

## Research Article

## Present status and distribution of naturalized plants in the island regions of the South Korea

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### Abstract

Studies have reported a total of 326 naturalized plant species in the South Korea; however, research on the distribution of naturalized plants across the island regions has not been conducted. The objectives were to analyse the distribution of naturalized plants in these island regions, which is an ecologically vulnerable space. A total of 113 islands – 53 inhabited and 60 uninhabited – with > 100 native species were selected for this study, and a list of 321 naturalized species was compiled based on available literature. The relative frequency of occurrence and ratio of naturalized plants to native plants was calculated for each species. There were 184 species of naturalized plants found distributed in the island regions, 10 of which are invasive. Four species had high relative frequencies of occurrence (> 0.5) but accounted for only 2.2% of naturalized plants in the regions. All islands shared 15 of the 20 most common species, but the remaining five were specific to individual islands. This approach shows promise for future monitoring of the naturalized species distribution. Currently, the Korean government (Ministry of Environment) has established the second invasive species management plan at the national level (2019–2023). Species that have not yet been introduced to South Korea and those that have already migrated and have settled are managed separately. Because island areas are geographically isolated, the impact on existing native plants may be more extreme than on land if exotic plants are introduced. In this regard, the importance of managing the island area is further emphasized.

**Key words:** naturalization, phytogeography, flora of naturalized plant, island area, invasive species

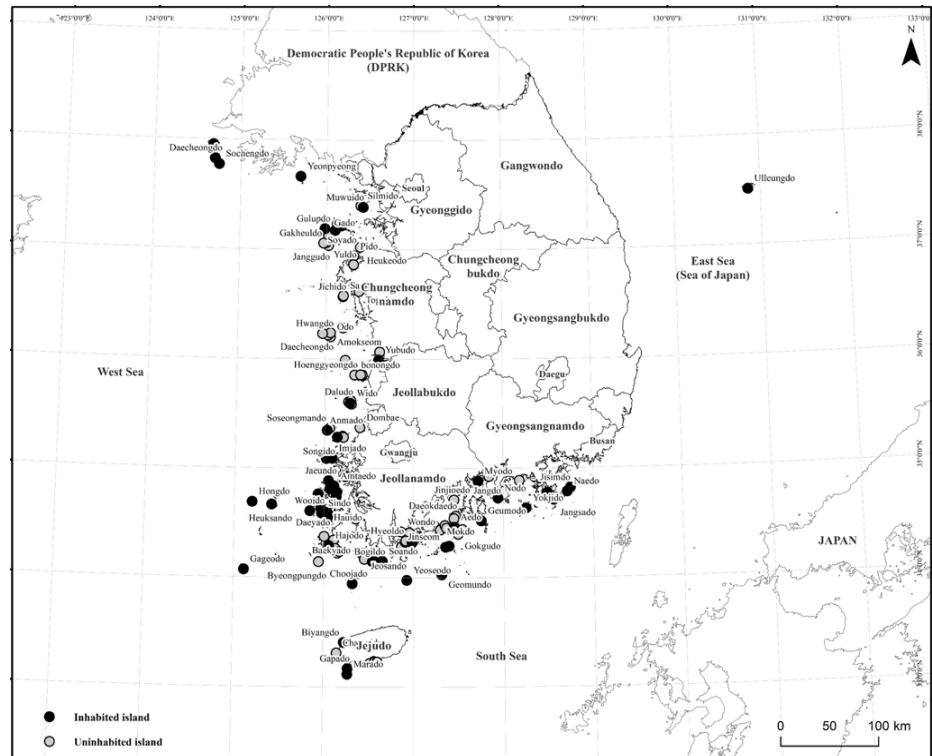
### Introduction

Naturalized plants are plant species that have moved from their natural habitat to another phytogeographic region due to human intervention and have survived independently in the new area (Yim and Jeon 1980; Ryu et al. 2017). Naturalized plants, which enter and settle in environments outside of their natural habitat, begin to exist when biotic and abiotic barriers are overcome and general reproduction of the species continues (Richardson et al. 2000). Today, international and regional travel is rapid and takes various forms; therefore, plant species that were limitedly native to a specific area are being spread around the world intentionally or accidentally by humans.

In the case of the South Korea, the distribution of 27 families and 110 species of naturalized plants was confirmed in a 1980 study on the distribution of naturalized plants, conducted in 200 locations across South Korea (Yim and Jeon 1980). Subsequently, an additional 40 families and 321 species were reported from other studies (Lee et al. 2011). More recently, 151 previous studies were analyzed, and a total of 39 families and 326 species of naturalized plants were reported in the South Korea (Ryu et al. 2017). Thus, it is surmised that more than 200 additional species of naturalized plants were introduced and have settled in the South Korea between 1980 and 2017. According to data from the Korea Forest Service, 100 species were introduced from the late 19th century until 1964, when full-scale domestic plant research began, and 221 species were introduced after 1964 (Korea National Arboretum 2021). The 1960s was a time when South Korea's economy began to grow rapidly, and an overwhelmingly large number of foreign plants were introduced in South Korea. Since the 1980s, international trade and migration have increased following the quantitative growth of the national economy, and there have been many opportunities for plants that do not grow in Korea to be introduced.

Research on naturalized plants in the 3,500 islands of the South Korea is lacking compared to research on the mainland. Numerous studies have been conducted on the local flora of the island regions, but there are limited studies on naturalized plants. Studies have been conducted on some island areas, including biogeographic studies on the distribution of naturalized plants in uninhabited islands of the South Korea, naturalized plant studies in the Jeollanam-do island region, Dadohaejaesang National Park, Jeju-do, Imja-do, Dok-do, and Ulleung-do, among others, but studies on all of the island regions of the South Korea have yet to be conducted (Chung and Hong 2006; Kim et al. 2017; Kim and Oh 2010; Yang et al. 2001; Kim et al. 2006; Lim et al. 2009; Kil et al. 2006). Furthermore, as most studies have merely investigated whether naturalized plants are present, phytogeographic studies that comprehensively analyze the regions are still lacking.

It is difficult to predict how newly introduced vegetation will affect the existing plant ecosystem in an island region that is geographically isolated and has a physically unfavorable environment, such as strong winds and insufficient surface water. If competition for space between the newly introduced naturalized plants and existing native plants occurs, there is a high possibility that the size of the native plant community in the island area will be reduced. Therefore, discussing the present status and distribution of naturalized plants in these island regions can provide useful basic information for the maintenance and preservation of the equilibrium in ecological communities as well as the conservation of the existing habitats of native plants that grow in the island regions. Thus, the main objective of this study was to analyze and discuss the distribution of naturalized plants in the island regions over a more comprehensive spatial range, looking at several representative islands throughout the South Korea.



**Figure 1.** Study area.

## Materials and methods

### *Study area*

There are about 3,348 islands in the South Korea, excluding North Korean territories. There were 472 inhabited islands as of 2017, accounting for about 14.1% of entire islands (Korea Maritime Institute 2017). In this study, a total of 113 islands were ultimately selected as research areas, of which 53 were inhabited, and 60 were uninhabited. By region, 15 islands are in Gyeonggi-do, 13 islands in Chungcheongnam-do, 8 islands in Jeollabuk-do, 59 islands in Jeollanam-do, 9 islands in Gyeongsang-do, and 9 islands in Jeju-do (Figure 1).

### *Study methods*

This study attempted to analyze and characterize the distribution of naturalized plants in major island regions of the South Korea. To this end, literature on flora, including research papers, government reports, and books published in academic circles since 2000 were obtained, and a list was compiled (Supplementary material Appendix 1). The reason for choosing research data published after 2000 is to analyze the flora data that reflects the current situation relatively well. To ensure the reliability of the research data, research papers that collected plant specimens were given priority, and research results reviewed by three or more researchers considered experts in the field were cited. Next, flora data were organized into one unified raw dataset to be used as the basis for analysis. There was no distinction between native plants and naturalized plants in the original

flora data. We rearranged the flora data by dividing them into native plants and naturalized plants for analysis.

Islands with more than 100 species of native plants were targeted as study locations to minimize the distortion of data by specific plants. Islands that have been connected to the mainland with bridges for more than ten years were excluded. According to South Korea's Islands Development Promotion Act (Act No. 14839), areas that have been connected to the mainland for more than ten years are no longer designated as islands. Furthermore, Jeju-do, an overwhelmingly large island, was also excluded from this study because it is not classified as an island. After applying these conditions, a total of 113 islands were ultimately selected for this study, 53 of which were inhabited and 60 of which were uninhabited.

To compare the distribution status of naturalized plants by island region, the relative frequency of occurrence (RFO) and ratio of naturalized plants to native plants (RNN) were calculated. The RFO is the number of islands in which a specific naturalized plant is distributed compared to the total number of islands (Eq. 1). The RNN is the number of naturalized plant species compared to the number of native plant species on a specific island, expressed as a percentage (Eq. 2). This concept was applied to the study of Yim (1980), the first comprehensive study on naturalized plants in South Korea. It can also be found in some studies of naturalized plants reported in South Korea and Japan (Hattori et al. 1996; Hashimoto et al. 2007; Park et al. 2007). Although not directly, the study of Sax and Gaines (2008) also compared naturalized plants with existing native plants. And the RNN of inhabited and uninhabited islands were compared through independent samples T-test. The present status of the island regions and the ratio of naturalized plants to native plants by region were mapped using ArcGIS 10.3.

RFO: Number of islands with the specific plant  $\div$  Total number of islands (Eq. 1)

RNN (%): (Number of naturalized plant species  $\div$  number of native plant species)  $\times$  100 (Eq. 2)

## Results

### *Flora of naturalized plants on the islands*

There are a total of 32 families and 184 species of naturalized plants distributed across 113 major island areas (53 inhabited and 60 uninhabited islands), where more than 100 species of native plants are also distributed. This accounts for 57.3% of the 321 species of naturalized plants in the South Korea. Of these, Asteraceae (48 species), Gramineae/Poaceae (32 species), Fabaceae (16 species), and Brassicaceae (10 species) accounted for 57.9% of the total. Most of them are herbaceous, and only three species are woody plants (*Amorpha fruticosa*, *Robinia pseudoacacia* and *Ailanthus altissima*).

**Table 1.** 184 naturalized plants and RFO in 113 island areas in the South Korea (items in bold indicate legally designated invasive species).

**0.5 or more (4 species)**

*Rumex crispus*, *Erigeron sumatrensis*, *Bidens frondosa*, *Erigeron annuus*

**0.4 or more (10 species)**

*Galinsoga ciliata*, *Ipomoea purpurea*, *Panicum dichotomiflorum*, *Phytolacca americana*, *Aster subulatus* var. *sandwicensis*, *Gnaphalium calviceps*, *Dactylis glomerata*, *Robinia pseudoacacia*, *Erechtites hieracifolia*, *Viola papilionacea*

**0.3 or more (6 species)**

*Lepidium apetalum*, *Poa pratensis*, *Trifolium repens*, *Chloris virgata*, *Festuca arundinacea*, *Bromus mollis*

**0.2 or more (17 species)**

*Diodia teres*, *Achillea millefolium*, *Fallopia dumetorum*, *Taraxacum officinale*, *Conyza bonariensis*, *Brassica juncea*, *Chrysanthemum leucanthemum*, *Lepidium virginicum*, *Bromus rigidus*, *Thlaspi arvense*, *Conyza canadensis*, *Phytolacca esculenta*, *Chenopodium ficifolium*, *Amorpha fruticosa*, *Euphorbia supina*, *Cuscuta pentagona*, *Sonchus oleraceus*

**0.1 or more (32 species)**

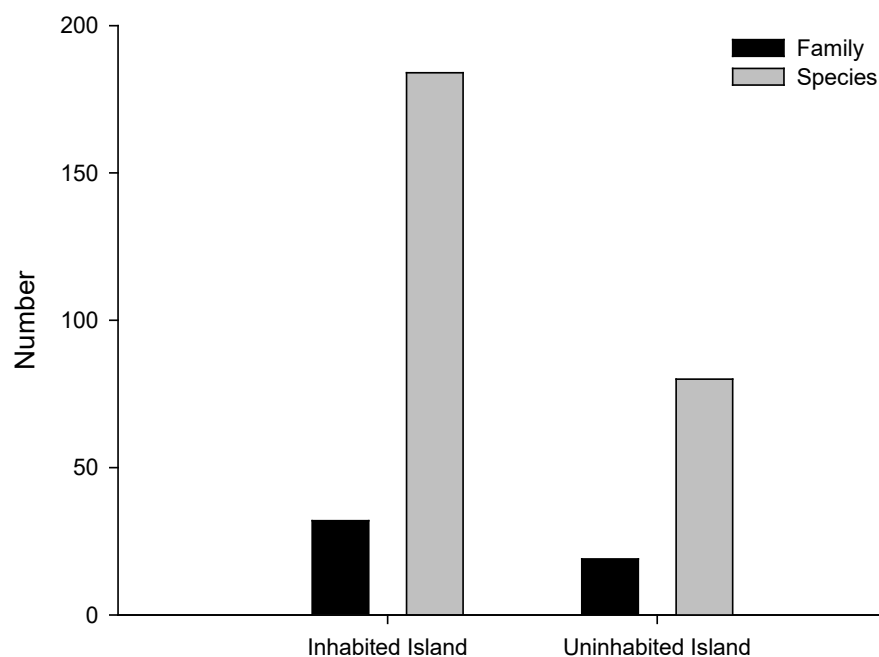
*Rumex acetosella*, *Ambrosia artemisiifolia*, *Chenopodium album*, *Sonchus asper*, *Medicago polymorpha*, *Oenothera biennis*, *Avena fatua*, *Helianthus tuberosus*, *Senecio vulgaris*, *Veronica arvensis*, *Avena sativa*, *Melilotus suaveolens*, *Symphytum officinale*, *Festuca myuros*, *Polygonum orientale*, *Amaranthus lividus*, *Datura stramonium*, *Datura stramonium* var. *chalybaea*, *Veronica persica*, *Xanthium strumarium*, *Lolium perenne*, *Cerastium glomeratum*, *Amaranthus retroflexus*, *Abutilon theophrasti*, *Rudbeckia bicolor*, *Chenopodium glaucum*, *Medicago lupulina*, *Hibiscus trionum*, *Physalis angulata*, *Cosmos bipinnatus*, *Crassocephalum crepidioides*, *Briza minor*

**Less than 0.1 (115 species)**

*Trifolium pratense*, *Oenothera erythrosepala*, *Aster subulatus*, *Coreopsis lanceolata*, *Bromus unioloides*, *Astragalus sinicus*, *Malva neglecta*, *Carduus crispus*, *Atriplex hastata*, *Ipomoea hederacea*, *Tradescantia reflexa*, *Bromus tectorum*, *Amaranthus patulus*, *Ailanthus altissima*, *Ipomoea hederacea* var. *integriuscula*, ***Solanum carolinense***, *Eclipta alba*, *Galinsoga parviflora*, *Bromus secalinus*, *Fallopia convolvulus*, *Silene armeria*, *Chenopodium ambrosioides*, *Amaranthus viridis*, *Potentilla supina*, *Oxalis articulata*, *Malva sylvestris* var. *mauritanica*, *Veronica hederifolia*, *Bidens pilosa*, *Rumex obtusifolius*, *Medicago sativa*, *Oenothera laciniata*, *Quamoclit coccinea*, *Plantago lanceolata*, ***Hypochaeris radicata***, ***Lactuca scariola***, *Tritonia x crocosmiiflora*, *Agropyron repens*, *Sorghum halepense*, *Fallopia dentatoalata*, *Rumex nipponicus*, *Silene gallica*, *Houttuynia cordata*, *Coronopus didymus*, *Oxalis corymbosa*, ***Sicyos angulatus***, ***Aster pilosus***, *Centaurea cyanus*, *Coreopsis tinctoria*, *Cosmos sulphureus*, *Lapsana communis*, *Tagetes minuta*, *Xanthium canadense*, *Eragrostis curvula*, *Festuca megalura*, *Papaver rhoeas*, *Sisymbrium officinale*

*Medicago minima*, *Vicia villosa*, *Ipomoea lacunosa*, *Scutellaria baicalensis*, *Solanum americanum*, *Taraxacum laevigatum*, *Zephyranthes candida*, *Festuca pratensis*, *Lolium multiflorum*, *Parapholis incurva*, *Paspalum dilatatum*, *Poa compressa*, *Amaranthus hybridus*, *Celosia argentea*, *Camelina microcarpa*, *Trifolium dubium*, *Sida spinosa*, *Convolvulus arvensis*, *Lindernia dubia*, *Conyza parva*, *Erigeron strigosus*, *Gamochaeta purpurea*, *Helianthus debilis*, *Rudbeckia laciniata* var. *hortensis*, *Tragopogon dubius*, *Sisyrinchium angustifolium*, *Agropyron repens* f. *aristatum*, *Alopecurus pratensis*, *Catapodium rigidum*, *Phleum pratense*, *Spergularia arvensis*, *Spergularia rubra*, *Lepidium bonariense*, *Lepidium campestre*, *Neslia paniculata*, *Sedum mexicanum*, *Melilotus officinalis* subsp. *alba*, *Trifolium campestre*, *Trifolium incarnatum*, *Geranium carolinianum*, *Geranium dissectum*, *Euphorbia maculata*, *Sida rhombifolia*, *Anthriscus caucalis*, *Apium leptophyllum*, *Foeniculum vulgare*, *Diodia teres* var. *hirsutior*, *Ipomoea triloba*, *Quamoclit pennata*, *Datura meteloides*, ***Ambrosia trifida***, *Erigeron philadelphicus*, ***Eupatorium rugosum***, *Rudbeckia hirta*, *Verbesina alternifolia*, *Arrhenatherum elatius*, *Cenchrus logispinus*, *Panicum miliaceum*, ***Paspalum distichum***

The species with the broadest distribution range was *Rumex crispus*, with distribution reported in 95 of 113 islands. The RFO was 0.84. The next most widely distributed was *Erigeron sumatrensis* (70 islands, 0.62), *Bidens frondosa* (62 islands, 0.55), and *Erigeron annuus* (62 islands, 0.55), all with RFOs above 0.5. These top four species account for 2.2% of the 184 naturalized plant species distributed across the islands of the South Korea. There were 10 species (5.4%) with an RFO of 0.4 or more, 6 species (3.3%) with an RFO of 0.3 or more, 17 species (9.2%) with an RFO of 0.2 or more, 32 species (17.4%) with an RFO of 0.1 or more, and 115 species (62.5%) with an RFO of less than 0.1. Species distributed in less than 10 of the 113 islands (RFO less than 0.1) accounted for more than half of the total naturalized plants (Table 1).



**Figure 2.** Number of naturalized plant species on inhabited and uninhabited islands.

South Korea's Ministry of Environment classifies non-native plants that disturb or are likely to disturb the ecosystem of a specific region and genetically modified plants that disturb or are likely to disturb the ecosystem as invasive species and manages them through legislation (Act on the Conservation and Use of Biological Diversity 2014). A total of 16 species have been designated as invasive, as they are harmful to ecosystems and other organisms, including humans, because of their allelopathy, high fertility, ability to reproduce quickly, and generation of large amounts of pollen. A total of 10 invasive species (*Rumex acetosella*, *Sicyos angulatus*, *Solanum carolinense*, *Ambrosia artemisiifolia*, *Ambrosia trifida*, *Aster pilosus*, *Eupatorium rugosum*, *Hypochaeris radicata*, *Lactuca scariola*, *Paspalum distichum*) were found to be distributed on the islands of the South Korea in this study.

Overall, 32 families and 184 species of naturalized plants were distributed on 53 inhabited islands, and 19 families and 80 species of naturalized plants were distributed on 60 uninhabited islands. There were over 100 species of naturalized plants found distributed on inhabited islands but not on uninhabited islands (Figure 2). Of the 184 naturalized plants distributed on inhabited islands, one hundred and four species, or 56.5%, were not distributed on uninhabited islands, but all 80 species distributed on uninhabited islands were also distributed on inhabited islands. For both inhabited and uninhabited islands, the distribution of *Rumex crispus* was the widest at 44 locations (RFO on inhabited islands: 0.83) and 51 locations (RFO on uninhabited islands: 0.85), respectively. The average RFO of 184 naturalized plants distributed on 53 inhabited islands was 0.18; of these, there were 16 species with an RFO of 0.5 or above, which accounted for 8.7% of the total. The average RFO of 80 naturalized plants distributed in

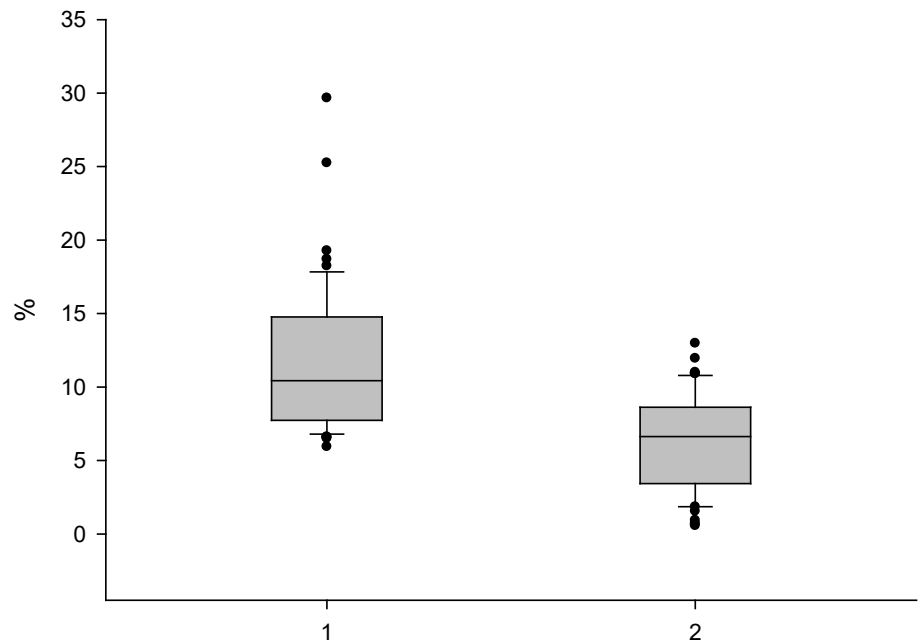
**Table 2.** Top 20 naturalized plant species and RFO in inhabited and uninhabited islands.

Inhabited Island	RFO	Uninhabited Island	RFO
<i>Rumex crispus</i>	0.83	<i>Rumex crispus</i>	0.85
<i>Erigeron sumatrensis</i>	0.83	<i>Erigeron annuus</i>	0.47
<i>Galinsoga ciliata</i>	0.75	<i>Bidens frondosa</i>	0.45
<i>Bidens frondosa</i>	0.66	<i>Erigeron sumatrensis</i>	0.43
<i>Erigeron annuus</i>	0.64	<i>Viola papilionacea</i>	0.37
<i>Robinia pseudoacacia</i>	0.62	<i>Erechtites hieracifolia</i>	0.35
<i>Phytolacca americana</i>	0.58	<i>Aster subulatus var. sandwicensis</i>	0.33
<i>Ipomoea purpurea</i>	0.58	<i>Dactylis glomerata</i>	0.33
<i>Gnaphalium calviceps</i>	0.57	<i>Ipomoea purpurea</i>	0.32
<i>Panicum dichotomiflorum</i>	0.57	<i>Bromus mollis</i>	0.32
<i>Aster subulatus var. sandwicensis</i>	0.53	<i>Panicum dichotomiflorum</i>	0.32
<i>Taraxacum officinale</i>	0.53	<i>Gnaphalium calviceps</i>	0.30
<i>Dactylis glomerata</i>	0.53	<i>Phytolacca americana</i>	0.28
<i>Festuca arundinacea</i>	0.53	<i>Lepidium apetalum</i>	0.28
<i>Brassica juncea</i>	0.51	<i>Galinsoga ciliata</i>	0.25
<i>Trifolium repens</i>	0.51	<i>Chloris virgata</i>	0.25
<i>Lepidium apetalum</i>	0.49	<i>Robinia pseudoacacia</i>	0.23
<i>Erechtites hieracifolia</i>	0.49	<i>Poa pratensis</i>	0.23
<i>Poa pratensis</i>	0.49	<i>Diodia teres</i>	0.18
<i>Lepidium virginicum</i>	0.47	<i>Datura stramonium</i>	0.18
		<i>Achillea millefolium</i>	0.18

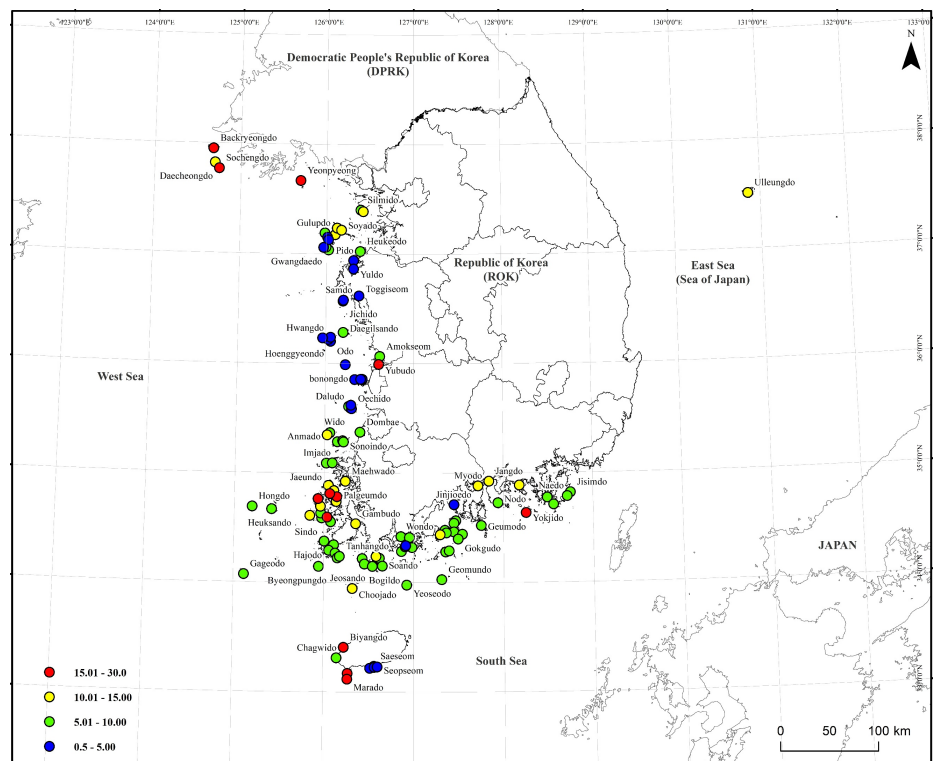
60 uninhabited islands is 0.13; of these, there are one species (*Rumex crispus*) with an RFO of 0.5 or above, which accounts for only 1.3% of the total. In a comparison of the top 20 species with the broadest distribution on inhabited and uninhabited islands, a total of 15 species were consistent. However, for both inhabited (*Brassica juncea*, *Lepidium virginicum*, *Trifolium repens*, *Taraxacum officinale*, *Festuca arundinacea*) and uninhabited islands (*Viola papilionacea*, *Diodia teres*, *Datura stramonium*, *Bromus mollis*, *Chloris virgate*), five of the top 20 species were specific to individual islands (Table 2).

#### Ratio of naturalized plants to native plants (RNN)

The average RNN, which is the number of naturalized plant species compared to the number of native plant species by island region, of the 113 islands was 8.72% (standard deviation of 4.84). The average RNN of the 53 inhabited islands was 11.55% (standard deviation 4.84), and the average RNN of the 60 uninhabited islands was 6.23% (standard deviation 3.19) (Figure 3). The RNN of inhabited islands was significantly higher than that of uninhabited islands ( $p < 0.01$ ). Yubu-do of Chungcheongnam-do was the highest at 29.66%, and Seopseom (around the southern part of Jeju Island) was the lowest at 0.57%. Regions with an average RNN greater than 15% were concentrated in the northern part of Gyeonggi-do (Ongjin-gun), the western coastal island region of Jeollanam-do (Sinan-gun), and around Jeju-do. Gyeonggi-do had a high overall RNN, as the RNN of the southern



**Figure 3.** Comparison of RNN between inhabited and uninhabited islands (x-axis 1: Inhabited Island, 2: Uninhabited Island).



**Figure 4.** Map of the RNN(%) of islands around the South Korea.

part of Deokjeok-gun was greater than 10%. In contrast, the RNN of the island region of Jeollabuk-do and southern Gyeonggi-do was less than 5%, which was relatively low compared to other regions. Compared to the surrounding areas, the islands Yubu-do of Chungcheongnam-do and Yokji-do of Gyeongsangnam-do had high RNN (Figure 4).



## Discussion

This study examined the present status and distribution characteristics of naturalized plants spread across the islands of the South Korea. We believe that this may be the first study of the distribution of naturalized plants in all island regions across South Korea. This study focused on naturalized plants of island regions and their relationship to the peculiarity of an island's physical environment. Generally, island regions provide a poor environment for plants to grow naturally compared to the mainland environment, because of factors including strong winds, steep slopes, narrow areas, and insufficient surface water. Therefore, plant species that are native to islands can be said to have adapted to such harsh environments. For this reason, naturalized plants introduced from outside can be an important biological factor for existing plants native to the island areas. In the equilibrium state centered on existing native plants, there is a high possibility of competition for space and competition between species due to the introduction of new species. Interestingly, islands experience a higher influx of species from other regions compared to the mainland. The influx of naturalized plants on islands is expected to have a greater negative effect than a positive effect on existing native plants (Pyšek and Richardson 2006). Therefore, a quantitative index of the distribution of naturalized plants on islands is needed for monitoring and management.

In this study, the distribution status of naturalized plants was investigated in 113 islands where more than 100 kinds of native plants were distributed. It was found that 184 species, or 57.3% of the 321 species of naturalized plants in the entire South Korea, were distributed in the island area. Among these naturalized plants, four species with an RFO of 0.5 or higher were *Rumex crispus*, *Erigeron sumatrensis*, *Bidens frondosa*, and *Erigeron annuus*, accounting for only 2.2% of the naturalized plants distributed in the island regions. In contrast, there were 115 species with an RFO of less than 0.1, which is 62.5% or more than half of all naturalized plants. These results show that the number of naturalized plants that have been introduced and have taken root in the island areas is still limited by region.

Of the 184 naturalized plants distributed in the island areas, 10 are particularly noteworthy as they are legally designated invasive plants. Recently, Kim et al. (2020) reported that regional differences in species are evident in an investigation of the current status of invasive plants in the islands around the South Korea. In this study, human activity was suggested as the most important cause of this distribution, to which the general distribution of naturalized plants can also be attributed. There are over 100 species of naturalized plants distributed on inhabited islands but not in uninhabited islands, and the high RNN of statistically significantly inhabited islands supports such results. The same is true for the fact that all naturalized species dispersed in uninhabited islands are also distributed in

inhabited islands. However, the average RFO of the top 20 species distributed on inhabited islands was 0.59, while that of the uninhabited islands was 0.33. This result shows that the naturalized plants introduced into inhabited islands are more widely spread than in uninhabited islands. Of course, the exception to this is *Rumex crispus*, which is widely distributed in both inhabited and uninhabited islands. Unlike naturalized plants for which the route of introduction to inhabited islands can be confirmed to be for use as edible or ornamental vegetation, there is still a need for further detailed investigation into the influx and settlement process of naturalized plants in uninhabited islands with little human interference. This is important for the efficient management of naturalized plants in the future.

Furthermore, through this study, clear differences in RNN were found by region across the country. In particular, the RNN of the northern island region of Gyeonggi-do, which is bordered by the Military Demarcation Line with North Korea; Sinan-gun, on the west coast of Jeollanam-do; and the islands around Jeju-do, were on average over 15%, which is considered high. These regions have a relatively high degree of human interference compared to other island regions. First, the northern islands of Gyeonggi-do are adjacent to North Korea, and artificial interference, such as from military facilities, has been present for many decades. In addition, as it is close to Incheon International Airport, which was created by reclaiming the surrounding island areas and tidal flats and is now a metropolitan area where a large population resides, there have been many opportunities for the influx of naturalized plants. This supports the fact that the islands in Gyeonggi-do and the Military Demarcation Line generally have a high naturalization rate (Kim et al. 2020). In the case of Sinan-gun, on the west coast of Jeollanam-do, farming has occurred there for a long time because of the favorable topographic characteristics of islands with large flat expanses and maritime exchanges between these closely clustered islands and the nearby mainland have been frequent. Many tourists visit the small, inhabited islands surrounding Jeju-do, as they are well-known tourist attractions. It is therefore theorized that human activity has played the most important role in increasing the naturalization rate of this region.

Some naturalized species are believed to be the main biological factors that reduce biodiversity (Rejmánek 2015). However, naturalized plants are also native plants somewhere and it may be short-sighted to unquestioningly label all naturalized plants negatively, though it should of course not be overlooked that there are invasive species that cause great harm to existing native plants. Therefore, there is a need to investigate the relationship between recent introductions of naturalized and native plants in a more scientific manner. Research on newly introduced species in isolated environments, such as island and alpine areas, has become more important

with respect to global environmental issues, such as global warming. In conclusion, this study was meaningful in that it collated and analyzed existing data and generated findings on the current distribution of naturalized plant species for the island regions of the South Korea, ultimately showing that the number of naturalized plants in the island areas is still largely limited by region. It is anticipated that this research approach could be used for continuous, comparative research on the distribution status and change in naturalized plants in island regions in the future.

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## Authors' contribution

HK: research conceptualization, sample design and methodology, investigation and data collection, data analysis and interpretation; KM: writing – review and editing; WK: writing – review and editing.

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### Web sites and online databases

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### Supplementary material

The following supplementary material is available for this article:

**Appendix 1.** List of flora research papers cited in this study.

This material is available as part of online article from:

[http://www.reabic.net/journals/bir/2023/Supplements/BIR\\_2023\\_Kim\\_et\\_al\\_SupplementaryMaterial.pdf](http://www.reabic.net/journals/bir/2023/Supplements/BIR_2023_Kim_et_al_SupplementaryMaterial.pdf)