.8	68	15	53
14	Umnugobi	71,720	62,895	1.1	49	15	34
15	Sukhbaatar	64,662	82,287	0.8	48	15	33
16	Selenge	108,878	41,153	2.6	119	21	98
17	Tov	93,468	74,042	1.3	102	17	85
18	Uvs	84,095	69,585	1.2	62	14	48
19	Khovd	91,127	76,060	1.2	89	19	70
20	Khuvsgul	136,714	100,629	1.4	46	6	40
21	Khentii	78,967	80,325	1.0	73	15	58
22	Ulaanbaatar	1,665,469	4704	354.0	110	19	91

represented 1.6% of the country's plant diversity. Most recently, Munkhnast et al. (2020) recorded 35 species of alien plants in Mongolia. The two recent lists differed in the numbers of reported aliens by 37%, therefore representing a somewhat unreliable basis for taking measures against alien species nationally. Presenting a thoroughly revised checklist of Mongolian alien flora that reflects an up-to-date state of knowledge is necessary to provide authorities and policymakers with more reliable data.

We further present data on the region of origin, year of introduction, economic uses, and life history of the alien taxa of Mongolia; data were extracted from the same literature as used for compiling the species list (see above).

Classification of invasion status

Alien plant taxa were defined as those in a given area whose presence is due to intentional or accidental human introduction (Richardson et al. 2000; Pyšek et al. 2004; IPBES 2023). As to the invasion status, we classified species as naturalized or casual, using the criteria developed by Richardson et al. (2000) – naturalized plants reproduce consistently in the wild without direct intervention by humans and form self-sustaining populations, while casual plants may occasionally reproduce in an area, but do not replace the populations and rely on repeated introduction. Information on the invasion status, i.e., whether a species is naturalized or casual in Mongolia, followed that presented by Urgamal (2017) and Munkhnast et al. (2020); the species not included in their papers were assessed based on our field observations. Current knowledge of the alien flora in Mongolia cannot reliably identify which naturalized species are invasive; therefore, this category has not been assigned.

Statistical analysis

We used the chi-square goodness of fit test to test whether naturalized and casual species are significantly distinct from an expected distribution in terms of their life form, habitat type, and continent of native distribution. We removed the attributes of which the expected values were below five from the calculations (for life forms, we removed aquatic, parasitic, shrub, and tree; for habitat type, wetlands; for native origin, Australasia; and for economic use, medicinal).

To analyze temporal trends in the proportional number of alien species' first records, we calculated a binomial generalized linear model (GLM). As a response variable, we used proportional alien species richness per year. As predictors, we included the first record of the respective species as an interaction term with invasion status (i.e., whether it is reported as a casual or naturalized species in Mongolia). We plotted the cumulative species richness as solid lines using the "loess" method.

To evaluate the similarity of species composition of alien species among phytogeographical regions in Mongolia, we used the Jaccard dissimilarity index, which is based on incidence data (Jaccard 1900). Jaccard dissimilarity index ranges from 0 (regions with identical species composition) to 1 (regions completely distinct in species composition).

All analyses were performed in R version 4.3.1 (R Core Team 2023) using the packages *betapart* (Baselga and Orme 2012), *ggplot2* (Wickham 2016), *tidyverse* (Wickham et al. 2019) and *sf* (Pebesma 2018; Pebesma and Bivand 2023). The map of Mongolia was obtained from the Database of Global Administrative Areas (GADM; https://gadm.org/).

Results

Species richness and structure of the alien flora

In total, we recorded 154 taxa of alien plants (further referred to as 'species' for simplicity), of which 33 species (22%) are naturalized and 121 (78%) are casual (Table 2). The complete species list with information on characteristics analyzed below is shown in Supplementary Information 1.

The alien flora belongs to 32 families; Fabaceae (n = 23 species), Asteraceae (n = 22), Poaceae (n = 21), and Brassicaceae (n = 16) are the families with the largest numbers of alien species, while 20 families are represented by only one or two species. The families with the most alien genera are Asteraceae (20) and Fabaceae (14). Amaranthaceae, Fabaceae, and Brassicaceae include the largest numbers of naturalized species, while Asteraceae, Poaceae, Fabaceae, and Brassicaceae are richest in casuals (Table 2).

Table 2 Alien species present in Mongolia with regard to the plant families. The number and percentage of genera and species separately for naturalized and casuals are shown for each family

No	Family	Genera		All aliens		Naturalized		Casual	
		n	%	n	%	n	%	n	%
1	Fabaceae	14	13	23	14.9	6	18.2	17	14
2	Asteraceae	20	18.5	22	14.3	3	9.1	19	15.7
3	Poaceae	11	10.2	21	13.6	3	9.1	18	14.9
4	Brassicaceae	11	10.2	16	10.4	4	12.1	12	9.9
5	Amaranthaceae	5	4.6	11	7.1	7	21.2	4	3.3
6	Apiaceae	9	8.3	9	5.8			9	7.4
7	Caryophyllaceae	4	3.7	6	3.9	2	6.1	4	3.3
8	Solanaceae	3	2.8	5	3.2			5	4.1
9	Alliaceae	1	0.9	5	3.2			5	4.1
10	Cucurbitaceae	3	2.8	5	3.2			5	4.1
11	Convolvulaceae	3	2.8	3	1.9	1	3	2	1.7
12	Caprifoliaceae	2	1.9	2	1.3	1	3	1	0.8
13	Lamiaceae	2	1.9	2	1.3			2	1.7
14	Malvaceae	2	1.9	2	1.3	2	6.1		0
15	Scrophulariaceae	2	1.9	2	1.3			2	1.7
16	Asparagaceae	1	0.9	1	0.6			1	0.8
17	Balsaminaceae	1	0.9	1	0.6			1	0.8
18	Boraginaceae	1	0.9	1	0.6			1	0.8
19	Campanulaceae	1	0.9	1	0.6			1	0.8
20	Cannabiaceae	1	0.9	1	0.6	1	3		0
21	Linaceae	1	0.9	2	1.3			2	1.7
22	Onagraceae	1	0.9	1	0.6			1	0.8
23	Orobanchaceae	1	0.9	1	0.6	1	3		0
24	Papaveraceae	1	0.9	1	0.6	1	3		0
25	Polemoniaceae	1	0.9	1	0.6			1	0.8
26	Polygonaceae	1	0.9	2	1.3			2	1.7
27	Portulacaceae	1	0.9	2	1.3	1	3	1	0.8
28	Ranunculaceae	1	0.9	1	0.6			1	0.8
29	Resedaceae	1	0.9	1	0.6			1	0.8
30	Sapindaceae	1	0.9	1	0.6			1	0.8
31	Tropaeolaceae	1	0.9	1	0.6			1	0.8
32	Violaceae	1	0.9	1	0.6			1	0.8

Annual (101 species: 82 casual and 19 naturalized) and perennial (27 species: 20 casual and seven naturalized species) plants account for the vast majority of the alien species in Mongolia, while woody, aquatic, and parasitic species are only represented by one or two species. We found no association between life form and status ($\chi^2 = 1.1$, df = 2, $p > 0.05$).

The most common continents of origin for Mongolian alien species are temperate Asia (81 species; 52.6%; 57 casuals and 24 naturalized), Europe (71 species; 46.1%; 49 casuals and 22 naturalized), and Africa (52 species; 33.7%; 37 casuals and 15 naturalized); note that each species can be native to more than one continent (Fig. 1). There was no association between the continent of origin and species status ($\chi^2 = 2$, df = 5, $p > 0.05$).

Habitats

Alien species in Mongolia are restricted to a relatively narrow range of habitats, all heavily transformed by humans. The greatest proportion of species are found in agricultural habitats (65 species, i.e., 42.2% of all species recorded), ruderal habitats, and ornamental

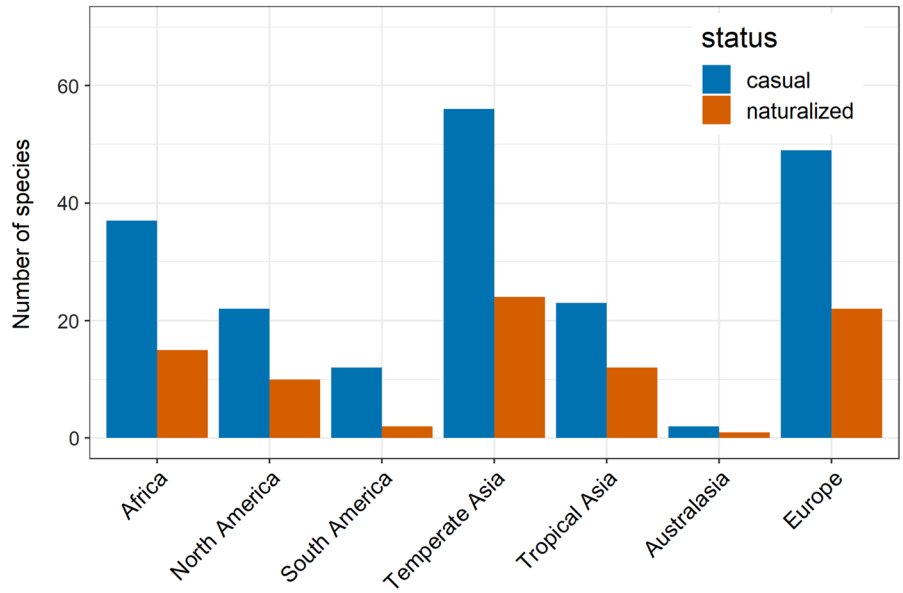

Fig. 1 Continents of origin of the alien species in Mongolia (note that each species can be native to more than one continent)

gardens harbor 45 species (29.2%) each. Only one alien species, *Lotus corniculatus*, has spread to wetlands in Mongolia. There was an association between habitat type and species status ($\chi^2 = 48.5$, df = 2, $p < 0.001$), in which more naturalized species than expected were found in ruderal habitats and more casual species than expected were found in agricultural and garden habitats.

Economic use

Regarding economic use, most species are used for human food (n = 71, of which 68 are casual and three naturalized), followed by land use (ornamental) (n = 46, of which 42 are casual and four naturalized), fodder (n = 19, of which 13 are casual and six naturalized) and medicine (n = 7, of which three are casual and four naturalized). We found a significant association between the economic use of plants and species invasion status ($\chi^2 = 13$, df = 2, $p < 0.001$). There was a higher prevalence than expected of naturalized (and consequently, lower of casuals) for fodder, as well as a higher prevalence of casuals for human food.

Dynamics of introduction

There was no statistically different trend between casual and naturalized richness proportions (Fig. 2a). Model results are given in Table S1 (Supplementary Information 2). The first alien plant species were recorded in Mongolia in 1955; at that time, 21 were reported (e.g., *Allium fistulosum*, *Amaranthus retroflexus*, *Panicum miliaceum*, *Xanthium strumarium*). After that, only from 1984 onwards, there was a sharp increase in the cumulative number of alien species that has continued to the present day (Fig. 2b).

The cumulative number of alien species increased mainly due to casuals that accumulated faster than naturalized species (Fig. 2b). Note that two sources of data (Ulziikhutag 1984; Javzan and Ochgerel 2010) account for about half of the recorded species (Fig. 2a).

Spatial patterns: distribution of alien species in administrative units and phytogeographical regions

In terms of administrative units, Darkhan-Uul is the richest province in alien species (130 species. i.e., 84.4%), followed by Selenge (119, 77.3%) and Ulaanbaatar city (109, 70.8%). The fewest aliens were recorded in the Bayan-Ulgii, Dornogovi, Gobi-Sumber, and Dundgobi provinces (less than 45 aliens in each, Fig. 3).

There are 29 species that occur in all 22 provinces, making them the most widespread (e.g., *Beta vulgaris*, *Anethum graveolens*, *Raphanus raphanistrum*, *Xanthium strumarium*). Three species (*Hordeum vulgare*, *Panicum miliaceum, Solanum melongena*) occur

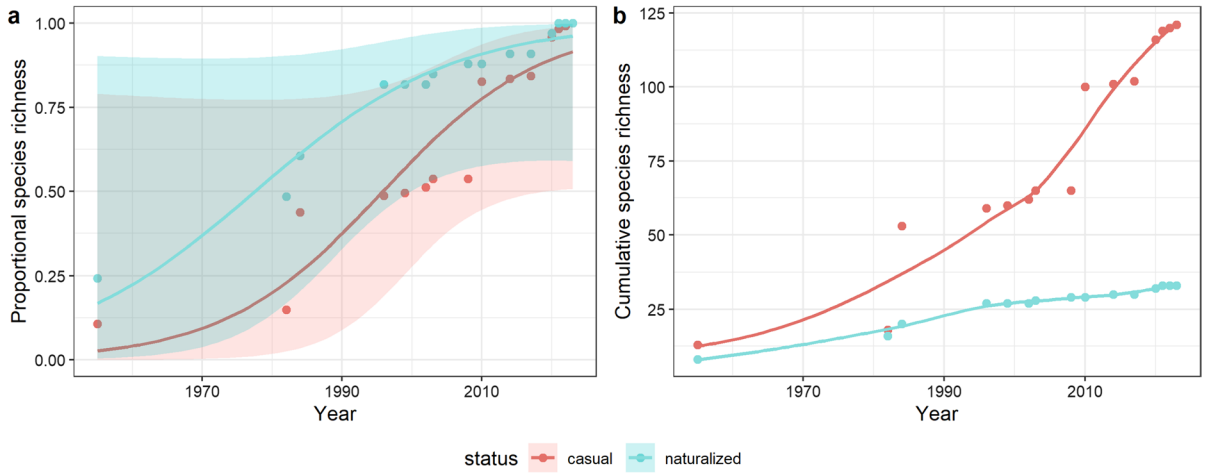

Fig. 2 **a** Proportional cumulative number of species in relation to the year of first record and **b** cumulative number of species

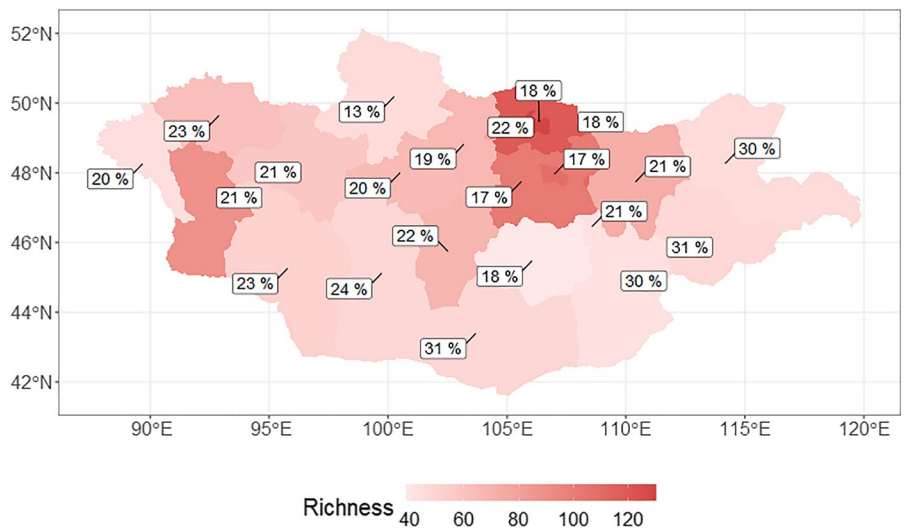

Fig. 3 Percentage of naturalized species from the overall alien flora for each administrative region in Mongolia. Coloration of the regions indicates the number of alien species present

in 21 provinces, and *Acer negundo* in 20 provinces (Supplementary Information 1). Regarding phytogeographical regions, Mongolian Dauria (n = 132), Khentii (n = 83), and Mongolian Altai (n = 56) were the richest in alien species (Table 3).

The analysis of species composition reveals that most phytogeographical regions in Mongolia are quite distinct in their naturalized floras (yellow to red color, Fig. 4). The exception, in which the pair of phytogeographical regions has similar species composition, are the neighboring biogeographic regions of Mongolian Altai and Dzungarian Gobi (in light blue). To a lesser extent, East Mongolia and East Gobi, also neighboring, share more species than other pairs of regions (Fig. 4).

Discussion

Alien plant species richness and regional distribution patterns

Our research revealed that the overall number of alien plant species in Mongolia is relatively low, just 154 for a country of that size. Moreover, a thorough reassessment of the invasion status with a focus on the

Table 3 Distribution of native and alien species in phytogeographical regions of Mongolia

No	Phytogeographical region	Number of native species	Number of alien species
1	Khuvsgul	1,054	45
2	Khentii	1,236	83
3	Khangai	1,514	43
4	Mongolian Dauria	1,198	132
5	Foothills of great Khyngan	793	6
6	Khovd	1,011	9
7	Mongolian Altai	1,400	56
8	Middle Khalkh	777	13
9	East Mongolia	952	16
10	Depression of great lakes	882	27
11	Valley of lakes	466	14
12	East Gobi	462	11
13	Gobi Altai	865	19
14	Dzungarian Gobi	913	52
15	Transaltai Gobi	356	10
16	Alashan Gobi	262	5

naturalization stage, revealed that only 33 species can be assigned this status. To put it differently, naturalized plants comprise just 1% of the native vascular plant species pool, and casuals make up another 4%. Compared to adjacent regions, the small size of the alien flora is conspicuous. In two adjacent regions of about half its size and similar climatic conditions to Mongolia, located in Kazakhstan (Aral Caspian and Lake Balkash Area), 51 and 56 naturalized species, respectively, are reported (Pyšek et al. 2017). Even greater contrast is given by 278 naturalized species reported from a Chinese province of Inner Mongolia (van Kleunen et al. 2019). In regions in Southern Siberia, 104 naturalized species were recorded in Khakassia, 165 in the Altai Republic, 44 in the Tuva Republic, and 128 in Buryatia (van Kleunen et al. 2019); all these regions are considerably smaller in area than Mongolia.

The low number of alien plant species in Mongolia likely reflects the specific environmental (e.g., harsh climate) and socioeconomic conditions. For the latter, the isolated location of the country and long-lasting communist dictatorship severely constrained socioeconomic development and international trade. Further, the very low population density of 2.2 people/km^2 makes Mongolia the most sparsely populated country in the world and likely explains some of the observed differences to neighboring countries (e.g., Kazakhstan: 7 people/km^2; Inner Mongolia: 20 people/km^2). Thus, road and railway infrastructures that facilitate alien species' introduction and spread are poorly developed in Mongolia. Railways mainly connect larger population centers, particularly the greater Ulaanbaatar region and neighboring districts, which correspond to areas with highest alien species richness. The harsh climatic conditions limit agriculture to small areas in the more humid parts of Mongolia; in fact, farming has no long tradition in the country, and despite a great expansion of the quota of arable land in the 1960s and 1970s, the cultivated land still accounted for less than 1% of the country's area (Hilbig 1982; Enkhbat and Nyamdavaa 2022). Thus, relatively few alien plant species have been introduced by farming activities, and the scarcity of suitable habitats limits the richness of alien flora in segetal habitats, which are highly invaded in other temperate regions of the globe (e.g., Chytrý et al. 2008). Still, the agricultural land represents the richest habitat, with over 40% of aliens recorded there, even though a significantly greater proportion of them are casuals. The greatest naturalization success was recorded for ruderal habitats, corresponding to findings from other countries where data on habitat affiliations are available (e.g., Crawley 1987; Chytrý et al. 2008; Pyšek et al. 2022). In contrast, only very few woody species, a life form that is well-represented in the alien global flora (Pyšek et al. 2017), are present in the alien flora of Mongolia, reflecting a lack of suitable environmental conditions and, consequently, habitats for such species. The same holds for aquatic species.

Despite the species-poor alien flora, the differentiation in its composition on the regional scale is quite pronounced in Mongolia. This finding seems to be mainly driven by the large size of the country, the concomitant substantial climatic gradients, and possibly further enhanced by differences in human population density and anthropogenic pressures.

Introduction and naturalization dynamics

The first records of alien plants in Mongolia were only documented in the mid-twentieth century. Although invasion dynamics have been dramatically increasing worldwide in recent decades (Seebens et al. 2017), this is a very late onset of recording of

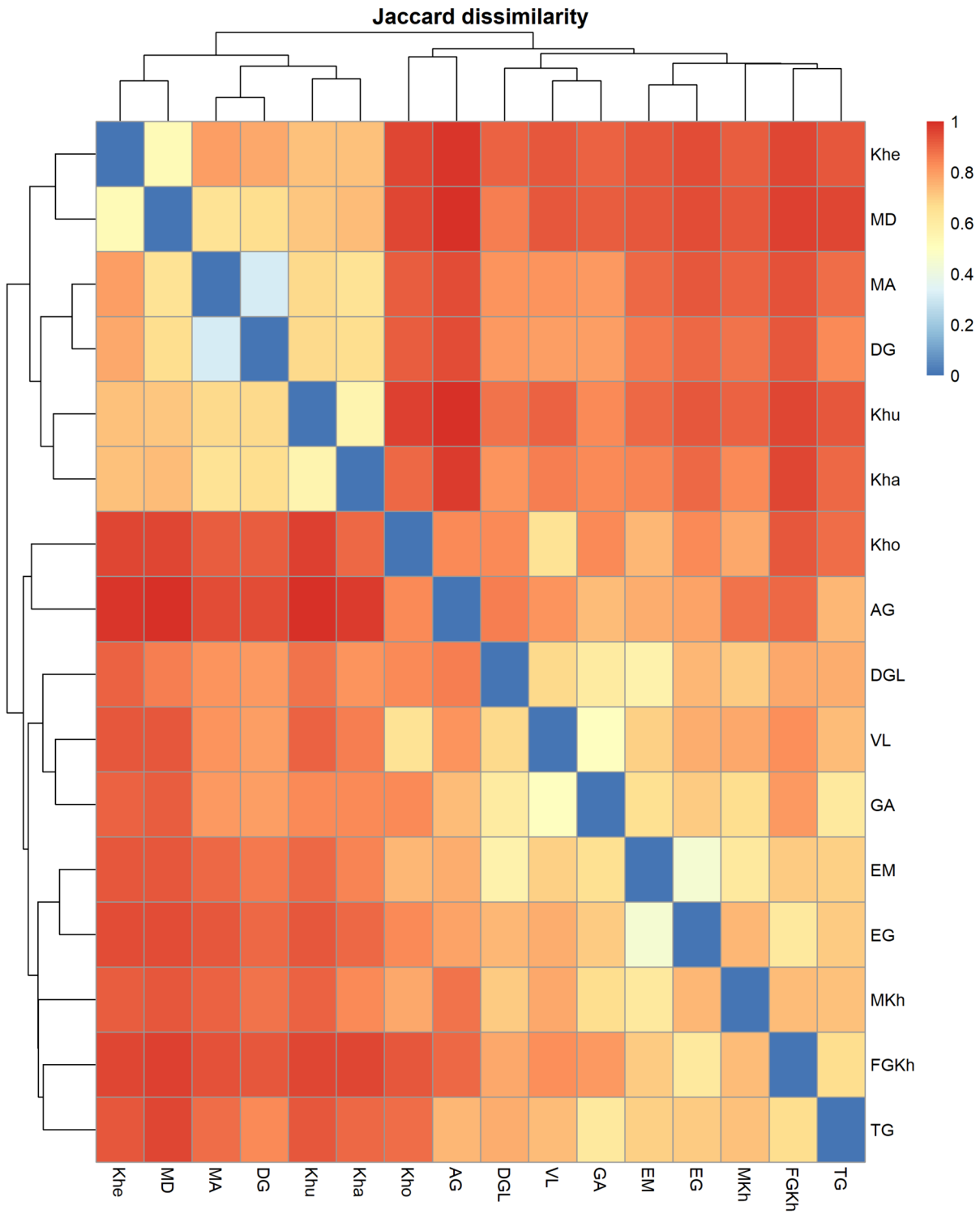

Fig. 4 The dissimilarity matrix of the alien flora amongst the biogeographical regions of Mongolia, calculated using the Jaccard dissimilarity index. Values approaching 0 (in blue) refer to regions with identical species composition, whereas values approaching 1 (in red) refer to regions with distinct species composition. The names of biogeographical regions are displayed by the first letters of full names that are given in Table 3.

alien plants compared to countries with a longer tradition of alien plant research. Most likely, this belated recording of alien plant species is caused by the long-lasting isolation of the country, little research into the flora of Mongolia until recent decades, and possibly also delayed inclusion of the data into global databases. Only recently has Mongolia become more thoroughly integrated into global trade networks, and together with increased research, the number of recorded aliens has been growing more rapidly since the 1980s.

However, the recently more steeply growing number of casual alien plant species indicates that the accumulation of alien plant species has gained momentum. Thus, it remains to be seen if, in the future, the records of naturalized plant species numbers will also grow more rapidly in Mongolia. Given the substantially larger alien flora in climatically similar adjacent regions such as Inner Mongolia, southern Siberia, and Kazakhstan (see Pyšek et al. 2017; van Kleunen et al. 2019 and references there), it seems likely that the currently rapid alien species accumulation will continue in the future.

Economic use and management implications

Economic use is one of the major factors contributing to the introduction of alien plants and, later on, may also support their success in new regions (Vilà and Pujadas 2001; Essl et al. 2011; van Kleunen et al. 2020; Pouteau et al. 2021). Individuals and organizations bring and grow many kinds of plants and crops from foreign countries for decoration, food, medicine, and hays (van Kleunen et al. 2020). Due to limited border inspection control and detection capabilities in Mongolia, imported plants and their propagules, including grains and seeds, can easily spread to agricultural areas. Our study emphasizes the importance of alien species introduced to Mongolia used for human food and as ornamentals. For example, alien plants (but also some native parasitic plants) have become abundant in the western provinces of Mongolia in the last 4–5 years, which has limited the growth of vegetables and grains in the region, worsened the yield, and hindered the growth of local native plants. The spread of these species also affects the livelihood of rural people. Examples of these species are *Amaranthus retroflexus, Brassica juncea*, *Chloris virgata*, *Lepidium densiflorum* and *Malva sylvestris*.

Our paper provides the first comprehensive checklist of the alien flora of Mongolia, which has been an understudied country in terms of plant invasion research until now. Reliable knowledge of the taxonomic composition, distribution patterns, and dynamics of alien flora, in particular its naturalized part, is a crucial step toward science-based management to be adopted by policymakers, authorities, and managers to mitigate the current and future impacts of alien species (Meyerson et al. 2022). In recent years, there has been progress toward a standardized approach for systematically monitoring alien species and tracking biological invasions (Latombe et al. 2017; Pyšek et al. 2018). The up-to-date information on its alien flora places Mongolia among countries concerned with the global consequences of biological invasions.

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Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

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