Rhododendron gone wild

conservation implications of Rhododendron ponticum *in Britain*

Rhododendron ponticum *flowers*

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Wild rhododrendron (*Rhododendron ponticum*) is widely regarded by conservationists as a scourge of the British countryside. However, in its native haunts such as Turkey, it is also one of Europe's most threatened species, with ancient rhododendron forests now reduced to only a few hectares.

Few plants give more joy to the British public and cause more concern for conservationists than *Rhododendron ponticum*. It is native in western and eastern Mediterranean areas but, except as a naturalised alien in Britain and Ireland, it is absent from northwestern Europe. It was present in the British Isles during interglacial periods (Cross, 1975), but failed to recolonise after the last Ice Age. Rhododendron returned to Britain as seed, carried by plant collectors to Kew Gardens from Gibraltar in 1763. The first plants were established in 1765; with commercial introduction to estates from the 1780s up to the early 1900s for game cover, for wildlife habitat, shelterbelts, ornament and stock for cultivated, hybrid rhododendrons (Cross, 1975; Rotherham, 1983). From these sites it has successfully colonised diverse environments, usually on sandy or peaty, acid soil (Table 1).

Little attention has been paid to native *Rhododendron ponticum*. Abundant and a pernicious weed in managed forests in northeast Turkey, it is very restricted, and sometimes rare and vulnerable across much of its range – northwest Turkey, Bulgaria, Spain, Gibraltar and Portugal. The last small areas of apparently undisturbed ancient rhododendron forest in the high mountains of northeastern Turkey are some of the most rare and distinctive 'natural' plant communities in Europe and the Balkans. Unfortunately, it is associated with weed status throughout large areas of Turkey, and in much of its British range. The interest and vulnerability of the undisturbed, native locations has been overlooked, and is now particularly threatened.

In the British Isles, rhododendron behaves much as it does in disturbed native areas, spreading invasively and aggressively throughout suitable environments. Now widely established and especially invasive in western England, Wales (primarily Snowdonia), Scotland and Ireland (particularly in the southwest around Killarney), it is a serious threat to native vegetation and commercial forestry. In Killarney, the native *Arbutus* is considerd under threat of displacement, as is holly (*Ilex aquifolium*) elsewhere in Britain.

In favourable environments rhododendrons form dense, impenetrable thickets, and whilst the massed flowers in open locations are very popular with the public, it causes serious management problems for forestry and wildlife

Table 1. The major habitat-types in which *R. ponticum* is naturalised.

Semi-natural habitat types (relatively undisturbed)	*Artificial habitat-types (relatively disturbed)*
Heather moorland	Coniferous plantation
Lowland heath	Deciduous plantations
Semi-natural deciduous woodland	Managed heather moorland
	Permanent pasture
Acidic bogs	Railway/road embankments
Acidic sand dunes	Cuttings and verges
Unmanaged riverine sites	Quarries/spoil heaps
	Riverine and reservoir sites

(Adapted from: Rotherham and Read, 1988)

Table 2. Key Factors in Invasion

- Prolific production of viable, easily dispersed seeds
- Capacity for winter photosynthesis under suitable climatic conditions, such as Britain's Atlantic west coast
- Ability to tolerate severe shading
- Enhanced growth on soils of low nutrient status due to mycorrhizal infection
- Apparently diminished herbivore pressure, probably due to high concentrations of simple 'free' phenols in *R. ponticum* tissues
- Possible 'allelopathy' associated with high concentration of simple 'free' phenols
- The dense, vigorous growth resulting from the factors (1-6), enables *Rhododendron* to overtop, crowd-out and shade its competitors
- Site disturbance is important in creating regeneration sites to allow invasion

conservation. It is often invasive, spreading by seed and vegetative expansion. Layering freely, it shades out ground flora, preventing natural woodland regeneration and hindering forestry replanting (Colak *et al.*, 1998; Cross, 1975; Rotherham, 1990; Shaw, 1984).

Establishment in Britain is interesting since this isolated the plant from both its original native phytophagous fauna and its mycorrhizal fungus. It is suggested that invasions of British woodlands, with displacement of native species such as holly, is an example of successful penetration of undisturbed communities by an exotic species. The consequences of this dramatic spread of rhododendron, especially along the Atlantic coast of the British Isles, are often referred to as the 'rhododendron problem' – that is, the massive invasion of woodlands and commercial forests (Shaw, 1984). The present situation is well reviewed by Colak *et al.* (1998) who highlight important contrasts in status in native and exotic situations. Recent research (Abbot and Milne, personal communication), confirms the Iberian origins of most British material, and hybridization in many colonies.

The rhododendron problem has been approached in two distinct ways: (1) work on the underlying ecology of invasion and (2) investigation into practical control. Cross (1975) investigated the status of rhododendron in the British Isles, with detailed studies in southwest Ireland. Other local and regional surveys have since been undertaken across Britain (Rotherham, 1986). Research has identified eight key factors in the invasive behaviour of *Rhododendron ponticum*, (Table 2).

Why rhododendron invades: a strong competitor

While rhododendron performs well under shade, and itself shades out competitors, how it becomes so dominant has been unclear.

Poisoning of competitors (allelopathy) is a possibly-important but controversial aspect of plant interactions; and has been demonstrated in heathland plant communities. Also, the critical role of plant biochemistry in plant-herbivore interactions is firmly established. *R. ponticum* tissue concentrations of 'free' phenols are sufficient for either allelopathic influences or anti-herbivore interactions. Indeed, potentially toxic chemicals, particularly simple 'free' phenols occur in significant quantities in rhododendron tissues, and have caused poisoning in both vertebrates and invertebrates (Judd and Rotherham, 1992; Rotherham and Read, 1988).

Laboratory experiments have shown interference by *R. ponticum* on seedlings of competitors, growth being almost totally inhibited. These effects influence competition between rhododendron and native plant species and, in both field and laboratory, are not removed by water or nutrient addition (Rotherham and Read, 1988). Similar observations have been made for heather (*Calluna vulgaris*). The agents of these effects are probably 'free' phenols, and highly-toxic short-chain aliphatic (open-chain) acids (Rotherham, 1983; Rotherham and Read, 1988).

Tissue biochemistry is the key to many aspects of rhododendron ecology. Phenols are most concentrated in young rhododendron tissues, which, lacking physical toughness are most vulnerable to herbivores. Young, emergent leaf buds produce a sticky exudate high in phenols. This may combine physical and chemical deterrents to herbivores at a critical stage in leaf development. Phenol levels fall as tissue age, when protection is through physical toughness of mature leaves. Research has shown 'free' phenol concentration in *R. ponticum* tissues considerably higher than in associated woody and herbaceous plants. *In vitro* concentrations of biologically active flavonoids between 0.1% and 1% can have inhibiting effects, and concentrations in *R. ponticum* tissues exceed these. High toxin concentrations **not** alien status, as previously suggested, are responsible for restricted herbivory (Judd and Rotherham, 1992; Rotherham and Read, 1988).

Mycorrhizal roots, vital to the growth and establishment of most ericaceous plants (belonging to the heath family), dramatically increase growth-rate of rhododendron (Rotherham, 1983 and Rotherham and Read, 1988). With low nutrient soils, seedling dry weight increased by 184%. Mycorrhizal roots compete more effectively for nutrients, enhancing growth in nutrient-deficient soils invaded by rhododendron.

These factors combine to out-compete native plants, the significance of each varying with environmental conditions at individual sites.

How rhododendron invades: control and facilitation

Rhododendron has two mechanisms of spread: vegetative extension and seed. Colonisation by seed and domination by vegetative spread are critical for invasion. However, despite extensive dispersal of viable seed, rapid invasion of a site does not always occur. The facilitation of seedling establishment is vital.

Disturbance creates safe regeneration sites for seedling establishments and, in apparently stable plant communities, subtle disturbances may precipitate invasion. Unable to establish in closed herbaceous swards, and vulnerable to desiccation, grazing and competition, the seedlings require damp, bare or mossy ground, and are the 'Achilles heel' for this generally competitive and robust plant. This vulnerability is partly compensated by huge numbers of seeds (>one million per bush), but suitable conditions for establishment are the key. Regeneration sites are essential for successful establishment in new areas, disruption of established vegetation giving opportunities for invasion. Like many aliens, rhododendron invades disturbed environments (roadsides, riversides, railway embankments *etc*). The invasion of established communities, in one location but not another, raises critical questions.

*Figure 1.*Rhododendron ponticum *spreading in the Cordwell Valley in the Derbyshire Peak District.*

The importance of disturbance

Grazing animals impact directly on the plant and indirectly *via* its environment. Browsing damage is limited by physical toughness of mature leaves, and by chemical toxins in young tissues. Since unpalatability of plant tissues is learnt and not instinctive, some damage to rhododendron occurs with young, inexperienced animals. Grazing animals also affect rhododendron seedlings where the amount of toxin is insignificant and the leaves relatively soft. Rabbit grazing restricts invasion but, following myxomatosis and the rabbit population crash, rhododendron spread rapidly into disturbed bare ground. Grazing may prevent establisment in new areas, but is ineffective in established stands of rhododendron.

However, the situation is complex. In the Irish Killarney oakwoods sika deer disturb soil and vegetation, enabling rhododendron invasion. In England's Peak District, sheep and deer grazing produce similar effects: high-grazing levels preventing colonisation but low levels triggering invasion.

Other disturbance by land management (forestry, fires and intensive recreation) may facilitate invasion by generating safe sites for seedlings. Moorland fires (accidental and deliberate) have been followed by rapid establishment from nearby rhododendron colonies, with complete replacement of heather moor in less than ten years.

Strategic control

Rhododendron control has two central issues: the eradication of existing populations, and the need to contain and minimise encroachment. Eradication at sites may be difficult if not impossible due to massive seed production, a propensity to regenerate from cut stumps and roots, together with physical and chemical resistance to herbicides. The terrain of many infested sites makes physical removal by machine very difficult. Also, for long-term control, land management in susceptible areas must be modified to minimise future invasion. This requires a strategic approach: removal and containment. At some sites high effort results in removal and control in limited heavily-infested areas, but at the same time massive invasion occurs elsewhere on the same estates. Resources are better applied to wider control of young, invasive plants and containment of mature stands.

Impact on fauna

Introduced to Britain, rhododendron was a vacant niche for herbivorous insects. As a food source it is predictable, apparent, and available all year. It was suggested that taxonomic isolation in Britain limits pre-adapted, herbivorous fauna, but in time it would acquire associates from native communities. The invasive nature of alien *R. ponticum* was attributed to restricted invertebrate herbivory, and despite over two hundred years here, this fauna is very restricted. Judd and Rotherham (1992) assessed the phytophages associated with *R. ponticum* in Britain.

Fourteen phytophagus (plant eating) insects were positively associated with *R. ponticum* in surveys with an additional 17 taken from literature, a total of 31. These were in two categories: (a) 26 highly polyphagous indigenous phytophages, (b) five host-specific introduced phytophages. Most were common polyphytophagous insects (those associated with a broad range of host plants) and were only found on rhododendron occasionally. Only two were frequent or numerous on rhododendron.

Seventeen other insects were found, but either feeding or identification were not confirmed. Some may be associates, but many insects had fallen as larvae from the tree canopy and, when reared on rhododendron leaves, tended to fail, suggesting poor adaptation.

Other associates are psocids (of the order Psocoptera) feeding on epiphytic fungi (growing on rhododendron for support but not feeding on it). With predators and parasites, these add to the biodiversity and biomass of associates. Predators also take fungivores; and the fungivores, predators and parasites feed higher predators. 'Tourist' species and casually-associated lepidopteran larvae are also taken. Many insects (especially diptera) and arachnids

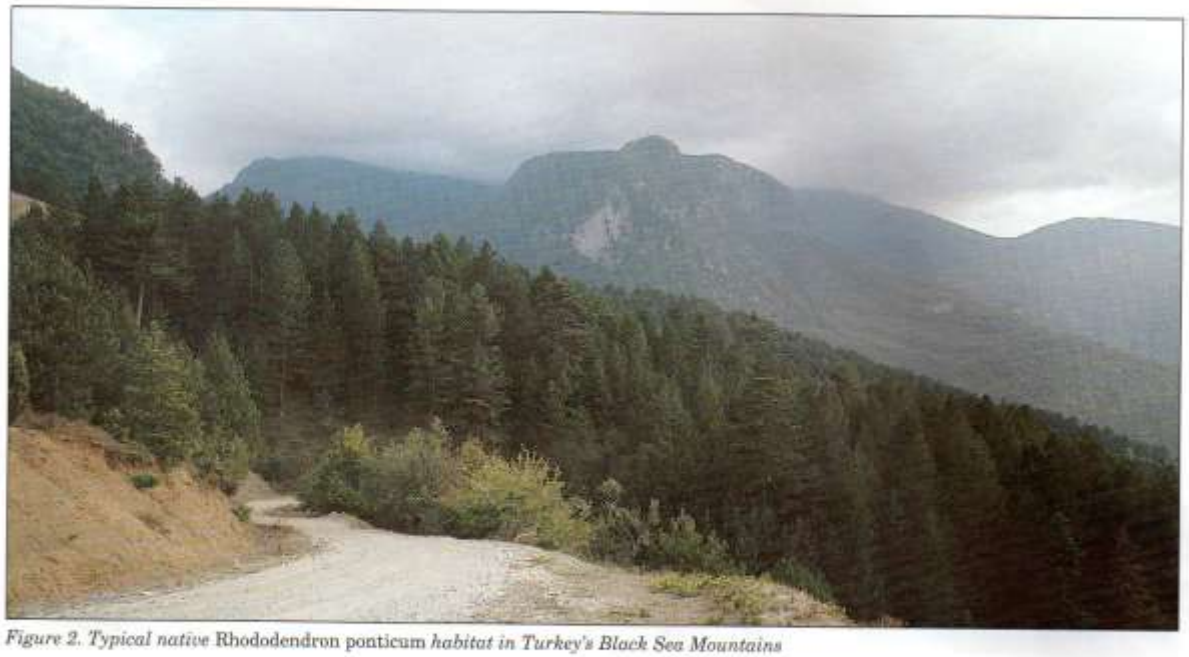

Figure 2. Typical native Rhododendron ponticum *habitat in Turkey's Black Sea Mountains*

are trapped by the sticky exudate of young rhododendron shoots. Predators take these immobilised arthropods, but themselves risk being trapped.

Comparison with other trees and shrubs

Thirty-one insects on *R. ponticum* in Britain, place it twenty-second (with Juniper (*Juniperus communis*) in a table of trees and shrubs with their associate phytophages. This list includes planted and naturalised aliens, and natives. For comparison, hawthorn (*Crataegus monogyna*) has 204; hazel (*Corylus avellana*) 102; and holly (*Ilex aquifolium*) has 10. *Buddleia davidii* another alien shrub (introduced around one hundred years ago and more isolated taxonomically), already has 37. Other species with less recorded associates than *R. ponticum*, include hornbeam (28), sweet chestnut (11), horse chestnut (7), false acacia (2), holm oak (5), walnut (5), yew (5).

Comparison with other plants can be misleading. Most insects associated with *R. ponticum* are catholic species found at sites with or without it. Just six (five phytophages and one predator) are host-specific to rhododendron, only three being frequent, numerous and widespread.

Biomass and diversity of associated fauna

Distinction is made between the number of species associated with a particular host plant and total associated biomass. *R. ponticum* is impoverished in both. Alien status and taxonomic isolation in Britain could explain this, and rhododendron may develop an adopted fauna. However, after 200 years, this has happened only slowly. Further casual associates of common polyphages will arise but a herbivore having a major impact is unlikely. The small number of invertebrate herbivores associated with *R. ponticum* in Britain is probably not due to its alien status, but is more likely a result of physical and biochemical tissue characteristics. These apparently restrict herbivore activity both in Britain and in its native haunts. Interestingly, little is known of the endemic fauna, except that where native, rhododendron is often invasive and generally unaffected by herbivore activity (Colak *et al.*, 1988).

Impact on mammals and birds

Rhododendron is generally felt to have a negative impact on British wildlife; replacing native vegetation with dense, mono-specific rhododendron stands. Substantial declines in breeding birds were found in infested Welsh and Irish woodlands. However, the impact is not simple and depends on *type* and *quality* of environment, and degree of infestation. Comparisons between unaffected, semi-natural woodlands and those with single-species rhododendron thickets show reduced diversity of structure and of associated fauna with rhododendron thickets show reduced diversity of structure and of associated fauna with rhododendron. Some species still utilise dense rhododendron. Warblers such as blackcap and chiffchaff, and the thrush family (robin, blackbird and nightingale) all feed and nest in rhododendron thickets, and northern expansion of chiffchaff has been linked to rhododendron. As noted by many ornithologists, dense stands are favoured winter roost sites for huge numbers of finches and thrushes. It provides cover for mammals, nesting and roosting birds, and a useful screen in areas of intense public use. Insects attracted to the masses of flowers during May and June, provide important food for predatory invertebrates and insectivorous birds. Coinciding with the critical period for birds feeding young, this can be a locally important food source.

Mammals are affected by invasion, with obvious effects of displaced native vegetation and some unexpected benefits. Badgers thrive under rhododendron, and sometimes have above-ground setts (Ernest Neal, personal communication). Otters in Wales and Scotland use dense riverside rhododendron cover for holts, and lying-up. Deer (red, fallow and roe) utilise rhododendron cover, as do sika deer in southwest Ireland, and muntjac in southeastern England. (These alien species are also widely regarded as a menace to native wildlife!)

Conclusions

As an alien, rhododendron is a problematic weed. However, the need to conserve native rhododendron, and address key aspects of its history and its ecology are highlighted by

recent research. If *R. ponticum* had recolonised the British Isles after the last Ice Age, our personal view of its native/ exotic status and conservation merit would be very different. Like many exotic species, 'wild' rhododendron is firmly established in Britain. Like it or not, it is here to stay, and management must accept co-existence, with containment not eradication. Acceptance of aliens strikes at the core of much conservation training, but is at least pragmatic.

The problems of managing rhoododendron in commercial forests are similar in native and exotic locations. Control is seen as necessary and desirable, but this is often without any thorough survey, or assessment of whether control is feasible. This approach has been exported from Britain to the native environments of rhododendron, where it may be unique and endangered. The imminent threat to ancient rhododendron forest in Turkey, and other native locations gives serious cause for concern.

Management of exotic species (such at *R. ponticum* in Britain) requires a strategic approach. Control, whilst effective, may be difficult and expensive, and may damage woodland ecology and archaeology. For long-term effectiveness (particularly avoiding recolonisation by rhododendron when control stops), different site management is necessary. Long-term on-going control measures are needed. The initial invasion into woodland by young rhododendron is the most effective stage for control, but most management strategies attack mature, established thickets. These are difficult and expensive to treat, damage to the original site has already occurred, and wildlife interest (badger setts, bird roosts *etc*) may be affected. Containing established colonies, and controlling invasive areas, is more effective.

Finally, many British locations for rhododendron are landscaped parks and gardens of the 1700s and 1800s. Rhododendrons are often fundamental in the landscape and structure planting, the cultivars and species (including *R. ponticum*) as integral to the historic landscape as the planted trees and built structures. Here, eradication for nature conservation is a misconception. These are imposed landscapes that often removed the original history and ecology in their development. Rhododendron, an alien, is in a landscape of aliens. Management and control of rhododendron should be appropriate. The misapplication of eradication under a guise of conservation should be moderated and resources should be concentrated where most vitally needed.

References and further reading

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Websites

www.shu.ac.uk/sybionet
The official website of the South Yorkshire Biodiversity Research Group and Biodiversity Network.

www.invasiveweeds.co.uk
British website with information about invasive weeds that are currently causing concern, such as Japanese Knotweed (*Fallopia japonica*) and Himalayan balsam (*Impatiens glandulifera*).

www.shu.ac.uk/wildtrack
Home of the Journal of Practical Ecology and Conservation, containing information and opinions on practical aspects of land management and restoration ecology, survey techniques and relevant professional practice.

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