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ORIGINAL PAPER

Invasive alien plants in China: diversity and ecological insights

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Abstract China's current invasive alien plant species were analyzed with regard to their floristic status, biological attributes and invasion status elsewhere. Most of the 270 species identified were annuals, followed by perennial herbs. Woody perennials made only about 10% of the species. The invasives were comprised of 59 families, the largest being Asteraceae, Poaceae, and Brassicaceae. The genera with most invasive species were *Amaranthus*, *Ipomoea*, and *Solanum*. Most of the species originated from the New World, notably from South America. About one-third of the species were serious invaders of natural habitats in countries other than China. The proportion of invasive alien plants in province floras ranged from 0.5 to 3.8%, absolute numbers from nine to 117 species per province. Density of invasive species was correlated positively with native species density at provincial scale. The results demonstrate that in China invasive plants are present throughout the country, with a particularly high species richness in the Southeast. The ecological diversity of invasive plants suggests wide ranging impacts which need to be assessed.

Keywords Alien species · Asia · China · Flora · Invasive alien species

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Introduction

The movement of species by man beyond natural dispersal barriers is a still accelerating process, resulting from global commerce and disturbance of natural ecosystems. Species introductions lead to biological invasions, which can have profound impacts on the regional economy and the ecological integrity of natural communities (Mooney and Hobbs 2000; Pimentel 2002). The number of alien plant species varies considerably among regions (Vitousek et al. 1997), and both socio-economic factors such as human density and degree of urbanization as well as biogeographic factors such as latitude and climate have been identified to correlate with alien species richness (Lonsdale 1999; Rejmánek 2000).

There is also considerable variation in the degree of knowledge of invasive alien species among various regions of the world. Plant invasions and alien floras of North American, Australian and European areas are well documented, whereas many countries of Asia are still understudied (Wu et al. 2004b).

Compilations of alien weeds or naturalized species for Asian countries and regions other than China are available for Japan (Enomoto 1999), Korea (Koh et al. 2000), the city of Singapore (Corlett 1988, 1992), the city of Chonju, Korea (Zerbe et al. 2004), the Kashmir Himalaya (Khuroo et al. 2007), and Doon Valley, Northwest Himalaya (Negi and Hajra 2007). The most comprehensive study for an east Asian region is probably that for Taiwan (Wu et al. 2004a). Compiling alien floras and analyzing patterns of floristic status, biological attributes, and geographical distribution has proved to be a useful approach to understanding alien species richness in various regions (Rozefelds et al. 1999; Stadler et al. 2000; Pyšek et al. 2004; Pyšek and Richardson 2006), and such datasets represent the necessary baseline information upon which management strategies can be built.

China is the world's third largest country in relation to territory, stretching 5,200 km from east to west, and spanning 50° of latitude. Its vast territories cover five climatic zones: tropical, subtropical, warm-temperate, temperate, and cold-temperate (Wang et al. 1997). The complex topography and the wide range of habitats make the country be one of the richest in terms of biological diversity, harbouring approximately 31,000 vascular plant species or one-eighth of the world's total (Flora of China 2007).

China currently undergoes a rapid economic development and increasing international trade, translating into ecological side effects that are of direct significance for the spread of weeds and invasive species, e.g. construction of new roads and railways, increased disturbance, ecological construction, and increased species introductions (Liu et al. 2003; López-Pujol et al. 2006). All these may promote the spread of invasive species and increasingly threat the integrity and diversity of China's unique ecosystems and species. Trade is believed to be a major vector for the introduction of harmful alien species (Convention on Biological Diversity 2002; Levine and D'Antonio 2003), and transport ways allow invasive species to reach remote yet uncolonized areas (Forman and Alexander 1998). The increasing trade between the United States and China (Callaway et al. 2006; Jenkins and Mooney 2006) is likely to onset further invasions, as well as increasing trade with other parts of the world.

The problem of invasive alien species in China has been addressed by a number of authors at both national and regional scales (Guo 1995; Guo and Li 1995; Qiang and Cao 2000; Li et al. 2001; Pan and Tian 2001; Xiang et al. 2002; Xie et al. 2001; Du et al. 2002; Li and Chen 2002; Li and Xie 2002; Chen et al. 2005). The estimated economic losses in China due to invasive alien species amount to US$ 15 billion annually (Xu et al. 2004). Removal of water hyacinth (*Eichhornia crassipes*) in Wenzhou city cost 128 million US$ in 1996 (Ding and Xie 1996). An estimate for the economic loss caused by *Mikania micrantha* on Neilingding Island ranges from 0.56 to 1.26 million US$ (Zhong et al. 2004). Data on ecological damages are rather scarce. Zhang et al. (2003) outlined potential ecological damages by the spread of fanwort (*Cabomba caroliniana*). In parts of Dianchi Lake of Yunnan province, the vigorous growth of water hyacinth outcompeted native hydrophytes, reducing the species number from 16 to 3 (Wu 1993). These few figures indicate the high potential of costs and damages, both ecological and economic, associated with plant invasions in China.

An analysis of regional distribution patterns of invasive alien plant species in China (Liu et al. 2005) showed that species richness among provinces was mainly associated with native species richness and socio-economic factors such as human population density. The currently known invasive alien plant species have, however, not yet been characterized in terms of their ecology and status in other parts of the world. Here, we present such an analysis, based on a literature survey. We address the following basic questions: (1) What is the current number of invasive alien plants in China and what is their status in other places of the world? (2) From where do these species originate? (3) Which growth strategies contribute most to invasive plants? (4) Are biogeographic regions within China different with regard to invasive plants?

Methods

Data sources

We consider here only plant species that are alien to China and that are currently invasive. We could not consider the whole array of naturalized alien plant

species because compiling such a list is not feasible. The term ‚invasive species' is used in the sense of McNeely et al. (2001), meaning that they cause damage to species, habitats, or to the economy, and the same definition has been adopted in the sources given below.

The species list was compiled from published literature, e.g. research articles, books and book chapters, and reports (Guo 1995; Guo and Li 1995; Zhang and Han 1997; Ding and Wang 1998; Li 1998; Hsu 1999; Qiang and Cao 2000; Pan and Tian 2001; Xie et al. 2001; Du et al. 2002; Li and Xie 2002; Liu et al. 2002; Xu et al. 2004; Tian 2004; Wu et al. 2004a; Liu et al. 2005; Qiang 2005; Lu et al. 2006; Xu et al. 2006a). A number of species are considered as invasive in some parts of China by the above references, whilst they are native to other parts of the country. These species were not considered in our analyses. Whereas it could not be excluded that plant materials of some of these species were introduced from other parts of Eurasia outside of China, we strictly focused on alien species in our analyses. For a number of species, e.g. *Bunias orientalis*, *Berteroa incana*, uncertainty exists with regard to native or alien status in China. The Flora of China checklist database (Flora of China 2007) considers these two species as native, and we therefore excluded them from our analyses. Other species such as *Narcissus tazetta* represent old introductions (Flora of China 2007) and hence alien to China. Because this species is considered as a noxious weed, we did include it.

Characterization of species

The species entries were supplemented with data on taxonomic position (family), life form and habitats, origin and distribution within China. Origins were extracted from the sources above and complemented by data on the native range. These were taken from the Germplasm Resources Information Network (USDA 2007).

We indicated the status of the species outside of China (invasive in natural areas elsewhere or not). The latter was granted to a species only if it is a serious invader of natural areas, according to Cronk and Fuller (1995), Daehler (1998), and Weber (2003). The status is called 'invasive elsewhere' hereafter. We used 'invasive elsewhere' as an indicator for the invasion potential of the respective species. Status as invasive (or weedy) in other countries than the country under consideration is believed to be one of the best predictors of invasibility in plants (Groves et al. 2001).

For 221 species, we could obtain presence-absence data among provinces. For 181 species, we could gather data on habitat types in which the species occur. Habitat type refers to a broad categorization of natural and man-made habitats, e.g. natural forests, lakeshores and river edges, coastal areas, tree plantations and afforestation sites (by native or exotic species), road- and railway sides, grassland and pastures. Information on economic uses of each species was obtained from the above sources and complemented by Wiersema (1999). Economic uses indicate the introduction mode (accidental vs. intentional) and the purpose for introduction in the case of intentionally introduced species. A species was allocated to more than one category if different uses apply to it.

Data analyses

Analyses comprised of cross-tabulations and correlations. Provinces were taken as spatial units and species density in a province was expressed as $D = N/\log(A)$, where N is the number of species and A the area (Rejmánek and Randall 1994). Correlations were used to analyse relationships between invasive and native species density and richness, respectively, among provinces.

To analyse patterns of similarity among major geographic regions in China, we allocated provinces to four main regions (Fig. 1), e.g. the high plateaus of western China (West), the provinces with subtropical climate not bordering the sea (Central), northeastern provinces (Northeast), and southern provinces bordering the sea (South). Index of similarity (S) of these regions was calculated according to Sørensen (McGarigal 2000) using species richness in these regions as

$$S = (2C/A+B) \cdot 100$$

where C is the number of common species; A and B are the total numbers of species in regions A and B, respectively.

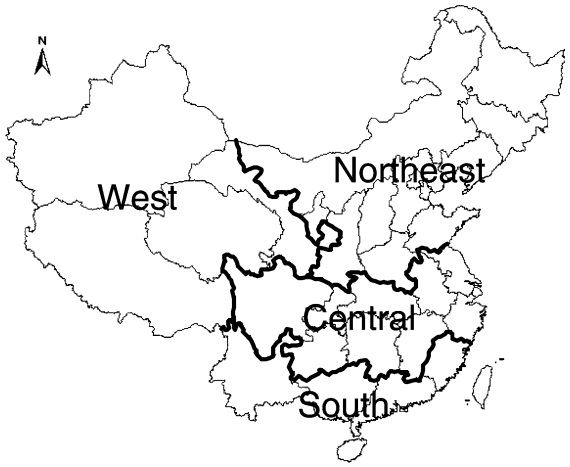

Fig. 1 Regions based on provinces for determining species overlap

Results

Numbers of invasive plant species and geographic distributions

We identified 270 invasive plant species, corresponding to 0.9% of the flora of China. They formed a heterogeneous group with regard to taxonomic position and ecological attributes, and are listed in Appendix 1. At least one-third of the species (36.3%) was invasive elsewhere. The number of invasive species among provinces showed considerable variation (Fig. 2), with the lowest species richness in Tianjin (9 species), and the highest species richness in Yunnan (94), followed by Taiwan (90). The proportion of invasive species among province floras ranged from 3.8% (Hubei province) to 0.5% (Qinghai province). A general trend of increasing invasive plant species richness from Northwest to Southeast was apparent (Fig. 2). Invasive plant species richness was correlated significantly with native species richness ($R^2 = 0.32$, $P = 0.002$) and with the number of endemic plant species (Fig. 3). Density of invasive plant species was correlated significantly with native species richness (Fig. 3) and with density of endemic plant species ($R^2 = 0.21$, $P = 0.017$). Multiple regression analysis showed that the most influential correlates of invasive plant species richness were native plant species richness and human population size (Table 1).

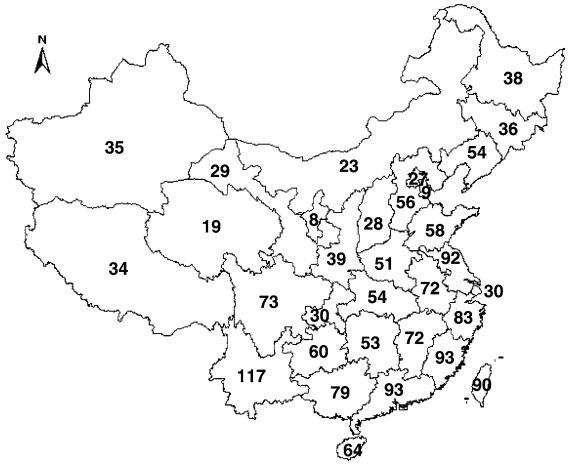

Fig. 2 Invasive alien plant species richness in provinces of China

The 10 most widespread species included mostly annuals, growing in disturbed ruderal sites, e.g. *Conyza canadensis* or *Ipomoea purpurea* (Appendix 1). A number of species occurred only in one province (56 or 26.9% of those species for which distributional data were available). Some of the invaders reached high elevations and had a large altitudinal distribution, e.g. *Ipomoea purpurea* (0–2,800 m asl), *Lepidium densiflorum* (0–3,800 m asl), or *Sisymbrium altissimum* (0–2,500 m asl).

The invasive alien floras of the four biogeographic regions showed distinct similarities to each other (Table 2). Western China was most distinct from the South with regard to invasive alien plant species, whereas central and northeastern provinces had a strong similarity. Western China and the South still shared 48 invasive plant species.

Taxonomic position

The invasive plant species of China were represented by 59 families and 177 genera (Table 3). About 79.6% of the species belonged to dictolyedons and 20.4% to monocotyledons. There were no ferns, fern allies, or gymnosperms that are considered to be invasive. Asteraceae, Poaceae, and Brassicaceae contributed most to the invasive plants in terms of absolute numbers (Fig. 4). Thirty-five families were represented by one species only, and 50 families with five species or less. The three largest families accounted for 40.6% of all species.

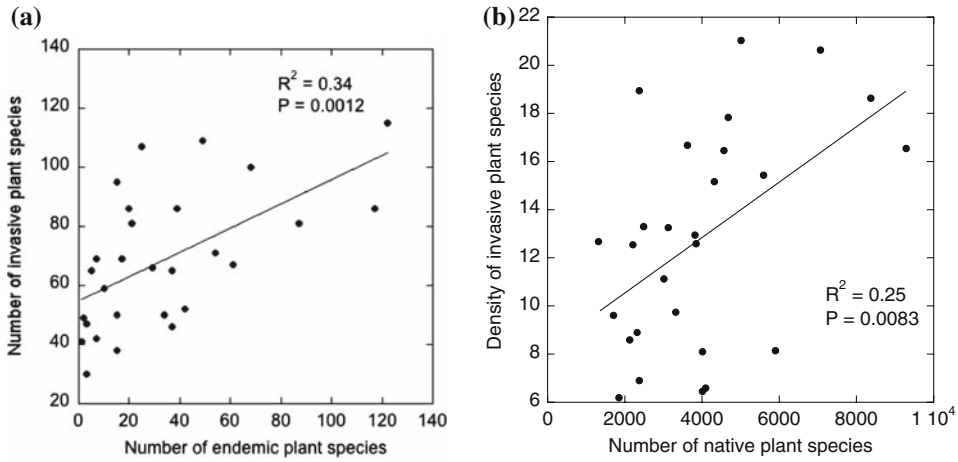

Fig. 3 Relationship between (**a**) invasive and endemic species richness, and (**b**) between density of invasive plant species and native species richness in 28 provinces of China

Table 1 Regression analyses showing the influence of geomorphological and socioeconomic factors on invasive plant species richness for 28 provinces in China

Source	df	Sum of squares	*F*	*P*
Area	1	429.4	2.29	0.145
Mid-latitude	1	530.5	2.83	0.107
Mid-longitude	1	187.6	1.00	0.328
Number of native plants	1	3841.4	20.48	0.0002
Population	1	831.8	4.43	0.047
Error	22	4126.9		

Table 2 Similarity of the invasive alien floras of four regions of China, e.g. western, southern, northeastern and central China

Region	West	South	Northeast	Central
West	–	42.5	59.4	51.5
South	188	–	48.3	67.1
Northeast	118	203	–	70.9
Central	147	298	155	–

Entries of the upper half are indices of similarity (Sørensen coefficient), of the lower half total numbers of species of the respective pair

The three major genera of invasive species were *Amaranthus*, *Ipomoea*, and *Solanum* (Table 4). Forty-seven or 26% of the genera contained only one species. Among the major genera, *Ipomoea* and *Lolium* contained most species that are invasive elsewhere. The proportion of species being invasive elsewhere was higher among monocotyledons than among dicotyledons ($\chi^2 = 10.2$, $P = 0.0014$), which is caused by the presence of many grasses in the former.

Table 3 Summary statistics for the current invasive alien flora of China

	Dicotyledons	Monocotyledons	Total
Family	47	12	59
Genus	140	37	177
Species	215	55	270
Invasive elsewhere	69	29	98
Not invasive elsewhere	149	23	173

Geographic origins

Invasive plant species in China originated from all continents (Fig. 5). The fraction of invasive species from the New World totaled to 44.2%, with most species originating from South America. Other important source areas included Europe, North America, and other parts of Asia. Few species of Australian origin were present in China's invasive flora, and also few species whose native range lies solely within Asia. Species that are invasive elsewhere predominated in African and New World species. New World species were overrepresented among dicotyledons compared to Old World species ($\chi^2 = 7.48$, $P = 0.006$).

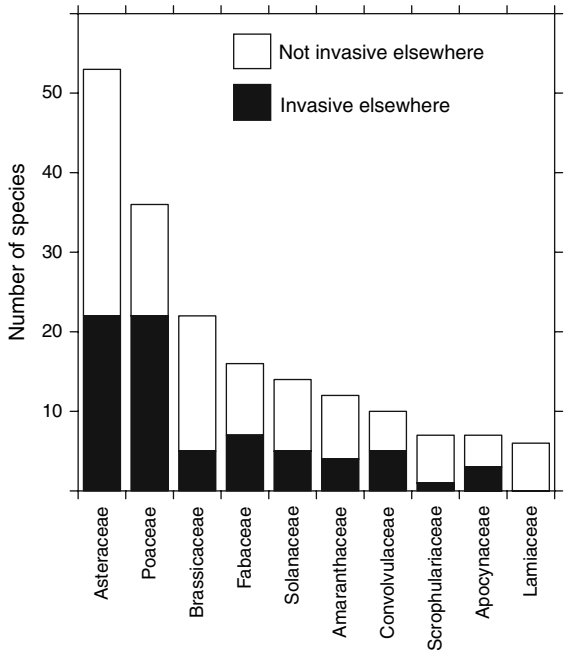

Fig. 4 The 10 major families with their numbers of invasive alien species of the Chinese flora

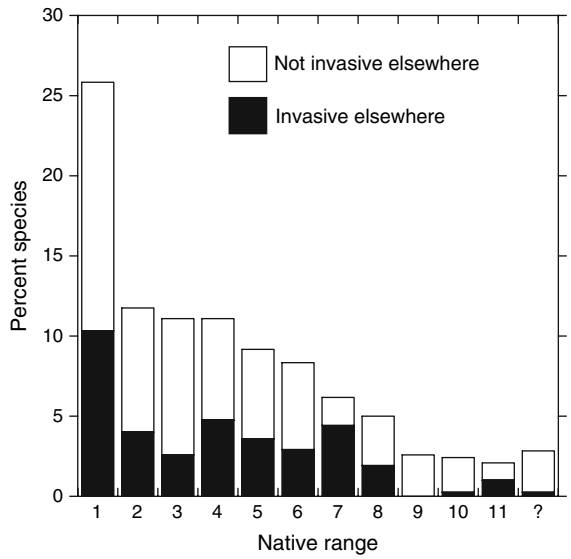

Fig. 5 The native ranges of invasive plant species of China ($N = 270$). Each species was allocated to one category only. 1 = South America, 2 = Africa, Eurasia, 3 = North America, 4 = North and South America, 5 = Europe, 6 = Eurasia, 7 = Africa, 8 = Central America, 9 = Asia, 10 = Australia, 11 = cosmopolitan, ? = unknown

Table 4 Invasive alien species richness of the ten major genera of invasive plants in China

Genus	Invasive elsewhere	Not invasive elsewhere	Total
Amaranthus	2	7	9
Ipomoea	5	3	8
Solanum	2	5	7
Veronica	0	5	5
Brassica	1	3	4
Euphorbia	0	4	4
Lepidium	0	4	4
Lolium	2	2	4
Ranunculus	0	4	4
Trifolium	1	3	4

Table 5 Distribution of invasive alien plants of China among life forms

Life form	IE	NE	IE/NE	Total	%
Annual	25	91	0.27	116	43.0
Annual or biennial	3	9	0.33	12	4.4
Biennial	4	7	0.57	11	4.1
Herbaceous perennial	40	42	0.95	82	30.4
Climber	10	3	3.30	13	4.8
Shrub	7	9	0.78	16	5.9
Tree	4	6	0.67	10	3.7
Free floating aquatic	2	3	0.67	5	1.8
Succulent	3	2	1.50	5	1.8

IE = invasive elsewhere, NE = not invasive elsewhere. Percentage refers to whole dataset

Life forms and habitats

The life form distribution was characterized by a prevalence of annuals and perennial herbs among the invasive plants (Table 5). The majority of climbers were vines of the genus *Ipomoea*, originating from the New World. Species being invasive elsewhere predominated among succulents and climbers. Woody perennials made only 9.6% of all invasive plants, aquatic plants only 1.8%. Herbs (annual to perennial) amounted to 81.9% of all species. The succulent species were members of *Opuntia* and *Bryophyllum*.

The invasive plant species were prevalent in disturbed grounds and in agricultural areas (Fig. 6). Species growing in ruderal sites (habitat type 1 in Fig. 6) were mostly not considered as being invasive

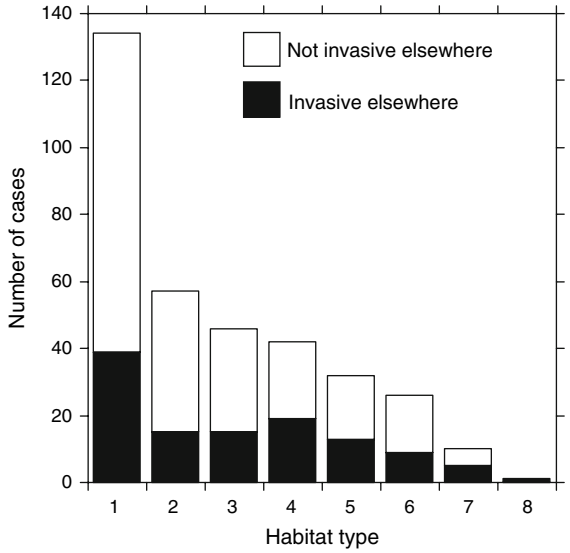

Fig. 6 Number of invasive alien plant species ($N = 181$) in various habitats of China. Species may occur in more than one habitat type. Habitats: 1 = Roadsides, railways, waste places, disturbed ground; 2 = agricultural areas, fields; 3 = grasslands, pastures, grassy slopes; 4 = tree plantations, afforestations; 5 = Lakeshores, riparian habitats; 6 = natural forests and forest margins; 7 = coastal areas; 8 = swamps, marshes

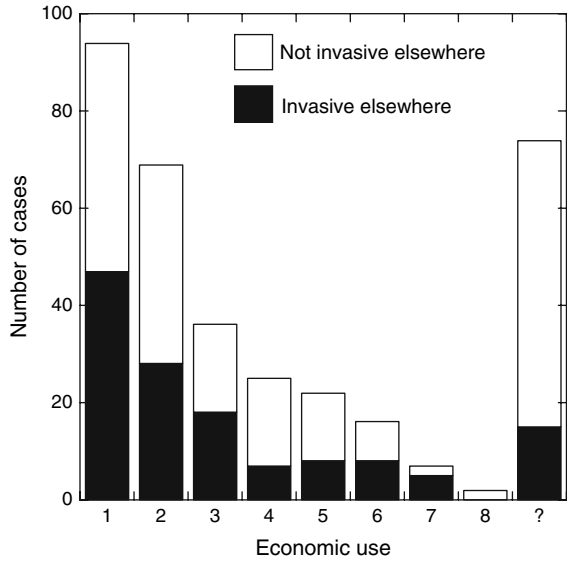

Fig. 7 Economic uses of invasive plant species ($N = 270$) of China. Medicinal plants include species that are used in folklore and species used for remedies. Invasive elsewhere refers to being harmful to natural areas (see text for explanations). Species may have been allocated to more than one category. 1 = ornamentals, 2 = medicinal plants, 3 = Fodder and forage, 4 = Food plants, 5 = Various materials, 6 = erosion control and soil improvement, 7 = turgrasses, 8 = other ises, ? = unknown or weed

elsewhere. The relatively higher proportion of species invasive elsewhere was evident in species colonizing afforestations, tree plantations, and coastal areas. Thus, the ranking of species richness among habitats was different between species being invasive elsewhere and species not being invasive elsewhere.

Economic uses

The profile of economic uses demonstrates the prevalence of ornamentals among invasive plant species in China (Fig. 7). The 94 ornamentals identified included species from 75 genera and 40 families. The second most frequent economic use was medicinal plants. These species were made of 54% annuals, and the families Asteraceae and Brassicaceae contributed each with 11 species. Plants used as fodder or forage included 14 grass species but also species such as *Alternanthera philoxeroides* and *Eichhornia crassipes*. Among turf grasses, most of the species were also invasive elsewhere. The proportion of species not considered as invasive elsewhere was the highest in food plants. The proportion of species being invasive elsewhere was higher in ornamentals than in non-ornamentals ($\chi^2 = 11.6$, $P < 0.001$). Weeds or species with unknown economic uses consisted of 65% annuals.

Discussion

Available data and species numbers

Compiling alien species for a given country has proved to be a useful approach to understanding plant invasion patterns (Rozefelds et al. 1999; Stadler et al. 2000; Silva and Smith 2004; Khuroo et al. 2007) and is the first step towards developing a management strategy for invasive species. Because we focused on invasive species, our species list certainly represents only a fraction of all naturalized alien plants within China's territories. Having such data would be indispensable but is currently not feasible to obtain. This represents a major gap of knowledge to be filled,

since complete floristic inventories of alien plants are essential for studying plant invasions (Pyšek et al. 2004).

Our data represent the current species pool of invasive plants and hence a snapshot in time. Since alien species spread and new species introductions are taking place, any floristic and biogeographic pattern will inevitably change over time. Previously published numbers of invasive plants in China differ markedly, e.g. 108 (Qiang and Cao 2000), 126 (Liu et al. 2006), 188 (Xu et al. 2006b). These differences are likely to reflect the dynamics of species naturalization as well as degree of knowledge. The list of Liu et al. (2005) does not include important invaders such as *Agave americana*, *Asparagus densiflorus* or *Robinia pseudoacacia*. We believe that our list represents the currently most updated compilation of invasive plant species in China.

The 270 invasive alien plant species make 0.9% of China's flora. The figure appears to be low compared to other regions. In California, for example, about 70 plant species are considered as serious invaders (Bossard et al. 2000), corresponding to 1.6% of the state's flora. The same has been observed for Taiwan, which has a much lower number of alien plants compared to Hawaii (8.1 and 43.8%, respectively, Wu et al. 2004b). Although plant introductions have a long history in China (Xie et al. 2001), large-scale introductions of species from other continents are a rather recent phenomenon and have probably not yet achieved the quantities of other regions in the world. The invasive perennial *Solidago canadensis* for example has been introduced into China in 1935 (Jin et al. 2004), whereas in Europe, the same plant was brought from North America in the 17th century (Weber 1998). According to Ding and Xie (1996), 837 plant species have been introduced into China up to 1970. International trade in China became important since the 1980s only but is now increasing rapidly (Normile 2004).

Status of species elsewhere and habitats

About one-third of the species reported here are serious invaders of natural areas in places outside of China, implying that there is considerable potential for damage to ecosystems in China. Whether those plant species are behaving similarly in China than in other parts of the world is an open question that merits further investigations. Some species (e.g. *Ochrosia elliptica*, *Tradescantia zebrina*, *Voacanga africana*) are rather unknown as weeds or invaders in other parts of the world. More data on their ecology and impacts on ecosystems in China are needed, as such species may become new threats if introduced to other regions.

The fact that most plant species identified here are not serious invaders of natural habitats in other regions than China may reflect that these are primarily agricultural weeds; the majority of the species reported here occurred indeed on disturbed grounds and in arable fields. However, other habitat types representing more natural vegetation (forests, lake shores, wetlands) do also have a high fraction of species not being invaders of natural areas outside of China. Our categorization of habitats may be too broad to show whether these species are penetrating into undisturbed vegetation or whether they are confined to disturbed sites within these habitat types.

Life forms

The life form distribution among invasive plants was characterized by a high fraction of annuals and a remarkably low number of woody perennials. Whereas the high proportion of annuals in our dataset corresponds to other findings, e.g. Taiwan (Wu et al. 2004b), the number of woody taxa is likely to be underestimated. The reasons are most likely the lack of surveys and recordings of alien species in China. In other regions, shrubs and trees contribute greatly to the number of invasive alien plants (Binggeli 1996). We assume that there are many more woody naturalized species in China, for example *Pinus* sp., *Acacia* sp., and *Eucalyptus* sp. Pines and eucalypt trees are widely planted in China and are frequently escaping (S. Qiang, pers. comm.), and species of both genera are serious invaders in other regions (Richardson and Rejmánek 2004; Weber 2003). *Pinus radiata*, highly invasive in South Africa where it displaces species-rich native shrublands (Richardson and Brown 1986; Lavery and Mead 1998) is currently being evaluated as a tree for revegetating degraded lands and to reduce soil erosion (Yan et al. 2006). Whereas this is necessary, introducing and planting tree species that have proved to be damaging to

natural environments in other regions should be undertaken with great caution (Binggeli 1996). Also, *Casuarina equisetifolia*, a highly invasive tree of coastal areas in Florida and the Caribbean (Weber 2003), has been introduced to China and is being cultivated (Zhong et al. 2005). The status of these trees in terms of their naturalization potential needs to be assessed.

Among the invasive trees identified here, a number of species did have profound impacts on natural ecosystems elsewhere, e.g. *Leucaena leucocephala*, *Robinia pseudoacacia*, *Salix fragilis*. The latter is frequently planted for reforestations in China (Flora of China 2007) and has proved to change riparian ecosystems in New Zealand (Lester et al. 1994). Among shrubs, three species are of particular interest, e.g. *Acacia farnesiana*, *Chromolaena odorata*, and *Ulex europaeus*. All three species are widespread invaders of natural areas (Cronk and Fuller 1995; Weber 2003). Whereas *Chromolaena odorata* is well known as an invader in mainland and Taiwan of China (Peng and Yang 1998; Xie et al. 2001), no studies have addressed the ecology of *Acacia farnesiana* and *Ulex europaeus* in China.

The high fraction of annuals in our list may reflect a high number of agricultural weeds. Annuals contributed most to species not being serious environmental weeds elsewhere, indicating that they are mainly weeds of disturbed grounds. The high fraction of annuals may also be due to the large area of China located at high elevations. The invasive plants of the four western provinces (Fig. 1), having high mean altitudes, consisted mostly of annuals and short-lived perennials.

Taxonomy

It is not surprising that most invasive plants belong to large families. Global family size is a predictor for the number of alien plants in a flora (Weber 1997; Daehler 1998; Pyšek 1998; Li et al. 2001), and Asteraceae and Poaceae are also among the major families in the naturalized flora of Chinese Taiwan of China (Wu et al. 2004b). In contrast to Chinese Taiwan, the family Brassicaceae is an important source of invasive plants in mainland China. Other families, e.g. Amaranthaceae, Euphorbiaceae, Solanaceae and Convolvulaceae, are well represented in alien floras of Asia (Zerbe et al. 2004; Wu et al. 2004b; Khuroo et al. 2007). The major genera contributing to invasive plants in China are also among the largest in the world, e.g. *Ipomoea*, *Solanum*, and *Euphorbia*. Some genera that provide many alien plants in Taiwan are missing in our list (e.g. *Crotalaria*, *Rumex*). However, many of the species in these genera are native to China. This is also the reason that *Polygonum* species did not appear in our list, although many species of *Polygonum* and *Rumex* are weedy in China (Li 1998).

Geographic origins and economic uses

As in most alien floras, species originated from all continents. However, South and North American species predominated among China's invasive plants, followed by Eurasian and African species. The profile of origins strongly resembles that of Europe's alien flora (Weber 1997) and the alien flora of Taiwan (Wu et al. 2004b). The large number of South American species invading Chinese habitats reflects the large area with a subtropical climate in this country.

Ornamentals contributed most to the invasive plants, which has been found for other countries and at a global scale (Reichard and White 2001; Mack and Erneberg 2002; Weber 2003). The large number of medical plants among the invasive flora is striking and makes the profile of economic uses different from that of other countries. One possibility might be that traditional Chinese medicine increasingly relies on alien species as native species become rarer. Overexploitation of native plants is one of the threats for rare species (López-Pujol et al. 2006). Well known invaders in this group include *Alliaria petiolata* or *Ipomoea cairica*. Grasses contributed mostly to forage and fodder plants but some species (e.g. *Spartina* spp.) have been planted for soil stabilizing.

Patterns of species richness of invasive plants within China

Within China, the proportion and number of invasive plants among provinces varies greatly. Overall, species richness and density of invasive plants among provinces were correlated with native species

richness and density. This is in accordance with other studies (Stohlgren et al. 1999; Sax 2002; Deutschewitz et al. 2003), and the positive relationship is most likely to reflect habitat diversity (Chong et al. 2001). However, the large size variation of provinces may mask any clear relationships and smaller spatial units than provinces would seem necessary for establishing accurate relationships between native and alien species richness (Stohlgren et al. 2006). The correlation between endemic and invasive species richness is obvious because larger province floras contain more endemics but demonstrates potential threats to the conservation of rare species. Field observations strongly suggest that many endemics and their habitats are threatened by invasive species (Lu et al. 2006).

Our regression analyses demonstrated that human population and native plant species richness are the best predictors for invasive plant species richness. These findings are similar to Liu et al. (2005), with the exception that in our study, latitude and longitude did not correlate with invasive species richness. However, Fig. 2 clearly suggests that southeastern provinces share more invasives than northwestern provinces. These are the most densely populated provinces and their ports recipients of international trade.

The variation in species richness also reflects China's markedly different topography, elevations, and climates (Ren 2000), so that a large diversity of habitats is given. It is therefore not surprising that the four biogeographic regions differ in their invasive floras. The western provinces Gansu, Qinghai, Xingjiang and Xizang (Tibet) are comprised of high plateaus and had the lowest similarity with the alien floras of the remaining biogeographic regions. It is, however, surprising that even there, the share of invasive plants includes 63 species, most of which are annual or short-lived herbs.

A number of invasive species in our list have been reported from high elevations, some of them occurring from sea level up to 2,500 m or more. Invasive plants growing in the western provinces are found at even higher elevations; the Qinghai-Tibet Plateau in the lower part of Western China has an average elevation of 4,000 m (Hou 1983). In other regions alien weeds have also been found to grow at high elevations (e.g. Pérez 1998; Daehler 2005; Khuroo et al. 2007).

The most widespread species included ornamentals (e.g. *Ipomoea purpurea*) and accidental introductions (e.g. *Lolium temulentum*). The latter entered China with the introduction of new wheat varieties (Ding and Xie 1996). Range sizes of alien plants are the product of species dispersal and human assisted dispersal, and some serious invaders have been planted. For example, the three aquatic plants *Alternanthera philoxeroides*, *Eichhornia crassipes*, *Pistia stratiotes* have been planted extensively throughout China in the 1950s because they were regarded as beneficial (Ding and Xie 1996). Thus, the distribution of any alien plant species cannot be understood without knowing their history.

Outlook

Many invasive plants in China are yet confined to few provinces and likely have not yet reached their distribution limits. This could be shown for *Solidago canadensis*, based on an estimation of its potential distribution range in China (Lu et al. 2007). However, accurate data on the distribution are scarce, and systematic surveys are badly needed.

China's fast economic growth and increasing international trade will foster biological invasions and invasive species will inevitably become more important here (Weber and Li, in press). Several authors stress that the increasing trade between eastern Asia and the United States will lead to the introduction of new invaders on both sides (Guo 2002; Callaway et al. 2006; Jenkins and Mooney 2006), asking for close collaborations between these nations. China, with its yet low number of invasive species may rely on experiences of other countries and take appropriate measures to counteract new invasions. It is therefore urgent to have baseline data on the invasive species pool in China and to accelerate research on invasive species. Needed are risk assessments of beneficial species intended for introduction. For example, in Liaoning province, a trial was conducted along a highway to control *Ambrosia artemisiifolia* by planting shrubs or large herbs (e.g. *Amorpha fruticosa*, *Coronilla varia*, *Helianthus tuberosus*) with the aim to replace rag weed (Ding and Xie 1996). However, all three species are alien to China and are serious invaders of natural areas elsewhere (Weber 2003).

Distribution data for native and alien species at regional and local scales are necessary to draw conclusions on the invasion potential and on ecological damages by invasive alien species. Considering the extraordinary species richness and extent of endemism of China's flora, even at low elevations, the potential of serious impacts on native species is high. Punctual observations support this connotation; *Mikania micrantha* for example is rapidly spreading in southern China, smothering trees and shrubs, killing them and replacing the original species-rich vegetation (Zhuang 1999, cited in Qiang 2005). Similarly, crofton weed (*Eupatorium adenophorum*) covers now more than 300,000 km^2 in southwestern China, invading forests, grasslands and decreasing biodiversity (Qiang 1998).

An increase of awareness and knowledge of invasive species in China is a prerequisite for setting up a national management strategy in the sense of McNeely et al. (2001). Intensified research on the ecology of invasive species in China and the development of proper control techniques seems necessary.

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Appendix

Appendix 1 Invasive alien plant species in China

Species	Family	Lifeform	Origin or native range	Provinces	Habitats
Acacia farnesiana	Fabaceae	Sh	NAm, SAm	9	
Acanthospermum australe	Asteraceae	An	SAm	2	1, 5
Aegilops squarrosa	Poaceae	An	Eurasia		2, 3
Aeschynomene indica	Fabaceae	An	NAm	1	
Agave americana	Agavaceae	Su	NAm	8	1, 3
Ageratum conyzoides	Asteraceae	An	SAm	13	1, 2, 4, 5, 7
A. houstonianum	Asteraceae	An	CAm		1, 2
Agrostemma githago	Caryophyllaceae	An	NAfr, Eurasia	5	1, 2, 3
Alliaria petiolata	Brassicaceae	An	Eurasia	2	1, 2, 5, 6
Aloe vera	Liliaceae	Su	Afr	1	
Alternanthera philoxeroides	Amaranthaceae	Pe	SAm	19	1, 5
A. pungens	Amaranthaceae	Pe	SAm	4	1
Alyssum alyssoides	Brassicaceae	An	NAfr, Eurasia	1	1
Amaranthus albus	Amaranthaceae	An	NAm	3	1
A. blitoides	Amaranthaceae	An	NAm		1, 2
A. caudatus	Amaranthaceae	An	SAm		1
A. hybridus	Amaranthaceae	An	SAm	10	1, 3
A. polygonoides	Amaranthaceae	An	CAm	3	1
A. retroflexus	Amaranthaceae	An	SAm	12	1
A. spinosus	Amaranthaceae	An	SAm	7	1
A. tricolor	Amaranthaceae	An	Asia		1, 2
A. viridis	Amaranthaceae	An	SAm	21	1, 2
Ambrosia artemisiifolia	Asteraceae	An	NAm	17	1, 2, 4
A. trifida	Asteraceae	An	NAm	15	1, 2, 4
Anredera cordifolia	Basellaceae	Vi	SAm	6	
Anthemis arvensis	Asteraceae	An	NAfr, Eurasia		1, 2

Appendix 1 continued

Species	Family	Lifeform	Origin or native range	Provinces	Habitats
Apium leptophyllum	Apiaceae	An	SAm	9	1, 4, 5
Armoracia rusticana	Brassicaceae	Pe	Eur	5	2
Asclepias curassavica	Asclepiadaceae	Pe	Tropics	16	1, 2
Asparagus densiflorus	Liliaceae	Pe	Afr	28	
A. setaceus	Liliaceae	Vi	Afr	28	
Aster subulatus	Asteraceae	An	NAm	7	1
Atriplex nummularia	Chenopodiaceae	Pe	Aus	1	
Axonopus compressus	Poaceae	Pe	NAm, SAm	6	3, 5, 6
Avena fatua	Poaceae	An	Afr, Eurasia	32	1, 3
A. sterilis	Poaceae	An	Afr, Eurasia	1	
Bidens frondosa	Asteraceae	An	NAm	5	1, 4
B. pilosa	Asteraceae	An	SAm	21	1
Brachiaria eruciformis	Poaceae	An	Afr, Eurasia		5
B. mutica	Poaceae	Pe	SAm		2, 3, 4
B. plantaginea	Poaceae	Pe	Afr, SAm	1	
Brassica juncea	Brassicaceae	An	Asia	28	1, 2
B. kaber	Brassicaceae	An	Eur		2
B. rapa subs. campestris	Brassicaceae	An	?	1	
B. tournefortii	Brassicaceae	An	Afr, Eurasia	1	
Bromus catharticus var. catharticus	Poaceae	An	SAm		5
Bryophyllum pinnatum	Crassulaceae	Su	Afr	5	
Buchloe dactyloides	Poaceae	Pe	NAm		1, 3
Cabomba caroliniana	Cabombaceae	Aq	SAm	3	5
Callisia repens	Commelinaceae	Pe	NAm, SAm	1	1
Cameraria latifolia	Apocynaceae	Tr	NAm, SAm	1	
Cannabis sativa	Cannabaceae	An	Asia	1	2
Capsella bursa-pastoris	Brassicaceae	An	?	28	1, 2, 3
Cassia mimosoides	Fabaceae	An	Tropics		1, 2
C. occidentalis	Fabaceae	An	Tropics		1, 5
C. tora	Fabaceae	Sh	Asia		1, 5
Catharanthus roseus	Apocynaceae	Pe	Afr	8	
Cenchrus echinatus	Poaceae	An	Tropics	5	
C. pauciflorus	Poaceae	An	NAm, SAm		
Centaurea cyanus	Asteraceae	An	Eurasia	1	
Chenopodium ambrosioides	Chenopodiaceae	Pe	NAm, SAm	10	1
C. giganteum	Chenopodiaceae	An	Asia	12	
C. hybridum subsp. hybridum	Chenopodiaceae	An	Eurasia	18	3, 6
Chromolaena odorata	Asteraceae	Sh	CAm, SAm	6	1, 4, 5
Chrysanthemum carinatum	Asteraceae	An	NAfr		1, 2
C. coronarium	Asteraceae	An	NAfr, Eurasia		1, 5
Conium maculatum	Apiaceae	An	Afr, Eurasia	1	2, 6
Conyza bonariensis	Asteraceae	An	SAm	12	1, 4
C. canadensis	Asteraceae	An	NAm, SAm	28	1, 2, 3, 5
C. sumatrensis	Asteraceae	An	SAm	13	
Cordyline fruticosa	Liliaceae	Pe	?	4	

Appendix 1 continued

Species	Family	Lifeform	Origin or native range	Provinces	Habitats
Coreopsis grandiflora	Asteraceae	Pe	NAm		1, 4
C. lanceolata	Asteraceae	Pe	NAm		3, 4
C. tinctoria	Asteraceae	An	NAm	2	1, 2
Coriandrum sativum	Apiaceae	An	Eur		1, 4
Coronopus didymus	Brassicaceae	An	SAm	11	1, 4
Cosmos bipinnatus	Asteraceae	An	CAm, SAm		3, 4
C. sulphureus	Asteraceae	An	CAm, SAm		1, 3, 4
Crassocephalum crepidioides	Asteraceae	An	Afr	15	
Cyclachaena xanthiifolia	Asteraceae	An	NAm	1	
Cyperus rotundus	Cyperaceae	Pe	Tropics	29	
Datura inoxia	Solanaceae	An	CAm	1	
D. metel	Solanaceae	An	NAm	7	1, 3
D. stramonium	Solanaceae	An	CAm	27	1, 3
Daucus carota	Apiaceae	Pe	Afr, Eurasia	8	1, 3
Deutzia crenata	Hydrangeaceae	Sh	Asia	7	
Digitalis purpurea	Scrophulariaceae	Pe	NAfr, Eur	4	1
Digitaria ciliaris	Poaceae	An	?	1	
Diplotaxis muralis	Brassicaceae	An	NAfr, Eurasia	1	7
Duranta erecta	Verbenaceae	Sh	NAm, SAm	8	1
Ehrharta erecta	Poaceae	An	Afr		1
Eichhornia crassipes	Pontederiaceae	Aq	SAm	19	5
Eleusine indica	Poaceae	Pe	Paleotropics	30	
Elsholtzia communis	Lamiaceae	Pe	?	1	
Erigeron annuus	Asteraceae	An	NAm	28	1, 4
E. philadelphicus	Asteraceae	Pe	NAm	6	1, 6
Eryngium foetidum	Apiaceae	Pe	SAm	5	1, 5, 6
Etlingera elatior	Zingiberaceae	Pe	Asia	1	6
Eupatorium adenophorum	Asteraceae	Pe	CAm	5	1, 2, 3, 4
E. catarium	Asteraceae	An	SAm	2	
Euphorbia dentata	Euphorbiaceae	An	CAm, NAm	1	
E. hirta	Euphorbiaceae	An	Tropics	8	
E. maculata	Euphorbiaceae	An	NAm	9	
E. marginata	Euphorbiaceae	An	NAm	1	
Eutrema wasabi	Brassicaceae	Pe	Asia	1	5
Evolvulus nummularius	Convolvulaceae	Pe	?	1	1
Galinsoga parviflora	Asteraceae	An	CAm, SAm	27	1, 4, 5
Geranium carolinianum	Geraniaceae	An	CAm, NAm	11	
Gomphrena celosioides	Amaranthaceae	An	SAm	3	1
Helenium autumnale	Asteraceae	Pe	NAm	1	1
Helianthus annuus	Asteraceae	An	NAm	1	
H. petiolaris	Asteraceae	An	NAm	1	
H. tuberosus	Asteraceae	Pe	NAm		1, 4, 5
Heliotropium europaeum	Boraginaceae	An	NAfr, Eurasia	3	1,2, 5
Hesperis matronalis	Brassicaceae	An	Eurasia	1	
Hibiscus trionum	Malvaceae	An	Afr, Eurasia	25	1, 4

Appendix 1 continued

Species	Family	Lifeform	Origin or native range	Provinces	Habitats
Hyptis rhomboidea	Lamiaceae	An	CAm	4	1
H. suaveolens	Lamiaceae	An	SAm	5	1
Ipomoea alba	Convolvulaceae	Vi	NAm, SAm	9	1, 5, 6
I. cairica	Convolvulaceae	Vi	?	6	1
I. carnea	Convolvulaceae	Sh	NAm, SAm	3	
I. hederacea	Convolvulaceae	Vi	NAm, SAm	1	
I. indica	Convolvulaceae	Vi	Pantropic	3	6, 7
I. lacunosa	Convolvulaceae	Vi	NAm	1	
I. nil	Convolvulaceae	An	Pantropic	24	1, 3
I. purpurea	Convolvulaceae	Vi	SAm	27	1, 2, 5, 6
Jacquemontia tamnifolia	Convolvulaceae	An	NAm, SAm	1	
Lantana camara	Verbenaceae	Sh	SAm	6	1, 4, 7
Lemna trinervis	Lemnaceae	Aq	NAm, SAm	3	
Lepidium campestre	Brassicaceae	An	Eurasia	1	1, 2, 3
L. densiflorum	Brassicaceae	An	NAm		1, 5, 7
L. sativum	Brassicaceae	An	NAfr, Asia	6	
L. virginicum	Brassicaceae	An	CAm, NAm	19	1, 2, 3, 4
Leucaena leucocephala	Fabaceae	Tr	SAm	9	
Leucanthemum vulgare	Asteraceae	Pe	Eurasia		4
Lilium hansonii	Liliaceae	Pe	Asia	1	5
Linum usitatissimum	Linaceae	An	?	1	
Lobularia maritima	Brassicaceae	Pe	NAfr, Eurasia	9	1
Lolium multiflorum	Poaceae	An	NAfr, Eurasia	16	1, 2, 3
L. perenne	Poaceae	Pe	NAfr, Eurasia		4
L. persicum	Poaceae	An	Asia		2
L. temulentum	Poaceae	An	Eur	30	2
Macfadyena unguis-cati	Bignoniaceae	Vi	CAm, SAm	2	
Malvastrum coromandelianum	Malvaceae	Pe	Pantropic	6	1, 4
Martynia annua	Pedaliaceae	Pe	CAm, SAm	1	1, 6
Medicago hispida	Fabaceae	An	NAfr, Eurasia		1, 4
Mikania micrantha	Asteraceae	Vi	CAm, SAm	1	1, 4, 6
Mimosa invisa	Fabaceae	Pe	SAm	2	
M. pudica	Fabaceae	Pe	SAm	6	1, 6
Mirabilis jalapa	Nyctaginaceae	An	SAm	18	1
Narcissus tazetta	Amaryllidaceae	Pe	NAfr, Eurasia	2	1
Nasturtium officinale	Brassicaceae	Pe	NAfr, Eurasia	18	5, 8
Nerium oleander	Apocynaceae	Tr	Afr, Eurasia	1	
Nicandra physalodes	Solanaceae	An	Sam	7	1
Nymphaea alba	Nymphaeaceae	Aq	NAfr, Eurasia	4	5
Ochrosia elliptica	Apocynaceae	Tr	Aus, Pac	2	
Oenothera erythrosepala	Onagraceae	An	Eur		4, 5
O. rosea	Onagraceae	Pe	CAm, SAm	3	
Opuntia ficus-indica	Cactaceae	Su	CAm	5	1, 2
O. monacantha	Cactaceae	Su	SAm	5	6
O. stricta var dillenii	Cactaceae	Su	NAm, SAm	3	

Appendix 1 continued

Species	Family	Lifeform	Origin or native range	Provinces	Habitats
Orobanche brassicae	Orobanchaceae	An	?	1	
Oxalis corymbosa	Oxalidaceae	Pe	SAm	12	4
Panicum maximum	Poaceae	Pe	Afr	6	
Papaver nudicaule	Papaveraceae	Pe	Eur	8	
Parthenium hysterophorus	Asteraceae	An	CAm, SAm	6	2, 3
Parthenocissus quinquefolia	Vitaceae	Vi	CAm, NAm		4, 6
Paspalum conjugatum	Poaceae	Pe	SAm	11	
P. dilatatum	Poaceae	Pe	SAm	4	1, 2, 3
P. fimbriatum	Poaceae	An	CAm, SAm		1
Passiflora foetida	Passifloraceae	Vi	NAm, SAm	6	
Pennisetum glaucum	Poaceae	An	?	1	
P. setosum	Poaceae	Pe	Tropics		3
Peperomia pellucida	Piperaceae	An	SAm	5	2, 6, 7
Persicaria pensylvanica	Polygonaceae	An	NAm	1	
Phalaris minor	Poaceae	An	NAfr, Eurasia		2, 4
P. paradoxa	Poaceae	An	NAfr, Eurasia		
Physalis peruviana	Solanaceae	Pe	SAm	4	1
P. philadelphica	Solanaceae	An	CAm	2	1, 3
P. pubescens	Solanaceae	An	NAm, SAm	3	1, 6
Phytolacca americana	Phytolaccaceae	Pe	NAm	18	1, 6
Pilea microphylla	Urticaceae	An	CAm, SAm	6	
Pistia stratiotes	Araceae	Aq	Afr, SAm	17	
Pittosporum tobira	Pittosporaceae	Tr	Asia	10	1, 3, 6, 7
Plantago aristata	Plantaginaceae	An	NAm	1	
P. lanceolata	Plantaginaceae	Pe	NAfr, Eurasia		5, 7
P. virginica	Plantaginaceae	An	NAm	10	1, 2, 5
Poa compressa	Poaceae	Pe	NAfr, Eurasia		1, 3
Polymnia uvedalia	Asteraceae	Pe	NAm	1	
Pseudelephantopus spicatus	Asteraceae	Pe	CAm, SAm		1, 3
Pyrethrum parthenifolium	Asteraceae	Pe	Eurasia		1
Ranunculus arvensis	Ranunculaceae	An	NAfr, Eurasia	2	1, 4
R. muricatus	Ranunculaceae	An	NAfr, Eurasia	3	1, 2, 3
R. sardous	Ranunculaceae	An	NAfr, Eurasia	1	1
R. trachycarpus	Ranunculaceae	An	?	1	3
Raphanus raphanistrum	Brassicaceae	An	NAfr, Eurasia	3	1, 2
Rapistrum rugosum	Brassicaceae	An	NAfr, Eurasia	1	1
Rauvolfia cubana	Apocynaceae	Sh	CAm	1	
Reseda lutea	Resedaceae	An	NAfr, Eurasia	1	1, 3
Rhus typhina	Anacardiaceae	Tr	NAm	1	
Rhynchelytrum repens	Poaceae	Pe	Afr, Asia	4	
Ribes multiflorum	Grossulariaceae	Sh	Eur	6	
R. nigrum	Grossulariaceae	Sh	Eurasia	3	1, 6
R. uva-crispa	Grossulariaceae	Sh	NAfr, Eurasia	6	1
Ricinus communis	Euphorbiaceae	An	Afr	25	4, 5, 6
Robinia pseudoacacia	Fabaceae	Tr	NAm		1, 6

Appendix 1 continued

Species	Family	Lifeform	Origin or native range	Provinces	Habitats
Rosmarinus officinalis	Lamiaceae	Sh	NAfr, Eurasia	28	
Salix fragilis	Salicaceae	Tr	Eurasia	3	
Salvia coccinea	Lamiaceae	An	NAm, SAm	1	
Saponaria officinalis	Caryophyllaceae	Pe	Eurasia	1	1
Scoparia dulcis	Scrophulariaceae	An	SAm	6	1, 4
Senecio dubtabilis	Asteraceae	An	Eur	6	
S. vulgaris	Asteraceae	An	Cosmopolitan	15	1, 2, 3
Sesbania exaltata	Fabaceae	Pe	NAm	1	
Setaria palmifolia	Poaceae	Pe	Asia	2	1
S. parviflora	Poaceae	Pe	NAm, SAm	1	
Sida rhombifolia	Malvaceae	Pe	Pantropic	1	
S. spinosa	Malvaceae	Pe	Pantropic	1	
Silybum marianum	Asteraceae	An	NAfr, Eur		1, 2, 4
Sinapis alba	Brassicaceae	An	NAfr, Eurasia	9	1, 3
Sisymbrium altissimum	Brassicaceae	An	Eurasia	3	1, 2, 3
Solanum aculeatissimum	Solanaceae	An	SAm	12	1, 3, 6
S. capsicoides	Solanaceae	Pe	SAm	9	1, 6
S. chrysotrichum	Solanaceae	Sh	CAm, SAm	2	
S. erianthum	Solanaceae	Sh	NAm, SAm	9	1
S. seaforthianum	Solanaceae	Vi	NAm, SAm	1	1
S. sisymbriifolium	Solanaceae	An	SAm	2	
S. torvum	Solanaceae	Pe	CAm, SAm	8	1
Solidago canadensis	Asteraceae	Pe	NAm	6	1, 4
Soliva anthemifolia	Asteraceae	An	SAm	7	1, 2, 4
Sorghum almum	Poaceae	Pe	SAm	1	
S. halepense	Poaceae	Pe	NAfr, Asia	15	1
S. sudanense	Poaceae	An	Afr		1, 2
Spartina alterniflora	Poaceae	Pe	NAm, SAm	4	7
S. anglica	Poaceae	Pe	Eur	11	7
Spergula arvensis	Caryophyllaceae	An	NAfr, Eurasia	5	3, 5
Spermacoce latifolia	Rubiaceae	Pe	SAm	4	
Stachytarpheta jamaicensis	Verbenaceae	Pe	CAm, SAm	6	3
Stellaria apetala	Caryophyllaceae	An	Eur	4	1, 2
Symphytum officinale	Boraginaceae	Pe	Eurasia	1	6
Synedrella nodiflora	Asteraceae	An	CAm, SAm	6	1
Tagetes erecta	Asteraceae	An	CAm, SAm		1
T. patula	Asteraceae	An	CAm, SAm		1
Talinum paniculatum	Portulacaceae	An	NAm, SAm		1, 5
Tectona grandis	Lamiaceae	Tr	Asia, Pac	5	
Tithonia diversifolia	Asteraceae	Pe	CAm		1, 4
Tradescantia spathacea	Commelinaceae	Pe	SAm	1	
T. zebrina	Commelinaceae	Pe	CAm	4	
Tridax procumbens	Asteraceae	Pe	CAm, SAm	5	1, 4
Trifolium hybridum	Fabaceae	Pe	NAfr, Eurasia	1	
T. incarnatum	Fabaceae	An	Eur		1, 2, 3

Appendix 1 continued

Species	Family	Lifeform	Origin or native range	Provinces	Habitats
T. pratense	Fabaceae	Pe	NAfr, Eurasia		1, 2, 3
T. repens	Fabaceae	Pe	NAfr, Eurasia	23	1, 2, 3
Ulex europaeus	Fabaceae	Sh	Eur	1	1, 3
Vaccaria segetalis	Caryophyllaceae	An	NAfr, Eurasia	8	2
Veronica arvensis	Scrophulariaceae	An	NAfr, Eurasia	9	1, 3, 4
V. hederifolia	Scrophulariaceae	An	NAfr, Eurasia	2	1, 2
V. peregrina	Scrophulariaceae	An	NAm, SAm	18	1
V. persica	Scrophulariaceae	An	Asia	16	1, 2
V. polita	Scrophulariaceae	An	NAfr, Eurasia	20	1
Vetiveria zizanioides	Poaceae	Pe	Asia	7	
Vinca minor	Apocynaceae	Pe	Eur	1	
Voacanga africana	Apocynaceae	Tr	Afr	1	
Waltheria indica	Sterculiaceae	Sh	NAm, SAm	6	
Wedelia trilobata	Asteraceae	Pe	CAm, SAm	4	1, 3
Xanthium spinosum	Asteraceae	An	SAm	4	1, 4
X. strumarium	Asteraceae	An	CAm, SAm	1	1
Zephyranthes candida	Amaryllidaceae	Pe	SAm	8	
Z. carinata	Amaryllidaceae	Pe	CAm	8	
Zinnia peruviana	Asteraceae	An	NAm, SAm		1, 3

Names in bold indicate species that are invasive in natural areas in other countries than China. Lifeform: An = annual or short-lived perennial herb, Aq = aquatic plant, Pe = perennial herb, Sh = shrub, Su = succulent, Tr = tree, Vi = vine or liana. Origins: Afr = Africa, Aus = Australia, Eur = Europe, CAm = Central America, NAm = North America, SAm = South America, NAfr = North Africa, Pac = Pacific, ? = unknown. Provinces: number of provinces in which the species is present. Habitats: 1 = roadsides, railways, waste places, disturbed ground; 2 = agricultural areas, fields; 3 = grasslands, pastures, grassy slopes; 4 = tree plantations, afforestations; 5 = lakeshores, riparian habitats; 6 = natural forests and forest margins; 7 = coastal areas; 8 = swamps, marshes

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