

Invasive species in grassland habitat: an ecological threat to the greater one-horned rhino (*Rhinoceros unicornis*)

Bibhuti P. Lahkar, Bibhab Kumar Talukdar and Pranjit Sarma

Aaranyak, 50 Samanwoy Path (Survey), PO Beltola, Guwahati - 781 028, Assam, India;
email: bibhuti@aaranyak.org

Abstract

The successes achieved in Assam towards conservation and management of greater one-horned rhinos (*Rhinoceros unicornis*) are often overshadowed by a few poaching incidences. Rhino conservation efforts made by the Assam Forest Department, assisted by communities and civil society organizations, have made it possible to downgrade the status of greater one-horned rhinos from Endangered to Vulnerable on IUCN's 2008 Red Lists of Threatened Species. One of the major threats besides poaching is the slow and steady intrusion of invasive species in grassland habitats, which directly reduces suitable flora for rhinos and other herbivores. This matter has not yet been highlighted to attract conservation intervention and support. The increasing invasion of weeds that has been observed in Nepal and India's grassland habitats in the past decade needs scientific intervention to ensure the long-term conservation of rhino habitats. Based on available information, we portray the threats posed by invasive species towards the survival of greater one-horned rhinos in India and Nepal.

Key words: greater one-horned rhino, invasive species, management, threats, grassland

Résumé

Les succès obtenus dans l'Assam dans la conservation et la gestion du grand rhinocéros unicorne (*Rhinoceros unicornis*) sont souvent obscurcis par quelques incidences de braconnage. Les efforts faits par le Département des Forêts de l'Assam pour conserver le rhinocéros, assisté par les communautés et les organisations de la société civile, ont permis de déclasser l'inscription du grand rhinocéros unicorne d'une Espèce menacée de disparition à une Espèce vulnérable sur les Listes rouges de l'UICN de 2008. L'une des principales menaces qui pèsent sur ces animaux à part le braconnage c'est l'intrusion lente et régulière des espèces envahissantes dans les habitats des herbages, ce qui réduit directement les essences adaptées aux rhinocéros et aux autres herbivores. Cette question n'a pas encore été mise en exergue pour attirer l'intervention et le soutien à la conservation. L'invasion croissante des mauvaises herbes qu'on a observée dans les habitats des herbages du Népal et en Inde au cours de la dernière décennie nécessite une intervention scientifique pour veiller à la conservation à long terme des habitats de rhinocéros. Selon les informations disponibles, nous décrivons les menaces posées par les espèces envahissantes à la survie des grands rhinocéros unicornes en Inde et au Népal.

Introduction

The critical issue facing the managers of protected areas and conservationists is how to maintain biodiversity in the face of naturally occurring and man-made perturbations in the habitat (Love et al., 2009). Biological invasions are among the anthropogenically-mediated perturbations threatening native biodiversity, preventing natural ecological succession and changing the community structure and composition; additionally, ecosystem services are impacted (Vitousek et al., 1996; Mack et al., 2000).

All rhino-bearing protected areas of India and Nepal are protected from poachers and encroachers by government decree since its inception under the legal framework of the two countries. Although threats to rhinos from poaching are highlighted more often (Talukdar, 2002, 2003, 2006), the spread of invasive species in the rhino habitats of India and Nepal has become a major concern in recent years.

Although it is a natural process, worldwide biological invasion threatens biodiversity, ecosystem dynamics, resource availability, national economies and human health (Ricciardi et al., 2000). It is a pervasive and costly environmental problem (Larson et al., 2001). Nevertheless, the growing human population and improved worldwide transport have led to a skyrocketing incidence and scale of invasions by non-indigenous species (Ewel et al., 1999).

Distribution of invasive plants may have relationships with human disturbances, which can be easily identified in forest fringe areas (Hooper et al., 2005). In general, increasing the frequency, intensity, spatial patterns or scale of disturbances will likely lead to faster replacement of native by exotic species (Yan et al., 2001).

All of the invasive plant species are from South America and were introduced to the Indian subcontinent as fodder crops or ornamentals in the early part of the last century (Lowe et al., 2000). The principal invasive species in rhino habitats are *Mikania micrantha*, *Mimosa* spp., *Ipomea* spp. and *Chromolaena odorata*, which have the potential to destroy prime animal habitats including that of rhinos.

This paper provides the foundation for developing urgently needed management components such as streamlined planning of 'priority areas' for controlling the invasive species and integration of control activities with existing park management strategies and activities.

Alien species in rhino habitats

Mimosa diplotricha is a fast growing, abundantly thorny, biennial or perennial shrub with angular branching stems that become woody with age. Its leaves are alternate, bipinnate and compound. Once established, *Mimosa* spp. is difficult to control. *Mimosa* seeds are typically dispersed in two ways: carried downstream during floods or transported by animals or machinery. Moreover, it is reported to be poisonous to herbivores and considered to be one of the most serious alien invasive species (IUCN/ISSG database). The invasion of *Mimosa* has emerged a major threat in Kaziranga National Park (NP) (Vattakkavan et al., 2002).

Chromolaena odorata is a perennial shrub species native to neotropical America stretching from southern Florida to the upper drainage basin of the Amazon in Southern Bolivia. IUCN's Invasive Species Specialist Group has identified *Chromolaena* as one of the hundred worst invaders. Until recently, it was taxonomically classified as *Eupatorium*. The genus *Chromolaena* belongs to the family Asteraceae, one of the largest and most evolved of plant families.

Mikania micrantha is a perennial creeping climber known for its vigorous and rampant growth. It grows best where fertility, organic matter, soil moisture and humidity are high. It damages or kills other plants by cutting out the light and smothering them and competing for water and nutrients. A native of Central and South America, *Mikania micrantha* was introduced to India after World War II to camouflage airfields. Once established, *Mikania micrantha* spreads at an alarming rate, readily climbing and twining on any vertical support, including crops, bushes, trees, walls and fences. Significantly, it is believed that the plant releases substances that inhibit the growth of other plants (IUCN/ISSG database).

Ipomoea carnea, the Pink Morning Glory, is of American origin. This flowering plant has heart-shaped leaves that are a rich green and 6–9 inches long. It can be easily grown from seeds which are toxic and it can be hazardous to herbivores (USDA database).

Lantana camara is a low erect or subscandent, vigorous shrub with stout recurved prickles and a strong odour of black currents. It grows to 1.2–2.4 metres or more. The diverse and broad geographic distribution of *lantana* is a reflection of its wide ecological tolerances. It occurs in diverse habitats

and on a variety of soil types. Lantana is now a major weed in many regions of the world where it invades natural and agricultural ecosystems. Lantana has been implicated in the poisoning of a number of herbivores including cattle, buffalos, sheep and goats (IUCN/SSG database).

Mode of invasion

The dispersal of plant species through natural dispersal agents like air and water has been slow process. However, with globalization there has been a phenomenal increase in trade, tourism, travel and other human activities, which have caused both the intentional and unintentional introduction of species from one country to another at an unprecedented pace.

A classic example of the intentional introduction of an invasive plant in Assam is Mimosa, which was brought by tea garden owners as nutrients (for their nitrogen containing property) for economic development. Unfortunately, Mimosa penetrated into

rhino habitats of Kaziranga NP (Vattakkavan et al., 2002) and Orang NP (pers. comm. and observations) from tea gardens through water and subsequently established itself in the grasslands of both of these rhino bearing parks.

Some of the most invasive and widespread unintentional introductions include *Mikania micrantha*, *Ipomea*, *Lantana camara* and *Chromolaena odorata*. The unintentional introduction modes include aircraft, road vehicles, boats, water, commercial goods and packaging materials. Wind, insects and birds also help in spreading invasive plant species.

Impact of invasive species on rhino habitat

Grasslands of the Indian subcontinent have suffered a rapid decline, mainly due to human-induced modifications that include human settlement, agriculture, urbanization, unsystematic fire, livestock grazing, irrigation and dams. All the extended grasslands both

Table 1. Some alien species that have detrimental impacts on grassland ecosystems, as recorded in rhino habitats in India and Nepal

Sites	Invasive species	Current Impact	Rate of spread	Management by Forest Department
Kaziranga NP	<i>Mimosa</i>	Severe	Increasing rapidly	Manual removal, fire
	<i>Mikania</i>	Moderate	Increased moderately	None
Orang NP	<i>Mimosa</i>	Severe	Increasing rapidly	Fire
	<i>Mikania</i>	High	Increasing rapidly	None
	<i>Chromolaena</i>	Moderate	Increasing slowly	None
Manas NP	<i>Chromolaena</i>	Severe	Increasing rapidly	Fire
	<i>Mikania</i>	High	Increasing rapidly	None
Pabitora WLS	<i>Ipomoea</i>	High	Increasing rapidly	None
	<i>Mikania</i>	Moderate	Increasing slowly	None
Jaldapara WLS	<i>Mikania</i>	High	Increasing rapidly	
Garumara NP	<i>Mikania</i>	High	Increasing rapidly	
	<i>Chromolaena</i>	High	Increasing rapidly	
Chitwan NP	<i>Mikania</i>	Severe	Increasing rapidly	Cut & burnt, Herbicides
	<i>Chromolaena</i>	High	Increasing rapidly	Uproot & fire
	Lantana	High	Increasing slowly	Cut & uproot
Bardia NP	<i>Mikania</i>	Severe	Increasing rapidly	
	<i>Lantana</i>	High	Increasing rapidly	Cut & uproot

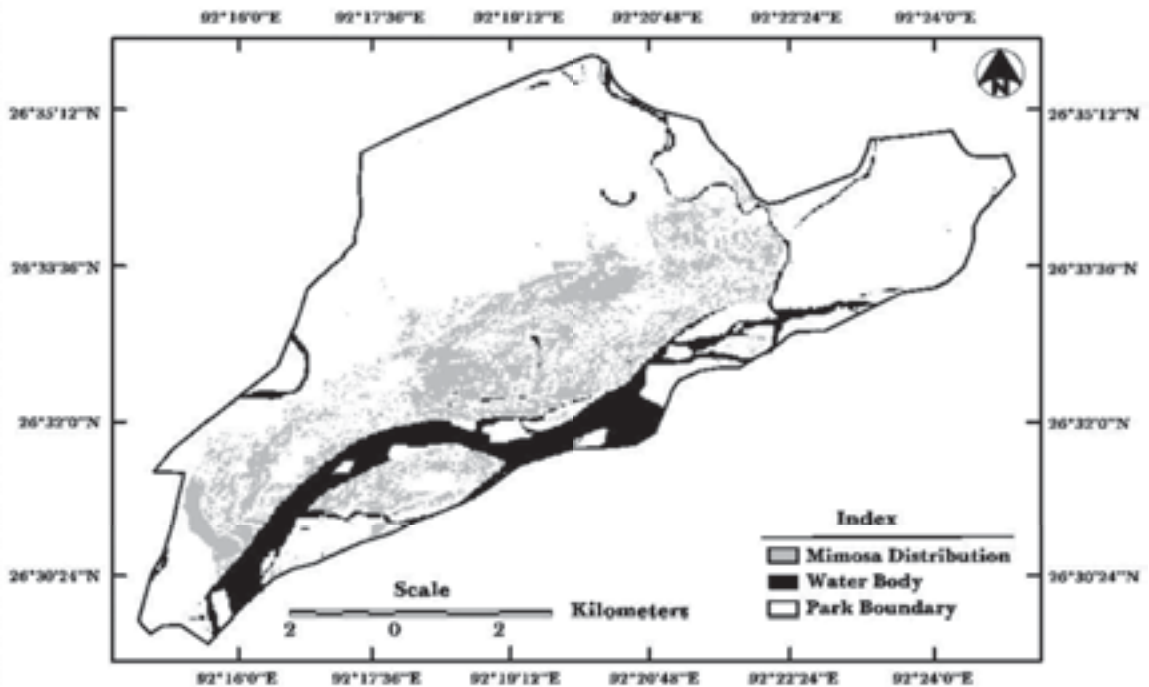


Figure 1. Mimosa spread and abundance in Orang NP.

in India and Nepal are now confined within protected area networks. Further, establishment of invasion by alien species in grasslands of protected areas especially in rhino habitats is the biggest challenge in terms of habitat conservation. Introduced species carries a heavy cost in terms of reduced habitat for threatened species like rhino apart from loss of native biodiversity.

The impacts of invasive species are commonly overlooked because the changes are often indirect phenomenon in the vegetation. The impact of invasive plant species on different rhino habitats in India and Nepal are as follows:

Kaziranga NP

The most important habitat for greater Indian one-horned rhinos is the Kaziranga NP. Mimosa invasion started in the Park in the mid-1990s (P. Sarmah, pers. comm.). However, the issue of *Mimosa* invasion in Kaziranga was highlighted around 2001–02. Initially, the invasion started in grasslands of the Baguri Range of Kaziranga and later spread all over the Park. This invasion has resulted in the disturbance and disruption of rhino habitat in Kaziranga. The Wildlife Trust of India conducted a preliminary study on Mimosa

invasion in the Park (Vattakkavan et al., 2002); they found that distribution of Mimosa was greater along the boundary of the Park and that the Bagori (western) range of the Park was more infested. The Park authority and later Wildlife Trust of India with the help of Forest Department uprooted much of this weed. The success was low as the uprooting operation was not continuous and follow-up action was not adequate. Currently, the Rain Forest Research Institute (RFRI) has been mapping the distribution of Mimosa in Kaziranga NP. The preliminary result of the RERI study reveals the presence of Mimosa in all sectors of the Park, however its invasion is greater in some areas (N.K Vasu, pers. comm.). After mapping, RFRI is planning to initiate some controlling measures.

Orang NP

After Kaziranga NP, the second largest home of rhino in Assam is Orang NP with an area of 78.18 km². The Mimosa invasion was first reported within the Park in 2003–04, especially areas along the Brahmaputra River. The invasion of Mimosa has been observed to increase rapidly in the Park. An area of 11.56 km² is under Mimosa invasion in the Park and the effect is greater in the western area along the Brahmaputra

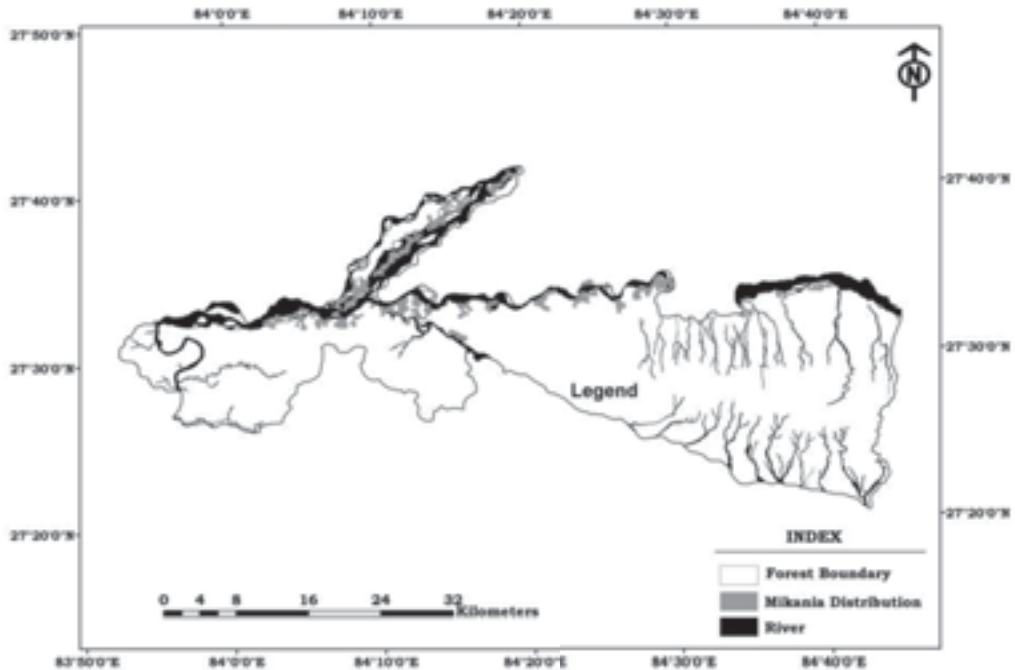


Figure 2. *Mikania micrantha* spread and abundance in Chitwan NP. Source: Rajan Amin, ZSL

River (Fig. 1). There has been an increase in straying of rhino from the Park. As rhino habitat is decreasing due to the invasion of weeds, there might be an increase in rhinos straying out (pers. observation). Apart from Mimosa invasion, the spread of Mikania in the rhino habitats of Orang is alarming. It has been observed that in some grassland patches, Mimosa invasion was followed by Mikania invasion. Consistent initiatives for controlling the spread of invasive species in the Park have not been taken by either government nor NGOs.

Manas NP

Manas NP is the only home of rhinos in the foothills of Assam. Currently there are only five reintroduced rhinos in the Park. In 2003–04, Lahkar (2008) conducted a preliminary study of the density of invasive species in the grasslands of the Bansbari Range of Manas NP. The density of *Chromolaena odorata* was found to be highest among invasive species in the Park's grasslands—ranging from 9.4 to 15.1 plants per m². A systematic study of invasive species in the Park has not yet been conducted, so a distribution map of *Chromolaena odorata* is not available. It has been observed that *Chromolaena odorata* invasion is greater

in a stretch of 2–4 km along the southern boundary of the Park. Invasive weeds have spread to the southern boundary, replacing *in situ* vegetation that has been destroyed due to biotic pressures including livestock grazing. *Chromolaena odorata* is spreading very fast in the grasslands of Manas, where the authorities face enormous challenges to eradicate it. Recognizing the seriousness of the problem, the 31st session of the World Heritage Committee held in Christchurch in 2007 suggested that the Forest Department of Assam develop an independent management plan to control invasive species.

In addition to *Chromolaena*, the spread of Mikania in Manas NP grasslands is alarming. The Mikania invasion is observed more in riverine grassland patches and on the edge of forest patches.

Invasive species have been changing the structure and function of grasslands in Manas NP. This may reduce the amount of habitat suitable for the reintroduction of rhinos, as outlined in IRV 2020.

Pabitora Wildlife Sanctuary

The Pabitora Wildlife Sanctuary (WLS) currently has the world's highest density of rhinos, holding an average of 5.25 rhinos per km². Although the total

area of the Sanctuary is only 38.81 km², 16 km² are inhabited by rhinos. The invasion of *Ipomoea* in grassland is the biggest threat to the rhino habitat in Pabitora. It has sparked competition among grasses and *Ipomoea* for space and nutrients. Sarma et al. (2009) highlighted the number of rhinos straying from the Sanctuary due to changes in grassland dynamics. Unregulated livestock grazing has also affected the quality of grassland in Pabitora.

So far no robust initiative has been taken by government nor NGOs for controlling the invasive species in the Sanctuary, which seems to be essential for improving the condition of rhino habitat.

Jaldapara WLS

Jaldapara WLS represents the remnant patches of grasslands in duars of North Bengal. Biswas and Mathur (2003) highlighted the *Mikania* invasion in grassland patches, which was found to be more widespread in grasslands in the old river bed with primary woodland succession, grasslands along the current riverbed and generated grassland patches. Not much information is available about the impact of invasive species in the Sanctuary. Although the Forest Department has been regularly clearing weeds, systematic initiative has not been taken by them or by NGOs for controlling the invasive species in the Sanctuary.

Garumara NP

All the grassland patches in the Park have been planted by the forest department to create grassland habitats suitable for rhinos. Not much information is known about the impact of invasive species in the Park, although the Forest Department has regularly cleared weeds; unfortunately, a systematic initiative has not been taken by concerned conservation and research agencies for controlling the invasive species in the NP.

Chitwan NP

The Zoological Society of London, the National Trust for Nature Conservation in Nepal and CABI have been working in the Park to understand the impact of invasive species and further prevent the spreading invasion through short- and long-term planning. They found that there were two main problematic invasives—*Mikania* in the wetter areas and *Chromolaena* in the dryer zones. About 50% of potential rhino areas are now affected by the principal invasive species with primary rhino habitats (Rajan Amin, pers. comm.) (Fig. 2). The initial focus in the short-term

could include improved cultural/mechanical control based on the experience from previous trials. Long-term measures could address developing biological control, looking at successful campaigns in India and elsewhere.

Bardia NP

Not much information is available on the impact of invasive species on rhino habitat. Again, the Zoological Society of London, the National Trust for Nature Conservation in Nepal and CABI have been working in the Park to understand the impact of invasive species and undertake mitigating measures through both short- and long-term planning.

Conclusion

It is now widely accepted that the control of alien invasive species is not a short-term or isolated effort. It requires the long-term application of efforts aided by constant monitoring and investigation. Concerted effort is needed to control invasive species and a better understanding of the causes of their spread can help to implement pre-emptive measures.

The potential of these invasive alien plants to destroy prime rhino habitat is enormous and should be investigated properly and immediately. The cost and difficulty of eradication increase exponentially with each season of delay. It cannot be over-emphasized; experience elsewhere has shown that if left too long the problem will become so immense that infestations cannot be practically or economically dealt with. Thus important habitats for the rhino would be destroyed.

Government agencies, institutions and individuals in rhino bearing areas lack adequate knowledge of the ecological and environmental consequences caused by invasive alien species and how to address it. Hence emphasis should be given to apprise policy makers, managers, conservationists, media and the academic community about this genuine threat to Asian rhinos.

References

- Biswas, T. and Mathur, V.B. (2003). 'The grasslands of Jaldapara Wildlife Sanctuary-composition, structure and their conservation significance'. *ENVIS Bulletin on Grassland Ecosystems and Agroforestry* 1(1):29–47.

- Ewel, J.J., O'Dowd, D.J., Bergelsen, J., Daehler, C.C., D'Antonio, C.M., Gomez, L.D. (1999). 'Deliberate introductions of species: Research needs'. *Bioscience* 49:619–30.
- Hooper, D.U., Chapin, F.S. III, Ewel, J. J., Hector, A., Inchausti, P., Lavorel, S., Lawton, J. H., Lodge, D. M., Loreau, M., Naeem, S., Schmid, B., Setälä, H., Symstad, A. J., Vandermeer, J., Wardle, D.A. (2005). 'Effects of Biodiversity on Ecosystem Functioning: A Consensus of Current Knowledge'. *Ecological Monographs* 75(1):3–35.
- Lahkar, B.P. (2008). 'Ecology and Management of Grassland with special reference to Grass and Bird Communities in Manas National Park'. Ph.D. Thesis Assam: Gauhati University, Guwahati.
- Larson, D.L., Anderson P.J., and Newton, W. (2001). 'Alien invasion in mixed-grass prairie: Effects of vegetation type and anthropogenic disturbance'. *Ecol Appl* 11:128–41.
- Love, A., Babu, S., and Babu, C.R. (2009). 'Management of *Lantana*, an invasive alien weed, in forest ecosystems of India'. *Current Science* 97(10):1421–1429
- Lowe S., Browne, M., Boudjelas, S. and De Poorter, M. (2000). *100 of the World's Worst Invasive Alien Species. A selection from the Global Invasive Species Database*. Published by the Invasive Species Specialist Group (ISSG) a specialist group of the Species Survival Commission (SSC) of the World Conservation Union (IUCN), 12pp. First published as special lift-out in *Aliens* 12, December 2000.
- Mack, R.N., Simberloff, D., Lonsdale, W.M., Evans, H., Clout M. and Bazzaz, F. (2000). 'Biotic invasions: causes, epidemiology, global consequences, and control'. *Ecol. Appl.* 10:689–710.
- Ricciardi A., Steiner, W.W.M., Mack R.N. and Simerloff. D. (2000). 'Towards a global information system for invasive species'. *Bioscience* 50(3):239–44.
- Sarma, P.K., Talukdar, B.K., Sarma, K. and Barua, M. (2009). 'Assessment of habitat change and threats to the great one-horned rhino (*Rhinoceros unicornis*) in Pabitora Wildlife Sanctuary, Assam, using multi-temporal satellite data.' *Pachyderm* 46:18–24.
- Talukdar, B.K. (2002). 'Dedication leads to reduced rhino poaching in Assam in recent years'. *Pachyderm* 33:58–63.
- Talukdar, B.K. (2003). 'Importance of anti-poaching measures towards successful conservation and protection of rhinos and elephants, north-eastern India'. *Pachyderm*, 34:59–65.
- Talukdar, B.K. (2006). Assam Leads in conserving the greater one-horned Rhinoceros in the new millennium. *Pachyderm* 41:85–89.
- Vattakkavan, J., Vasu, N.K., Varma, S., Gureja N. and Aiyadurai, A. (2002). 'Silent Stranglers: Eradication of Mimosa in Kaziranga National Park, Assam'. Wildlife Trust of India, New Delhi, 55 pp.
- Vitousek, P. M., Dantonio, C.M., Loope, L.L. and Westbrooks, R. (1996). 'Biological invasions as global environmental change'. *Am. Sci.*, 84:468–478.
- Yan, X, L Zhenyu, Gregg, W.P. and Dianmo, L. (2001). 'Invasive species in China—an overview'. *Biodiversity and conservation* 10:1317–1341.