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DEMONSTRATING THE BREADTH OF THE ALIEN TAXA USING HERBARIUM

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Abstract

The present study examined the PNUH herbarium specimens from the period (2002-2022) to analyze three elements of them: nativeness, habit, and phytogeographical distribution. A total of 6000 specimens with 251 species were examined, they included 44 families and 168 genera. Of which 205 native species and 46 alien ones belong to 18 families and 39 genera. The most represented families were *Asteraceae* and *Poaceae* followed by *Brassicaceae*. The most represented native genus was *Convolvulus* L. but the most represented alien genus was *Amaranthus* L. on the other hand the Saharo-Arabian was the most represented monoregional (40 species, 16%) for native taxa, but cosmopolitan followed by Mediterranean and Irano-Turanean were the most represented alien taxa, also it was recorded that most taxa of the phytogeographical region were herbaceous. Also, the number of alien species exceeds especially in the last decade. Our data provide an estimate of the widespread most successful alien species over a very large area of the KSA. This work considered as the first thorough compilation and analysis of all records on alien plant taxa in KSA herbaria, has identified knowledge gaps about the geographic distribution and life form. We believe that our findings will raise environmental awareness about invasive species in Saudi Arabia and, more importantly, that they will spur and direct additional research on this topic in Saudi Arabia, particularly field-oriented studies. No management strategy can be created without a solid understanding of the issue.

Key words: Herbarium, Alien, Native, Saudi Arabia, Flora.

Introduction

Exotic creatures known as "alien species" are those that exist outside of their naturally adapted ranges and dispersal capabilities (Chandra, 2012), according to the International Union for Conservation of Nature and Natural Resources (IUCN), an alien invasive species is one that establishes itself in a natural or semi-natural ecosystem or habitat, affects the native biological diversity, and causes change. All classes of living things as well as all types of ecosystems worldwide are home to these invading species.

Van Kleunen *et al*., (2015) reported a total of 13,168 naturalized alien species, which indicates that at least 4% of the 337,137 known vascular plant species (The Plant List, 2015) on earth have naturalized outside of their native ranges because of humans. According to the well-known Tens Rule (10% of vascular plant species would show up in the wild as casuals; (Jeschke *et al*., 2012; Williamson & Fitter, 1996), and 10% of those would naturalize, predicts a global estimate of only 3,371 naturalized plant species, i.e. a large underestimate of the global naturalized alien flora.

Species extinction, hydrological changes, and ecosystem function are all brought on by invasive species, which reduce biodiversity (Chandra, 2012). It is commonly acknowledged that biological invasion by aliens offers the second-greatest threat to the world's biodiversity (after direct habitat loss) (Khuroo *et al*., 2007). The severity of alien species' effects on indigenous biota and human societies is continuously growing. We still know relatively little about the global expansion and distribution of naturalized species, or alien species that establish self-sustaining populations in new areas (Van Kleunen *et al*., 2015).

Much progress has been made in recent years in creating regional catalogs of alien plant species see; (Pyšek *et al*., 2017 for an overview). These inventories serve as essential data sources for regional and worldwide databases. These offer information for testing broad theories about biological invasions, spotting long-term patterns in species introductions, and detecting invasion-related causes. Biological invasions have become a focus of national and international strategies because there are well-documented effects of alien plants on the environment and human livelihoods caused by a subset of foreign species (Vinogradova *et al*., 2018).

Beginning in the 2000s, extensive and rather comprehensive lists of naturalized alien plants in areas (countries, islands, federal states, or provinces of large countries) using a standardized classification of invasion status, primarily following the one proposed by (Richardson *et al*., 2000), began to appear. For instance, in Europe, Austria's national alien plant species checklists were the first to be released in 2002 (Essl *et al*., 2002), and the Czech Republic (Pyšek *et al*., 2002). Similar activities were also carried out abroad, such as in temperate Asia (Liu & Wang, 2006; Wu *et al*., 2010; Shrestha., 2016; Pergl *et al*., 2018). However, there are still some significant data gaps in global coverage, with the largest one being large portions of temperate Asia, according to two recent publications that provide the most comprehensive overviews of naturalized plant species inventories worldwide (Van Kleunen *et al*., 2015; Pysek *et al*., 2017).

For many reasons, including a better understanding of the factors causing local invasions, but also for obtaining a more complete picture of global alien species richness, it is crucial to increase our knowledge of the distributions and richness of alien plant species, both naturalized and invasive, in understudied regions(Van Kleunen *et al*., 2015; Pysek *et al*., 2017).

Saudi Arabia's flora is like that of other geographical regions, such as southeastern and northeastern Asia, the northern and western Mediterranean, and western Africa. A thorough investigation of Saudi Arabia's flora resulted in

the identification of 835 genera and 2,250 plant species (Chaudhary, 1999, 2000, 2001b; Collenette, 1999).

Saudi Arabian biological invasions have been the subject of extensive investigation during the past few years see; (Al-Harthi *et al*., 2019; Alharthi *et al*., 2023a, 2023b) these represented an important study for the collection of regional data on alien plant species, other studies concentrated on specific alien species such as (Moussa *et al*., 2012; Fadl *et al*., 2016; Alharthi *et al*., 2021).

In this regard, the herbarium labels are considered as the primary source of historical data on alien plant species in a specific zone. Location and environment descriptions in herbarium data vary widely(Lavoie *et al*., 2005), but they at least give us geographic information and collecting dates so we can approach the arrival and establishment of alien species(Fuentes *et al*., 2008) also Plan invasions have been extensively studied using herbarium data (Pysek & Prach, 1993, 1995; MacDougall *et al*., 1998; Lavoie *et al*., 2005).

Future research that will help develop management techniques for alien flora must first accurately identify, catalog, and characterize such floras. It is crucial to distinguish between native and foreign species in current floras since doing so would increase their usefulness, expand their "clientele," and largely resolve the issue of "taxonomic inflation" in inventories of native plant biodiversity. Also, comparing the alien flora of phytogeographically different places is a crucial scientific step for detecting the distinctive invasion patterns(Pyšek, 1998).

In this study, we used for the first time the herbarium records for our region to determine the times when alien plant species invaded Saudi Arabia. To do that, we accept that the pattern of specimen accumulation can be utilized to determine the spread of alien species introductions across time. A reference for future assessments of the degree of invasion in this location with rich biodiversity, such baseline data would serve as the cornerstone for further studies in invasion ecology.

Material and Methods

Study area: Saudi Arabia dominates the majority of the Arabian Peninsula and is at an ideal geographic location with an area of approximately 2,250,000 km^2. It is located between longitudes 34°40′E–55°45′E and latitudes 15°45′N–34°35′N (AlNafie, 2008). It is home to a wide range of habitats, including high-altitude mountains (Jabals) (up to 3050 m asl), valleys (wadis), meadows (Raudhas), salt pans (Sabkhas), lava areas (Harrats), deep swamps (Sabkhas), canals for drainage and deep sand (Nafud).

Winters are typically chilly with sporadic frost in the northwest region's mountains. The summertime is warm, with highs occasionally exceeding 50 °C. Most of the country experiences irregular and sporadic rainfall, with the majority of it falling in the winter and spring (100–150 mm), except for the southwest region, which experiences high rains (>600 mm) between September and November. Central Najd has low humidity (15-20%), while coastal areas have high humidity (55–75%) that was extracted by map and chart using Google Earth Engine Program (GEE) (Figs. 1 & 2).

Fig. 1. Map of Saudi Arabia demonstrates the temperature using GEE.

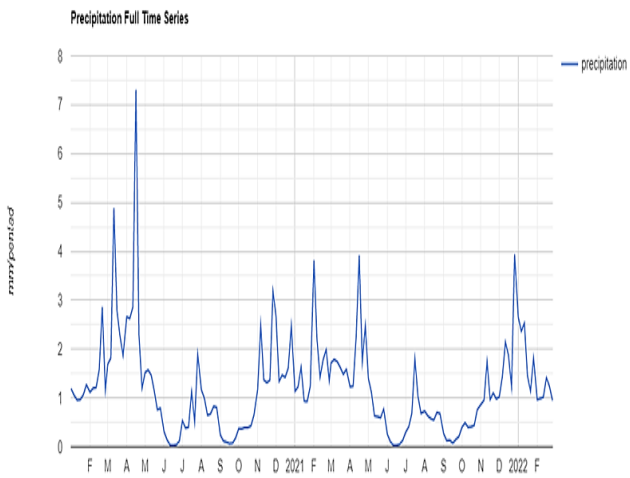

Fig. 2. Precipitation of study area through the last two years using GEE.

Identification of alien taxa: We examined the list of all plants found in the Princess Nourah University Herbarium (PNUH) established in (2002) at Princess Nourah bint Abdulrahman University in the kingdom of Saudi Arabia with around 6000 specimens between (2002-2022). According to (Richardson *et al*., 2000), "the alien species (exotic plants, non-native plants, non-indigenous plants) are plant taxa in a given area whose presence is due to intentional or accidental introduction as a result of human activity" were used as the definition of the term for the current study. Identification of plants and their habit were determined according to the flora references of Saudi Arabia (Chaudhary, 1999; 2000; 2001b; Collenette, 1999), and determination of chorotypes and alien species was depended on 49 sources include mainly original articles, standard floras and checklists which were (Abulafatih, 1987; Rahman *et al*., 2002; Randall, 2003; Al-Turki & Al-Olayan, 2003; Rahman *et al*., 2004; Arévalo *et al*., 2005; Khuroo *et al*., 2007; Mosallam, 2007; AlNafie, 2008; Fridley, 2008; Youssef *et al*., 2009; Arianoutsou *et al*., 2010; El-Sheikh *et al*., 2010; Sher *et al*., 2010; Bhatt *et al*., 2011; Jankju *et al*., 2011; Yassin *et al*., 2011; Chandra, 2012; Masrahi *et al*., 2012; Al-Khamis *et al*., 2012; Al-Taisan, 2012; Abdel Khalik *et al*., 2013; 2017; Youssef, 2013; Al-Sodany *et al*.,

2013; Alsherif *et al*., 2014; Osman *et al*., 2014; Thomas *et al*., 2014; 2016; Alshammari & Sharawy, 2015; Fadl *et al*., 2015, 2016; Grigore *et al*., 2015; Howladar *et al*., 2015; Alsherif & Fadl, 2016; Amal & Bimal, 2017; Al-Robai *et al*., 2017; Hamed *et al*., 2018; Jaradat *et al*., 2018; Jeddi & Chaieb, 2018; Salama *et al*., 2019; Tounekti *et al*., 2019; Abbas *et al*., 2020; Alghamdi *et al*., 2020; Al Shaye *et al*., 2020; Shawky & Alzamel, 2020; Ashfaq *et al*., 2021; GIoNAF, 2023) and internet databases, such as the International Plant Names Index, also I estimated these numbers of alien taxa by extrapolation of the known native origins of 130,641 accepted vascular plant species in the WCSP (http://apps.kew.org/wcsp/) to the total number of 337,137 accepted species in The Plant List (http://www.theplantlist.org/).

Data analysis

The correlation between the habit and chorology was created with 46 records, species habit for the identified alien species and chorology. Correlation relationship analysis was applied to examine the correlation between the habit and the chorology of the identified alien species using "R" software for windows version 3.5.1.

Results

Floristic diversity: The material from the PNUH collections was subjected to taxonomic analysis, 6000 herbarium specimens, with 251 plant species (native and alien) listed along with their families and lifestyles in (Table 3). We have 205 native and 46 of which (18.3%) were alien species, representing 168 genera and 44 plant families. Ranking families reveals that *Asteraceae* and *Poaceae* represented the most number of species (72 species, 29%), then *Brassicaceae* (7.5%) followed by *Fabaceae* and *Chenopodiaceae* (6.7% and 5.2% respectively), but the lowest representation was for *Amaranthaceae* and *Solanaceae* (5 species, 2%) (Fig. 3A). 46 alien species were related to 18 families and 39 genera, (Fig. 3B) shows that also *Asteraceae* and *Fabaceae* had the highest number of species (15 species), followed by *Poaceae* (five species).

Most specimens discovered for native species were *Rumex vesicarius* L. and *Pulicaria undulata* (L.) C.A. Mey however, *R. vesicarius* L. was the earliest samples collected (2002) (the average age of specimens is 20 years). The most represented genus was *Convolvulus* L. represented by six native species and *Plantago* L. (six natives species), followed by five species of *Euphorbia* L. (two aliens and three natives), *Heliotropium* L. (one alien and four natives), then four species to *Amaranthus* L. (all species are alien), *Anthemis* L. (all species are native) *Picris* L. and *Launaea* Cass. (one alien and three natives species), *Fagonia* L. (one native and three aliens species) on the other hand there are ten genera represented by three species which are *Cyperus* L. (one alien and two natives), *Erodium* L. (three natives species), *Acacia* Mill, *Sonchus* L. (two aliens and one native), *Arnebia* Forssk., *Astragalus* L., *Cleome* L., *Stipagrostis* Nees and *Zygophyllum* L. (all species are native) *Chenopodium* L. (two alien and one native), in addition there, 29 genera were represented by just two species (Table 1). Also, the distribution of species was varied, but there were 10 species (4%) restricted to Asir province as shown in (Fig. 4).

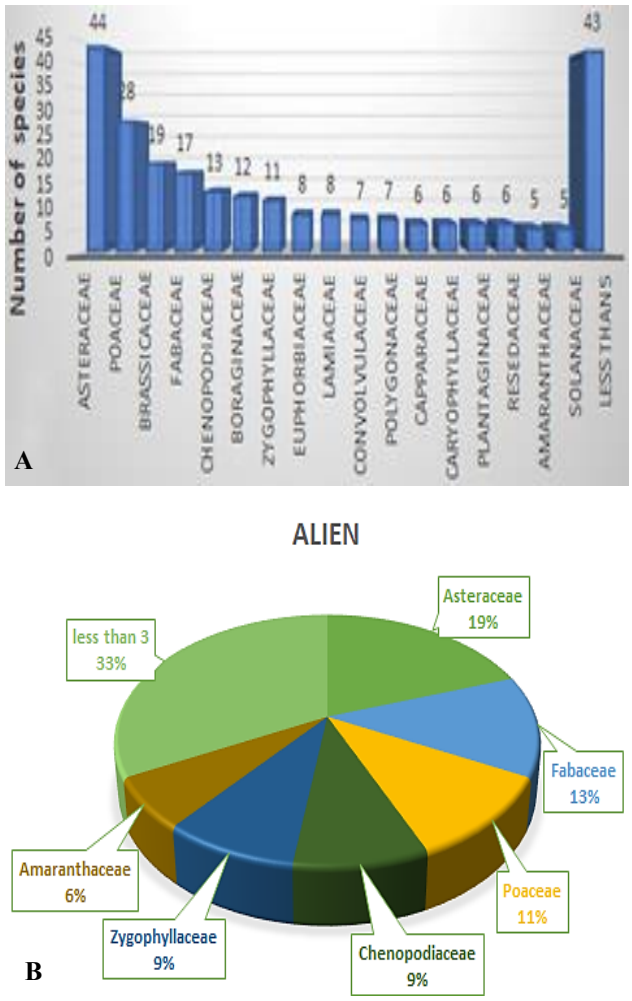

Fig. 3. The taxa distribution along the richest families (A), for all studied species, (B), for alien species.

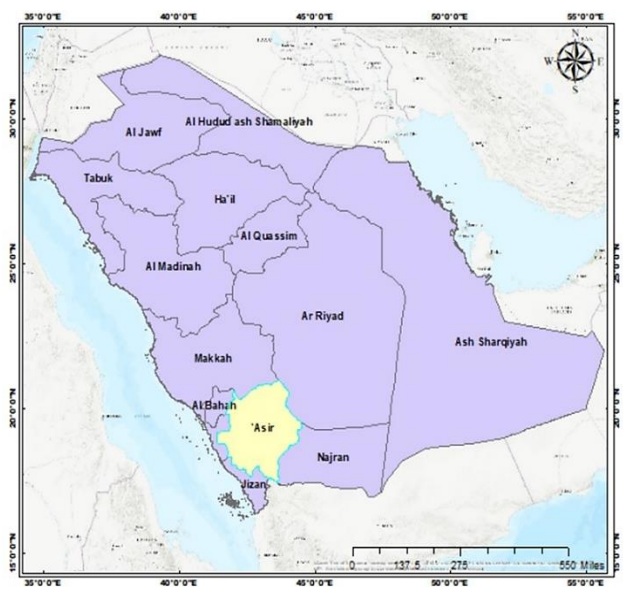

Fig. 4. The studied area with a concentration on Asir region.

Table 1. Number of species concerning genera (the lowest representation).

Genus	Number of species
Atractylis L.	2
Atriplex L.	2
Bassia All.	2
Capparis L.	2
Cenchrus L.	2
Chrozophora Neck. Ex Juss.	2
Diplotaxis DC.	2
Eremobium Boiss.	2
Ficus L.	2
Lavandula L.	2
Lepidium L.	2
Ochradenus Del.	2
Panicum L.	2
Pennisetum L.C.Rich.	2
Polygonum L.	2
Pulicaria Gaertn.	2
Reseda L.	2
Rostraria Trin.	2
Rumex L.	2
Salvia L.	2
Senecio L.	2
Sisymbrium L.	2
Solanum L.	2
Tamarix L.	2
Tetrapogon Desf.	2
Teucrium L.	2
Tribulus L.	2
Ziziphus Mill.	2

Chorology: The native and alien species came from all major global floristic zones as shown in (Fig. 5), we discovered that Saharo-Arabian were the most represented monoregional (40 species, 16%) for native taxa, however, 53 native species (21%) were pluriregional, but a small percentage (4%; ten species) of native species, including those from the tropics, the pantropics, and cosmopolitan. On the other hand, cosmopolitan species make up the majority of alien species (19.5%; nine species), followed by Mediterranean and Irano-Turanean species (10.9%; five species). However, for those species that only came from one region, we noted that they came from American and Saharo-Arabian (17.4% and 8.7%; eight and four species respectively), but pantropical was represented by only (6.5%). On the other hand, the Sudano-Zambesian region was the smallest donor to the alien flora of the studied specimens (two taxa) (Fig. 5).

Habit: The composition of growth form was overrepresented among annual and perennial herbs in native and alien flora (70% and 78% respectively), but on the contrary shrub, shrublet and annual grass were the worst representation in alien one (one species for each). (Fig. 6).

Relationship between habit and chorology for alien taxa: Table (2) shows that 50-80% of AM and SA-SI alien taxa were herbaceous (annual or perennial).

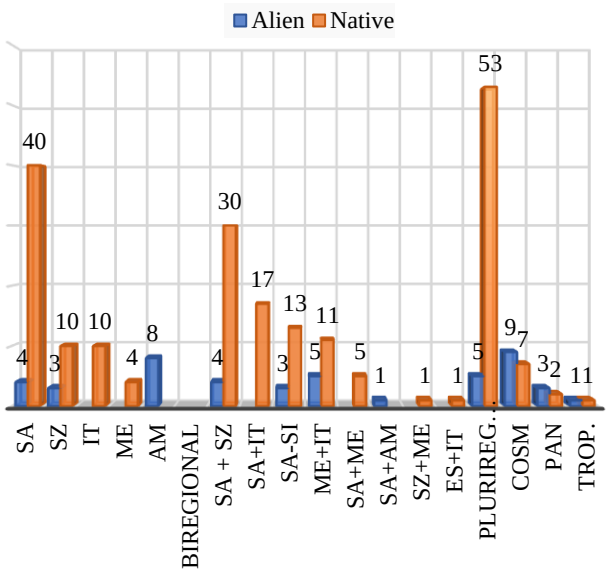

Fig. 5. The floristic regions of native and alien species.

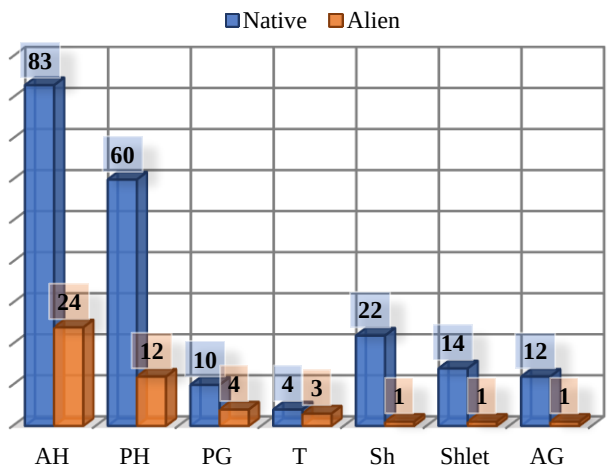

Fig. 6. The representation of habits for both native and alien taxa.

Table 2. Statistic correlation between habit and the highest represented regions for the alien taxa using R.

	AH	AG	PH	PG	Shlet	Sh	T
SA	0.204	-0.222	0.093	-0.240	-0.222	-0.222	-0.344
SZ	0.220	-0.240	0.240	-0.192	-0.240	-0.240	-0.372
AM	0.131	-0.038	0.651	0.054	-0.301	-0.038	-0.466
SA-SZ	-0.325	0.354	0.196	-0.113	0.354	0.354	-0.091
SA-SI	0.529	-0.240	0.801	0.615	-0.240	-0.240	-0.372
PLURI	0.382	-0.417	0.222	0.040	-0.417	-0.417	-0.194
COSM	0.016	0.142	-0.142	-0.205	-0.256	0.142	-0.397

Species frequency during the lifetime of herbarium (two decades): Table (3) was an attempt to follow the frequency of herbarium taxa during the last two decades, the traced species were grouped in generalized 13 categories of frequency.

1- **Species with 65% frequency:** This category had the largest frequency, it included just two native species (*Pulicaria undulata* (L.) C.A. Mey and *Rumex vesicarius* L.). which were recorded through 13 years of the period of the study.
2- **Species with 60% frequency:** This category included also two native species (*Citrullus colocynthis* (L.) and *Rhayza stricta* Decne.), which were recorded over 12 years.
3- **Species with 55% frequency:** It included three species, two natives (*Rhanterium epapposum* Oliv. and *Tripleurospermum auriculatum* (Boiss.) Rech.f.) and one alien species (*Cynodon dactylon* (L.) Rasp.) which collected over 11 years from the period.
4- **Species with 50% frequency:** It included three natives species (*Bassia eriophora* (Schrad.) Asch., *Anvillea garcinia* (Burm.f.) DC. and *Sisymbrium irio* L.) and two alien species (*Chenopodium murale* L., *Malva parviflora* L.) where they recorded through 10 years
5- **Species with a 45% frequency:** This category included seven species collected during nine years, these are six native species and one alien species which was (*Fagonia indica* Burm.f.)
6- **Species with 40% frequency:** It included six species, five native and one alien which was (*Sonchus oleraceus* (L.) L.)
7- **Species with 35% frequency:** This category included 12 species, eight native and three alien species (*Launaea mucronata* (Forssk.) Muschl., *Salsola imbricata* (Schult.) Dandy and *Fagonia bruguieri* DC.)
8- **Species with a 30% frequency:** It included 16 native species recorded during six years of the studied period and one alien species (*Stipa capensis* Thunb.).
9- **Species with a 25% frequency:** It included species noted in five years, 14 species; 11 natives of these *Pergularia tomentosa* L. and *Farsetia longisiliqua* Decne. and three alien species among them *Amaranthus lividus* L.
10- **Species with 20% frequency:** It included 18 species recorded through four years, 15 native and 3 alien species
11- **Species with a 15% frequency:** This category included 30 species noted during three years, 25 native and 5 alien species.
12- **Species with a 10% frequency:** It included 41 species recorded during two years, 33 native and 8 alien species
13- **Species with a 5% frequency:** It included 100 species noted through one year of the studied period, 77 native and 23 alien taxa.

Also, it is clear that from Fig. (7) the number of alien species exceeds especially in the last decade (2008-2019).

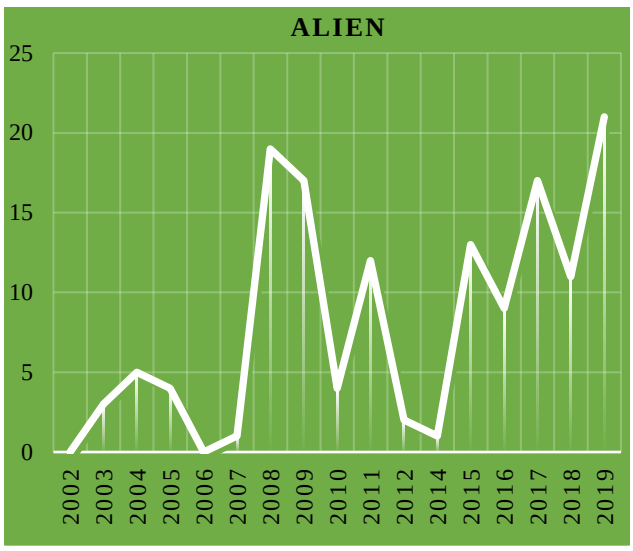

Fig. 7. The recorded alien species during period from 2002-2019.

Discussion

The Saudi Arabian flora, located in a subtropical region of the world (GIoNAF., 2023), according to (Collenette., 1999), consists of 2250 species, 835 genera, and around 142 families, of which 107 species are "endemic," 721 species are "endangered," and 22 species are "totally extinct."

44 families and 251 plant species (205 native and 46 foreign) were found in the current study. Ranking families by their absolute number of naturalized species reveals that those that are generally the richest in species also contribute most to the global flora. i.e., Asteraceae, Poaceae, Brassicaceae, and Fabaceae were the three most predominant families for both native and alien taxa. In the same order, these families were also the ones that make up the majority of Saudi Arabia's plant species(Migahid, 1996; Chaudhary, 2001c), or as mentioned by Pyšek *et al*., (2012) where they revealed that Asteraceae, Poaceae, and Brassicaceae are the three families with the highest representation in the alien flora. However other families (Amaranthaceae and Solanaceae) represent the lowest value (5 species, 2%). This might be because few of these plant species can adapt to and survive in these challenging environments (Al-Sherif *et al*., 2013).

Native species had the highest number of specimens found, such as *Rumex vesicarius* L. and *Pulicaria undulata* (L.) C.A. Mey, this was expected because both of them have wide distribution along the KSA (Chaudhary, 1999, 2000). On the other hand, the *Convolvulus* L. genus, with six native species, was the most well-represented, this is because it is considered one of the largest genera in Saudi Arabian flora (Chaudhary, 2001b).

Our data revealed that 18.3% of the recorded species are alien, and this has exceeded through the last decade. This follows (Van Kleunen *et al*., 2015), who mentioned that Asia's temperate regions exhibit a low rate of area-based naturalized alien species accumulation. Unlike other continents, most of temperate Asia has not been colonized by Europeans, and significant portions of it have just lately allowed the inward movement of people and plants. We could anticipate a large growth of naturalized alien species in temperate Asia in the ensuing decades due to China's

recent emergence as a key trading partner also (Arianoutsou *et al*., 2010) mentioned that Agriculture expanded as a result of the development of new irrigation systems that allowed for the utilization of desert regions. The final two decades of the twentieth century were marked by land abandonment, tourism growth, population concentration near the shore, and the development of extensive transportation networks. These past two decades have seen fast socio-economic transformation, which has significantly altered the patterns of the landscape and the biodiversity they support.

Despite differences in size, temperature, and history, *Amaranthus* L., the genus with the most representatives in the list of alien plants, is also common in other parts of the world (Pyšek *et al*., 2002; Weber *et al*., 2008) this genus includes mostly weeds in urban and agricultural areas, whose natural environment is similar to the typical artificial habitat where they settle as foreign species. Also, the genus *Chenopodium* L. is considered a high representation of alien species, this is following (Pyšek *et al*., 2012).

Among the most common aliens, annuals are noticeably more abundant, while shrubs and trees are disproportionally underrepresented. This may be connected to annuals' higher dispersal capacities and rates of spread, which are connected to their wider geographic range (Forcella, 1985; PyšEK & Hulme, 2005). Also, as annual can complete their brief life cycle in a few months, they might be less impacted by climate factors like cold winters and droughts. Also, annuals spread more quickly than woody plants compared to them because of their short generation times, an affinity for anthropogenic habitats where they can easily colonize and establish, and some common traits like the ability to form seed banks (Gioria *et al*., 2012; Gioria & Pyšek, 2016; Milakovic & Karrer, 2016). Trees and shrubs take decades to centuries to fully establish themselves after being introduced to a new area (Kowarik, 1995). Another element that contributes to this pattern is the fact that annuals frequently enter the environment through crop contamination as weeds e.g. (Wilson *et al*., 2016), which then spreads to areas that have been naturalized as a result of human disturbance from agriculture.

Interestingly, the Saharo-Arabian region was home to the majority (44 native and alien species 17.5%) of the detected plant species in the research area. This is directly attributable to the research area's placement in this area (Takhtadzhian & Crovello, 1986), also (Al-Sherif *et al*., 2013) according to their research on the Khulais region in western Saudi Arabia, Saharo-Arabian elements had the highest number of species because plant species in this area exhibit the typical mechanisms for adaptation to aridity and very low rainfall. But according to numerous early studies the Saharo-Arabian-Sindian region and the Sudano-Zambezian region, which together cover much of North Africa and the Middle East, are said to have influenced the flora and vegetation of Saudi Arabia (Zohary, 1973; White, 1983), these factors account for why monoregional and pluriegional species recorded the highest values.

The majority of alien species were cosmopolitan (19.5 %), followed by Mediterranean and Irano-Turanean species (10.8%) also (Van Kleunen *et al*., 2015) mentioned that the Northern Hemisphere serves as the primary donor of alien plants among the world's continents, However, as noted by (Vinogradova *et al*., 2018) for the flora of Russia in each of the European, Siberian, and Far Eastern regions, this may be related to the closeness of the two nations (Iran and Saudi Arabia). We found that the American species represented 17.4 % of the alien taxa and this is more than expected, on the other hand the tropical is the smallest donor to the alien flora of the studied specimens (one taxa), the likely cause could be due to the increasing temperature of the region, which attracts tropical vegetation, or to more or less similar climatic conditions to those of tropical America (Amal & Bimal, 2017), or as founded by (Van Kleunen *et al*., 2015) where they revealed that North America is also overrepresented, with 57% more species donated than expected and Southern Hemisphere are all underrepresented as donors, in addition (Alharthi *et al*., 2023b) stated that the overrepresentations of American in alien species for Saudi Arabian region could be due to that certain plants planted for afforestation, ornamentation, and shading, such as *Prosopis* sp., *Conocarpus* sp., etc., as well as imported crop seeds, such as Wheat, may be contaminated with unusual seeds. Also, this implies that, for the donor continents of naturalized alien plants globally, the generally accepted Old World versus New World divide in biological invasions (Castri, 1989; Lonsdale, 1999) needs to be replaced with a Northern Hemisphere versus Southern Hemisphere dichotomy.

Tables 2 exhibit that most alien species, that come from Saharo-Arabian -Saharo-Sindian, or American, were weeds (annual or perennial), and there was a relationship between them and the distribution. This might be attributed to their preference for the lower altitude(Stadler *et al*., 1998), or it may be related to the fact that these American species are more suited to the environment. This finding matches the general expectations from the invasion study (Jäger, 1988; Rapoport, 1991), where they reported that species from South America are more suited to the environment in East Africa than those from Eurasia.

Some species like *Pulicaria undulata* (L.) C.A. Mey, *Rumex vesicarius* L., *Citrullus colocynthis* (L.), *Rhayza stricta* Decne., *Tripleurospermum auriculatum* (Boiss.) Rech.f.), *Cynodon dactylon* (L.) Rasp., *Anvillea garcinia* (Burm.f.) DC., *Sisymbrium irio* L., *Chenopodium murale* L. and *Malva parviflora* L. *Fagonia indica* Burm.f. and *Trigonella hamosa* Del. ex-Smith *Sonchus oleraceus* (L.) L.) have high frequency ranging from 65 to 40% (collected through 13, 12, 11,10, 9 or 8 years) this back to these taxa have widely distributed through Saudi Arabia (Chaudhary, 1999, 2000, 2001a, 2001c), or may be related to human activities that promote some species, and a species that was previously unnoticeable may now provide a severe pest problem (Stadler *et al*., 1998). Others have low frequency reached to 5% (just collected through one year) this might be due to the restricted distribution of them to a specific region like *Dodonaea angustifolia* (L.) Jacq., *Euphorbia schimperiana* Scheele, *Convolvulus cephalopods* Boiss., *Verbesina encelioides* (Cav.) Benth. & Hook., *Sonchus saudensis* Boulos, *Scorzonera musilii* Velen., *Osteospermum vaillantii* (Decne.) Norlindh and *Euryops arabicus* Steud. ex Jaub. & Spach where they recorded only in a specific area called Asir (Fig. 4.), or *Tetrapogon cenchriformis* (A.Rich.) Clayton, *Alternanthera sessils* (L.) DC. where they distributed in the southern area on the other hand *Heliotropium curassavicum* L. was recorded in the western area. (Chaudhary, 2001c, 2000, 1999).

Table 3. The studied species of herbarium (2002-2020).

Species	Family	Chorotype	Habit	Nativness	Sum	
					20	F%
Aaronsohnia factorovskyi Warb. & Eig in Eig	Asteraceae	SA	AH	N	1	5
Abutilon bidentatum Hochst. ex A.Rich	Malvaceae	Trop.	PH	N	1	5
Acacia farnesiana (L.) Willd.	Fabaceae	SA-SZ	Sh or small tree	AL	2	10
Acacia gerrardii Benth.		SA-SI	T	AL	2	10
Acacia tortilis (Forssk.)		SZ	PH	N	2	10
Achillea biebersteinii Afan as		ES+IT	AH	N	1	5
Aerva javanica (Burm.f.) Juss. ex Schult.	Amaranthaceae	IT	PH	N	4	20
Aizoon canariense L.	Aizoceae	SZ	AH	AL	1	5
Alhagi graecorum Boiss.	Fabaceae	SA+ME	PH	N	2	10
Alternanthera sessils (L.) DC.	Amaranthaceae	SA+SZ+SA-SI	AH	N	1	5
Althaea ludwigii L.	Malvaceae	SA+SZ+SA-SI	AH	N	3	15
Amaranthus hybridus L.	Amaranthaceae	Cosm	AH	AL	1	5
Amaranthus lividus L.		PAN	AH	AL	5	25
Amaranthus viridus L.		Cosm.	AH	AL	4	20
Anabasis setifera Moq.	Chenopodiaceae	SA	PH	N	3	15
Anagallis arvensis var. *caerulea* (L.)	Primulaceae	ES+M+IT	AH	N	1	5
Anastatica hierochuntica L.	Brassicaceae	SA	AH	N	1	5
Anchusa arvensis (L.) Bieb.	Boraginaceae	SA+SZ+IND+IT+ES	PH	N	1	5
Anisosciadium lanatum Boiss.	Apiaceae	SA	AH	N	4	20
Anthemis arvensis L.	Asteracea	SA	AH	N	1	5
Anthemis deserti Boiss		SA+ME	AH	N	7	35
Anthemis melampodina Del.		SA+ME	AH	N	3	15
Anthemis zoharyana Eig		SA	AH	N	1	5
Anvillea garcinia (Burm.f.) DC.		SA	Shlet	N	10	50
Arnebia decumbens (Vent.) Coss. & Kralik	Boraginaceae	SA+SZ	AH	N	3	15
Arnebia hispidissima (Lehm.) A.DC.		SA-SZ	A or PH	N	2	10
Arnebia linearifolia A.DC.		IT	AH	N	2	10
Artemisia monosperma Del.	Asteraceae	SA-SI+ME+IT	Shlet	N	4	20
Asphodelus fistulosus var. *tenuifolius* Cav.	Asphodelaceae	ME	PH	N	2	10
Astragalus sieberi DC.	Fabaceae	SA-SI	Shlet	N	2	10
Astragalus spinosus (Forssk.) Muschl.		SA-SI +IT	Sh	N	6	30
Atractylis carduus (Forssk.) C.Christ	Asteraceae	SA-SI	AH	N	1	5
Atractylis mernephtae Asch., Schweinf. & Letourne.		SA-SI	AH	N	1	5
Atriplex halimus L.	Chenopodiaceae	SA + SZ	Sh	N	1	5
Atriplex leucoclada Boiss.		SA+SZ+IT	PH	N	2	10
Bassia eriophora (Schrad.) Asch.		SA-SI +IT	AH	N	10	50
Bassia muricata (L.) Asch.		SA+SA-SI +IT	PH	N	4	20
Blepharis ciliaris (Forssk.) Pers.	Acanthaceae	SA + SZ	PH	N	2	10
Bromus madritensis L.	Poaceae	ME+IT	AG	N	1	5
Cakile arabica Velen & Bornm	Brassicaceae	SA+IT	AH	N	1	5
Calendula arvensis L.	Asteraceae	PAN	AH	AL	3	15
Calligonum comosum L'Hér.	Polygonaceae	SA-IT	Sh	N	1	5
Calotropis procera (Ait.)	Asclepiadaceae	SA	PH	N	7	35

Table 3. (Cont'd.).

Species	Family	Chorotype	Habit	Nativness	Sum	
					20	F%
Capparis cartilaginea Decne.	Capparaceae	SZ	PH	N	7	35
Capparis decidua (Forssk.) Edgew.		SA+SZ	Sh	N	1	5
Carthamus oxyacantha M.Bieb.	Asteraceae	IT	AH	N	1	5
Cassia italica	Fabaceae	SZ + SA-SI	AH	N	6	30
Caylusea hexagyna (Forssk.) M.L. Green	Resedaceae	SA + SZ	AH	N	3	5
Cenchrus ciliaris L.	Poaceae	SA+SZ+IT	PG	N	9	45
Cenchrus echinatus L.		AM	PG	AL	2	10
Centaurea pseudosinaica Czerp.	Asteraceae	SA	AH	AL	3	15
Chenopodium album L.	Chenopodiaceae	Cosm	AH	N	1	5
Chenopodium ambrosioides L.		Cosm	AH	AL (south America)	1	5
Chenopodium murale L.		Cosm	AH	AL	10	50
Chloris barbata Swartz	Poaceae	IT	AG	N	1	5
Chrozophora oblongifolia (Delile) A.Juss. ex Spreng.	Euphorbiaceae	SZ	PH	N	1	5
Chrozophora tinctoria (L.) Raf.		SA+ME	AH	N	3	15
Chrysanthemum coronarium L.	Asteraceae	SA+ME	AH	N	2	10
Citrullus colocynthis (L.) Schrad.	Cucurbitaceae	SA	PH	N	12	60
Cleome amblyocarpa Barratte & Murb	Capparaceae	SA+SZ	AH	N	9	45
Cleome arabica L.		SA+IT	PH	N	9	45
Cleome noeana Boiss.		SA+SZ+IT	AH	N	1	5
Cocculus pendulus (J.R.Forst. & G.Forst.) Diels	Menispermaceae	SZ	PH	N	1	5
Convolvulus arvensis L.	Convolvulaceae	Cosm.	PH	N	7	35
Convolvulus austro aegyptiacus var. *cancerianus* (Abdullah & Sa'ad) Alfarhan		SA	PH	N	3	15
Convolvulus cephalopods Boiss.		SA	PH	N (Endemic)	1	5
Convolvulus glomeratus Choisy		SA-SI+ IT	PH	N	1	5
Convolvulus oxyphyllus ssp. Oxycladus Rech.f.		SA-SI +IT	Sh	N	3	15
Convolvulus piloselifolius Desr.		SA+IT	PH	N	3	15
Conyza bonariensis (L.) Cronq.	Asteraceae	SA+SZ	PH	AL	2	10
Cornulaca aucheri Moq.	Chenopodiaceae	SA+SZ+IND	AH	N	1	5
Cressa cretica L.	Convolvulaceae	ME+IT	PH	N	1	5
Cynodon dactylon (L.) Rasp.	Poaceae	Cosm	PG	AL	11	55
Cyperus alternifolius L.	Cyperaceae	SA + SZ	PH	N	2	10
Cyperus conglomeratus Rottb.		SA	PH	N	2	10
Cyperus rotundus L.		Cosm.	PH	AL	1	5
Datura innoxia Mill.	Solanaceae	AM	PH	AL	2	10
Diplotaxis acris (Forssk.) Boiss.	Brassicaceae	SA-SI	AH	N	3	15
Diplotaxis harra (Forssk.) Boiss.		SA-SI	AH	N	3	15
Dipterygium glaucum Decne.	Capparaceae	SZ	PH	AL	1	5
Dodonaea angustifolia (L.) Jacq.	Sapindaceae	PAN	Sh	N	4	20
Ducrosia anethifolia Asch.	Umbelliferae	SA+SZ+IT	PH	N	4	20
Echinochloa colona (L.) Link	Poaceae	ME+IT	AG	N	1	5
Echium rauwolfia Del.	Boraginaceae	SA	AH	N	3	15
Eclipta prostrata (L.) L.	Asteraceae	PAN	AH	AL	1	5
Eleusine indica (L.) Gaertn.	Poaceae	Trop.	AG	N	1	5

Table 3. (Cont'd.).

Species	Family	Chorotype	Habit	Nativness	Sum	
					20	F%
Emex spinosa (L.)	Polygonaceae	SA+ME+ IT	AH	AL	1	5
Eragrostis barrelieri Dav.	Poaceae	SA+SZ+ME + IT	AG	N	3	15
Eremobium aegyptiacum (Spreng.) Ascher & Schweinf ex. Boiss	Brassicaceae	SA-SI	AH	N	6	30
Erodium glaucophyllum (L.) L'Hér.		SA-SI +IT	PH	N	1	5
Erodium laciniatum (Cav.) Willd.	Geraniaceae	SA-SI + IT + M	AH	N	1	5
Erodium oxyrhynchum M.Bieb.		PAN	AH	N	1	5
Erucaria hispanica (L.)	Brassicaceae	SA+SZ+ME+IT	AH	N	1	5
Euphorbia hirta L.		AM	AH	AL (Southern and Central USA)	1	5
Euphorbia indica Lam.		SA+IT+ES+IND.	AH	N	1	5
Euphorbia retusa Forssk.	Euphorbiaceae	SA	AH	N	4	20
Euphorbia schimperiana Scheele		SA + SZ	PH	N	2	10
Euphorbia serpens Kunth		AM	AH	AL (North America)	1	5
Euryops arabicus Steud. ex Jaub. & Spach	Asteraceae	SA+SZ	Sh	N	2	10
Fagonia olivieri DC.	Zygophyllaceae	SA+IT	AH	N	1	5
Fagonia arabica L.		SA-SI	PH	AL	1	5
Fagonia bruguieri DC.		SA-SI	PH	AL	7	35
Fagonia indica Burm.f.		SA	PH	AL	9	45
Farsetia aegyptia Turra		SA-SI	PH	N	4	20
Farsetia burtoniae Oliver	Brassicaceae	SA	AH	N	1	5
Farsetia longisiliqua Decne.		SZ	PH	N	5	25
Farsetia stylosa R.Br.		SZ	AH	AL	3	15
Ficus carica L.	Moraceae	SZ+SA-SI	T	N	2	10
Ficus palmata Forssk.		SA+SZ+ME	PH	N	1	5
Forsskoalea tenacissima L.	Urticaceae	SA+SZ	PH	N	8	40
Glossonema varians (Stocks) Benth. ex Hook.f.	Asclepiadaceae	SA+SZ	PH	N	1	5
Haloxylon salicornicum (Moq.) Bunge	Chenopodiaceae	IT	Sh	N	6	30
Haplophyllum tuberculatum (Forssk.) A.Juss.	Rutaceae	SA	PH	N	2	10
Helianthemum lippii (L.) Dum. Cours.	Cistaceae	SA-SI+ME+IT	Shlet	N	1	5
Heliotropium bacciferum Forssk.		SA+SZ	PH	N	8	40
Heliotropium crispum Desf.		SA+IT	PH or small sh	N	2	10
Heliotropium curassavicum L.	Boraginaceae	AM	PH	AL	1	5
Heliotropium digynum Asch. ex C.Chr.		SA	Shlet	N	6	30
Heliotropium pterocarpum (Hochst. & Steud.) Jaub & Spach		SA + SZ	AH	N	1	5
Horwoodia dicksoniae Turrill	Brassicaceae	SA	AH	N	6	30
Ifloga spicata (Forssk.) Sch.Bip.	Asteraceae	SA-SI+ME+IT	AH	N	3	15
Imperata cylindrica (L.) Raeusch.	Poaceae	ME+IT	PG	N	1	5
Juniperus procera Hochst. ex Endl.	Cuperessaceae	ME	T	N	4	20
Koelpinia linearis Pallas.		SA-SI+ME+IT	AH	N	2	10
Lactuca saligna L.	Asteraceae	Cosm.	AH	N	1	5
Lactuca serriola L.		ME	AH	N	6	30
Lasiurus scindicus Henrard	Poaceae	SZ+SA-SI	PH	N	3	15

Table 3. (Cont'd.).

Species	Family	Chorotype	Habit	Nativness	Sum	
					20	F%
Launaea angustifolia (Desf.) Kuntze	Asteraceae	SA	AH	N	1	5
Launaea capitata (Spreng.) Dandy		SA	AH	N	6	30
Launaea mucronata (Forssk.) Muschl.		SA	AH	AL	7	35
Launaea nudicaulis (L.) Hook.f.		SA	AH	N	7	35
Lavandula dentata L.	Lamiaceae	IT	Sh	N	1	5
Lavandula pubescens Decne.		SA + SZ	Sh	N	3	15
Leontodon laciniatus (Bertol.) Widder	Asteraceae	SA-SI+ME	AH	N	2	10
Lepidium aucheri Boiss.	Brassicaceae	IT	AH	N	2	10
Lepidium sativum L.		SA	AH	N	1	5
Leptadenia pyrotechnica (Forssk.) Decne	Asclepiadaceae	SA+SZ	Sh	N	1	5
Lolium rigidum Gaud.	Poaceae	ME+IT	AG	N	2	10
Lycium shawii Roem. & Schult.	Solanaceae	SA+SZ	Sh	N	5	25
Malva parviflora L.	Malvaceae	ME+IT	AH	AL	10	50
Medicago sativa L.	Fabaceae	ES+ME+IT	PH	N	2	10
Melilotus indicus (L.) All.		SA+IT	AH	N	8	40
Mentha longifolia (L.) L.	Lamiaceae	SZ+SA-SI	AH	N	5	25
Moltkiopsis ciliata (Forssk.) I.M. Johnst.	Boraginaceae	SA	Shlet	N	2	10
Monsonia nivea (Decne.) Webb	Geraniaceae	SA+SA-SI	PH	N	2	10
Moricandia sinaica (Boiss.)	Brassicaceae	SA+SZ+IT	AH	N.	5	25
Moringa oleifera Lam.	Moringaceae	SZ+SA-SI+IT	T	AL	1	5
Neurada procumbens L.	Neuradaceae	Cosm	AH	N	3	15
Ochradenus baccatus Del.	Resedaceae	SA	PH	N	9	45
Ochradenus arabicus Chaudhary, Hillc. & A.G.Mill.		SA	Sh	N	2	10
Oligomeris linifolia (Vahl ex Hornem.) J.F. Macbr.		ME+IT	PH	N	2	10
Onobrychis ptolemaica (Delile) DC.	Fabaceae	SZ	PH	N	1	5
Osteospermum vaillantii (Decne.) Norlindh as	Asteraceae	SA	AH	N	1	5
Otostegia fruticose (Forssk.) Schweinf	Lamiaceae	SA	Sh	N	1	5
Panicum coloratum L.	Poaceae	Trop.	PG	N	6	30
Panicum turgidum Forssk.		SA+SZ	PG	AL	1	5
Parkinsonia aculeata L.	Fabaceae	AM	PH	Al (tropical America)	1	5
Paronychia arabica (L.) DC.	Caryophyllaceae	SA	AH	N	4	20
Peganum harmala L.	Zygophyllaceae	SA-SI +IT	PH	N	2	10
Pennisetum orientale L. C.Rich.	Poaceae	SA+IT	PG	N	1	5
Pennisetum setaceum (Forssk.) Chiov.		SA+SZ	PG	N	8	40
Pergularia tomentosa L.	Asclepiadaceae	SA+SZ	PH	N	5	25
Phalaris minor Retz.	Poaceae	ME+IT	AG	N	5	25
Phragmites australis (Cav.) Trin. & Steudel		Cosm	PG	AL	4	20
Picris babylonica Hand-Mazz.	Asteraceae	SA+IT	AH	N	7	35
Picris cyanocarpa Boiss.		SA	AH	AL	4	20
Picris damascene Boiss. & Gail		SA	AH	N	1	5
Picris longirostris Sch. Bip.		SA+IT	AH	N	1	5

Table 3. (Cont'd.).

Species	Family	Chorotype	Habit	Nativness	Sum	
					20	F%
Plantago albicans L.	Plantaginaceae	SA+IT	PH	N	5	25
Plantago amplexicaulis Cav.		SA-SI+ME+IT	AH	N	6	30
Plantago boissieri Hausskn. & Bornm.		ME	AH	N	6	30
Plantago ciliate Desf.		SA+IT	AH	N	4	20
Plantago lanceolata L.		SA-SI+ME	PH	N	1	5
Plantago ovata Forssk.		SA-SI +IT	AH	N	5	25
Pluchea dioscoridis (L.) DC.	Asteraceae	SA+SZ	Shlet	N	1	5
Polycarpaea repens (Forssk.) Asch. & Schweinf.	Caryophyllaceae	SA-IT	PH	N	1	5
Polygonum argyrocoleun Steud. ex Kunze	Polygonaceae	IT	PH	N	3	15
Polygonum equisetiforme Sibth &Sm.		ME+IT	AH	AL	1	5
Polypogon monspeliensis (L.) Desf.		ES+ME+IT	AG	N	5	25
Portulaca oleracea L.	Portulacaceae	Cosm	AH	AL	3	15
Prosopis juliflora (Sw.) DC.	Fabaceae	SA+AM	T	AL	2	10
Pteranthus dichotomus Forssk.	Caryophyllaceae	SA+ME+ IT	AH	N	1	5
Pulicaria glutinosa (Boiss.) Jaub. & Spach	Asteraceae	SA + SZ	Shlet	N	6	30
Pulicaria undulata (L.) C.A. Mey		SA+SZ	Shlet	N	13	65
Reseda arabica Boiss.	Resedaceae	SA-SI	AG	N	2	10
Reseda muricata C. Presl		SA + SZ	PH	N	2	10
Rhanterium epapposum Oliv.	Asteraceae	SA	Shlet	N	11	55
Rhayza stricta Decne.	Apocynaceae	SA+SZ	PH	N	12	60
Rhynchosia malacophylla (Spreng.) Boj.	Fabaceae	Trop.	PH	AL	1	5
Ricinus communis L.	Euphorbiaceae	IT	Sh	N	3	15
Rostraria cristata (L.) Tzvelev	Poaceae	ME+IT	AG	N	1	5
Rostraria pumila (Desf.) Tzvelev		SA-SI +ME+ IT	AG	N	1	5
Rumex dentatus L. Mant.	Polygonaceae	ES+ME+IT	AH	N	2	10
Rumex vesicarius L.		SA	AH	N	13	65
Ruta chalepensis L.	Rutaceae	ME+IT	AH	AL	5	25
Salicornia europaea L.	Chenopodiaceae	SA+ME+IT+CB	AH	AL	1	5
Salix acmophylla Boiss. Diag.	Salicaceae	ME+IT	T	N	4	20
Salsola imbricata (Schult.) Dandy	Chenopodiaceae	SZ+SA-SI	Shlet	AL	7	35
Salvadora persica L.	Salvadoraceae	SA+SZ+ME + IT	PH	N	2	10
Salvia aegyptiaca L.	Lamiaceae	SA+ SZ	PH	N	1	5
Salvia spinosa L.		ME+IT	PH	N	1	5
Savignya parviflora (Delile) Webb	Brassicaceae	SA-SI	AH	N	8	40
Scabiosa olivieri Coult.	Dipsacaceae	IT	AH	N	1	5
Schimpera arabica Hochst. & Steud.	Brassicaceae	SA-SI	AH	N	7	35
Schismus arabicus Nees	Poaceae	SA+ME+ IT	AH	N	2	10
Sclerocephalus arabicus Boiss.	Caryophyllaceae	SA+IT	AH	N	3	15
Scorzonera musilii Velen.	Asteraceae	SA	PH	N	4	20
Scrophularia deserti Del.	Scrophulariaceae	SA-SI	Sh	N	3	15
Seetzenia lanata (Willd.) Bullock	Zygophyllaceae	SA+SZ+SA-SI	PH	AL	1	5
Seidlitzia rosmarinus Bunge	Chenopodiaceae	SA+IT	Sh	N	1	5
Senecio flavus (Decne.) Sch. Bip.	Asteraceae	SA + SZ	AH	N	1	5

Table 3. (Cont'd.).

Species	Family	Chorotype	Habit	Nativness	Sum	
					20	F%
Senecio glaucus L.		SA-SI + IT	AH	N	4	20
Senna occidentalis (L.) Link	Fabaceae	AM.	PH	AL	1	5
Setaria verticillata (L.) P. Beauv.	Poaceae	Cosm	AG	N	3	15
Silene yemensis Defl.	Caryophyllaceae	SA+SZ	PH	N	1	5
Sisymbrium erysimoides Desf.	Brassicaceae	SA+SZ+ME	AH	N	1	5
Sisymbrium irio L.		SA-SI	AH	N	10	50
Solanum incanum L.	Solanaceae	SZ	Sh	N	1	5
Solanum nigrum L.		ME+IT	AH	AL	5	25
Sonchus tenerrimus L.		Cosm	AH	N	6	30
Sonchus oleraceus (L.) L.	Asteraceae	ME+IT	AH	AL	8	40
Sonchus saudensis Boulos		SA	PH	N	1	5
Sorghum halepense (L.) Pers.	Poaceae	Trop.	PG	N	1	5
Spergularia diandra (Guss.) Heldr & Sart	Caryophyllaceae	ES+ME+IT	AH	N	1	5
Stipa capensis Thunb.		SA+SZ	AG	AL	6	30
Stipagrostis ciliata (Desf.) De Wint.	Poaceae	SA+ME+ IT	PG	N	1	5
Stipagrostis obtuse (Del.) Nees		SA+SZ	PG	N	1	5
Stipagrostis plumosa Munro ex T. Anders.		SA+SZ	PG	N	5	25
Tamarix aphylla (L.) Karst.	Tamaricaceae	SZ	PH	N	2	10
Tamarix nilotica (Ehrenb.) Bunge		SA	PH	N	3	15
Tephrosia purpurea (L.) Pers.	Fabaceae	SA+ IT	PH	N	1	5
Tetrapogon cenchriformis (A.Rich.) Clayton	Poaceae	SA	AG	N	1	5
Tetrapogon villosus Desf.		SZ+SA-SI+IT	PG	N	1	5
Teucrium oliverianum Ging. ex Benth.	Lamiaceae	Cosm	Shlet	N	5	25
Teucrium polium L.		SA-SI+ME+IT	Sh	N	1	5
Tribulus macropterus Boiss.	Zygophyllaceae	SZ	Sh	N	2	10
Tribulus terrestris L.		SZ+ME	AH	N	6	30
Trichodesma africanum (L.) R.Br	Boraginaceae	SA	AH	N	6	30
Trigonella hamosa Del. ex Smith	Fabaceae	SA	AH	N	9	45
Tripleurospermum auriculatum (Boiss.) Rech.f.	Asteraceae	SA	AH	N	11	55
Urospermum picroides (L.) Scop.		SA-SI+ME+IT	AH	N	3	15
Urtica urens L.	Urticaceae	Cosm	AH	N	1	5
Verbesina encelioides (Cav.) Benth. & Hook.	Asteraceae	AM	AH	AL	1	5
Withania somnifera (L.) Dun.	Solanaceae	ME+IT	Sh	N	2	10
Xanthium strumarium L.	Asteraceae	Cosm.	AH	AL	1	5
Zilla spinosa (L.) Prantl	Brassicaceae	SA+SA-SI	Shlet	N	9	45
Ziziphus nummularia (Burm.f.) Wight & Arn.	Rhamnaceae	SA+IT+IND	Sh	N	3	15
Ziziphus spina-christi var. *inermis* (L.) Willd.		SA+SZ	T	N	4	20
Zygophyllum coccineum L.		SA	Shlet	N	7	35
Zygophyllum simplex L.	Zygophyllaceae	SA	AH	N	3	15
Zygophyllum propinquum ssp. Migahidii (Hadidi) J. Thomas & Chaudhary		SA-SI	Shlet	N	1	5

AH: annual herb, AG: annual grass, AL: alien, Aus: Australian, AM.: American, CB: Circumboreal Cosm: Cosmopolitan, E: endemic, ES: eastern Asiatic, IND: Indian, IT: Irano-Turanian, ME: Mediterranean, N: native, PG: perennial grass, PAN: Pantropical, PH: perennial herb Shlet: shrublet, Sh: Shrub, SA: Saharo-Arabian, SI: Saharo-Sindian, SZ: Sudano-Zambezian, SU: Sudanian, T: tree, Trop: Tropical

(Pysek *et al*., 2017) used the novel database Global Naturalized Alien Flora (GIoNAF) version 1.1, which covers ~83% of the Earth's land surface (which was compiled between 2011–2015 by the GloNAF core team (WD, FE, HK, JP, PP, MvK, PW and MW)(Pyšek *et al*., 2017) as a source for the number of the naturalized alien species. GloNAF 1.1 includes naturalized alien plant species inventories for 844 non-overlapping regions of the world, including infraspecific and hybrid taxa (see Van Kleunen *et al*., 2015 for more information on database compilation and Electronic Appendix 1 for further information). We found some confusion between our data and the data recently published (Alharthi *et al*., 2023a) where they considered some species as alien but the (GIoNAF, 2023) revealed them as native such as *Citrullus colocynthis* (L.) and *Cenchrus ciliaris* L. they considered them as alien but the database revealed them as native to Saudi Arabia, in addition the distribution of both of them is included in Saharo-Arabian region as shown in (Table 3).

In addition to providing a preliminary evaluation of these plants' status and characteristics, this works the first thorough compilation and analysis of all records on alien plant taxa in KSA herbaria has also identified knowledge gaps about the geographic distribution and life form. We believe that our findings will raise environmental awareness about invasive species in Saudi Arabia and, more importantly, that they will spur and direct additional research on this topic in Saudi Arabia, particularly field-oriented studies. No management strategy can be created without a solid understanding of the issue.

Conclusion

Herbaria are yet underused establishments. Also, they are somewhat in danger of extinction globally because of the decline and datedness of plant collecting. Also, it is noted that this trend is generally exacerbated by a decline in interest in plant taxonomy, which has led to the closure of herbaria at various universities in recent years. These tendencies are concerning because they will make it difficult to understand and model biological invasion processes in the future and will substantially impede future historical reconstructions of such events. Nevertheless, as our analysis demonstrates, invasive plants are excluded from this tendency since they have instead become a topic of interest.

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