

## Range expansion of an endangered beetle: Alpine Longhorn *Rosalia alpina* (Coleoptera: Cerambycidae) spreads to the lowlands of Central Europe

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*Rosalia alpina* is an endangered and strictly protected icon of saproxylic biodiversity throughout its range. Despite its popularity, information on its habitats and host-plants is insufficient, which may compromise the adoption of suitable conservation strategies. *R. alpina* has been considered as montane and associated with beech in central Europe, whereas in southern Europe *R. alpina* has often been reported from lowlands and its host spectrum is broader. We present evidence of an elm-feeding population of *R. alpina* occurring in a lowland (beech-free) forest in the Czech Republic. This plus other information available suggest, that *R. alpina* spreads into central European lowland forests along large rivers, and that spectra of hosts and habitats exploited by *R. alpina* in Central Europe are wider than generally thought. Alteration of its habitat preference has either occurred in Central European populations, or lowland-inhabiting populations from the South are spreading northwards, possibly due to climate change.

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### 1. Introduction

Saproxylic organisms are among the most rapidly declining elements of European biodiversity, and thus have a prominent position in most national

red-lists of European countries. The Alpine or Rosalia longhorn (*Rosalia alpina* Linnaeus, 1758) is an attractive, widely known icon of saproxylic biodiversity conservation, thus representing the saproxylic guild to the general public.

It is classified as endangered or critically endangered in most European countries (Jäch 1994, Geiser 1998, Nicollet & Lempérière 2002, Witkowski *et al.* 2003, Farkač *et al.* 2005), and is listed in the IUCN Red List of Threatened Species (IUCN 2007). It is a “priority species” among the 21 saproxylic beetles explicitly protected by the EU Habitats Directive (Council of the European Communities 1992).

The original range of *R. alpina* covers southern and central Europe (Sama 2002). The current distribution is highly fragmented, with only a few isolated localities in most of central Europe (Binner & Bussler 2006). In the Czech Republic for example, only a few populations survived to the end of the 20th century, although many populations existed at its beginning (Sláma 1998); *R. alpina* became extinct in most of Germany, surviving only in the south (Bense 2002). In Poland, the surviving populations inhabit the Carpathians, although old records came from many parts of the country (Starzyk 2004). The situation is better in Austria, Switzerland and Slovakia, where the distribution is less fragmented or even continuous in parts of the Alps and Carpathians (Sláma 1998, Gepp 2002, Duelli & Wermelinger 2005, Jendek & Jendek 2006).

The transformation of beech forests into conifer plantations is often given as a major cause of *R. alpina* decline (Sláma 1998, Duelli & Wermelinger 2005); the beetle, however, became extinct even in many areas where beech is still common. This species prefers old trees and traditional woodland management practices such as pasturing and pollarding (Sláma 1998, Binner & Bussler 2006, Lequet 2008). Alteration of woodland structure brought about by modern forestry, such as increasing canopy closure and removal of old trees, thus seems to be the primary cause of its decline.

*R. alpina* has always been associated with beech in central Europe (Heyrovský 1955, Sláma 1998, Csóka & Kovács 1999, Sama 2002, Starzyk 2004). It has also been reported as developing in other hosts, but these observations are usually rare, and the former distribution of *R. alpina* corresponds with the distribution of beech (Horion 1974, Švácha & Danilevsky 1988, Merkl *et al.* 1996, Zabransky 2001, Binner & Bussler 2006, Ciach *et al.* 2007). As a result of this association

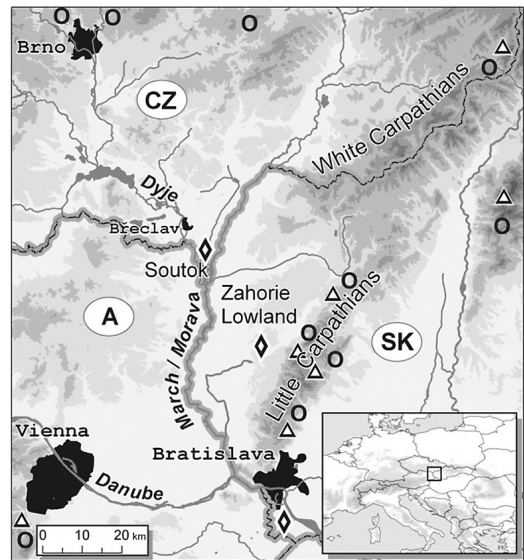


Fig. 1. Historical and current distribution of *Rosalia alpina* in and near the Vienna Basin. Empty circles: distribution up to 1990s; triangles: currently occupied mountain localities; diamonds: currently occupied lowland localities.

with beech, *R. alpina* occurred at middle and higher altitudes, and was considered a montane species in central Europe (Heyrovský 1955, Sláma 1998, Csóka & Kovács 1999, Starzyk 2004, Duelli & Wermelinger 2005). *R. alpina* displays a broader host range and occupies more habitats in southern Europe (e.g. Sláma 1998), where some populations are not associated with beech and inhabit sea-shore and floodplain forests (Luigioni 1923, 1927, Simandl 2002). The northernmost occurrence of such a population was reported from southern Hungary (Horvátovich 1980).

Jendek & Jendek (2006) reported the expansion of *R. alpina* to the beech-free lowlands of south-western Slovakia. This suggests that a change in the ecology of *R. alpina*, including its habitat and host preferences, is recently occurring in central Europe.

In this paper, we report the existence of an elm-feeding population of *R. alpina* in a floodplain (beech-free) forest in the south-east of the Czech Republic and discuss its origin, and ecology. We also review information on host plants and habitats of *R. alpina*.

## 2. Methods

The records of adults reported below were mostly the result of accidental encounters by the authors; only one adult was caught in a flight interception trap set at 0–50 cm above ground during a systematic survey. Potential host plants were deliberately searched for larvae and exit-holes. All records originated from an area of approximately 10 km<sup>2</sup> in the Soutok Game Park; exact localities are omitted for conservation reasons.

”Soutok Game Park” lies in the south-eastern tip of the Czech Republic (48°40’N 16°57’E; 151–153 m a.s.l.) south of the town of Břeclav (Fig. 1). The area is an occasionally (i.e. 1–2 times a year) flooded alluvium of the lower Dyje (Thaya) and Morava (March) rivers. It is covered by a complex of woodlands and meadows. The forests are mainly even-aged oak, ash and poplar

plantations, with occasional remnants of pasture woodlands. The prevailing trees are pedunculate oak (*Quercus robur*), narrow-leaved ash (*Fraxinus angustifolia*), hornbeam (*Carpinus betulus*), limes (*Tilia cordata*, *T. platyphyllos*), elms (*Ulmus laevis*, *U. minor*), white and black poplar (*Populus alba*, *P. nigra*), and field maple (*Acer campestre*). Beech (*Fagus sylvatica*) does neither occur naturally here, nor has it been planted (Vičerek et al. 2000).

## 3. Results

Adults: 1994 – single female found on August 16 by J. Helešic (JH); 2001 – two females observed in July by JH; 2006 – one adult male observed in July by D. Hauck (DH); 2007 – one female caught in flight interception trap set between June

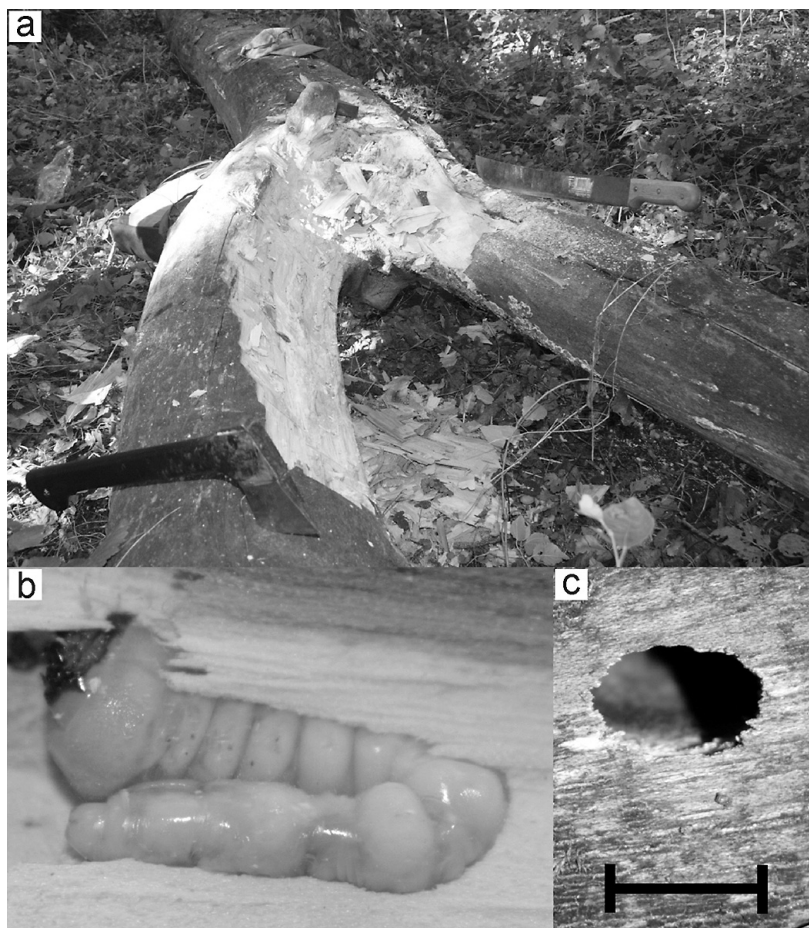


Fig. 2. – a. Broken dead elm where *Rosalia alpina* larvae and exit-holes were found. – b. Larva in the heartwood of dead elm. – c. Fresh exit hole in dead elm. Scale 10 mm.

12 and June 27; one male observed on a fallen elm trunk on June 27 by J. Schlaghamerský; one individual observed on June 23 by JH.

Larvae: Five larvae were found in a fallen elm trunk by J. Bořucký (JB), DH and L. Cizek on September 23, 2007; identified by JB, confirmed by Petr Švácha (Institute of Entomology, České Budějovice). The elm trunk had partial contact with the ground; it was without bark, but the wood was still hard. Fresh and older exit holes and larvae 22–40 mm long were found in parts of the trunk with no direct contact with the ground. The diameter of infested parts was 30–45 cm. (Fig. 2 a, b)

Exit holes: Exit holes of oval shape (8–10 mm × 4–5 mm) (Fig. 2 c), not belonging to any other co-occurring xylophagous species, were found on four other elms in a similar stage of decay (i.e. hard wood, no bark; diameter 22–90 cm) in the same forest stand. Some pieces with fresh looking exit holes had apparently been moved by flooding that had occurred at the locality twice in 2006. All trunks with exit holes of *R. alpina* found were lying on the forest floor; however, the parts containing the exit-holes were not in direct contact with the ground.

## 4. Discussion

The occurrence of *R. alpina* has been recorded in the Soutok Game Park over a period of 13 years, repeatedly and independently by several entomologists. Sightings have become more frequent over time. A population of *R. alpina* is thus established in this area with no beech present. Larvae and exit holes provide the evidence that the host plant of *R. alpina* at this locality is elm.

### 4.1. Colonisation of the reported site and potential source populations

The Soutok Game Park and the adjacent alluvial forests along the Dyje River near the town of Břeclav are renowned for their rich fauna of saproxylic insects. The area is frequented by entomologists, insect collectors, natural-history enthusiasts and photographers. As a result, the entomofauna of the area is rather well known (Hepp-

ner 1971, Rozkošný & Vaňhara 1995–1996, 1998–1999). However, with the exception of the single individual found in 1994, all records fall into the period 2001–2007. Further, JH and JS observed the beetle only after multiple seasons of surveying the locality (JH has been working as a forester in the area since 1990; JS has been studying saproxylic beetles there since 1996). We consider it highly unlikely that such an attractive and widely known species would escape the attention of generations of naturalists visiting the area. Therefore we assume that *R. alpina* has only recently colonized the area.

No surviving *R. alpina* population is known from the upstream catchments of the Morava and Dyje rivers; this makes it unlikely that a log infested by *R. alpina* larvae was deposited from upstream. The closest beech stands are found about 20 km NW of Soutok Game Park (Pálava Protected Landscape Area); however, *R. alpina* is absent at this extremely well-surveyed locality (cf. Rozkošný & Vaňhara 1995–1996). The closest localities traditionally occupied by this species include montane sites 30–40 km away (Little and White Carpathians). In Austria, the range of *R. alpina* populations inhabiting the Alps reaches Vienna. The closest known “lowland population” was recently reported from the Záhorie lowland (exact locality not given) in western Slovakia (Jendek & Jendek 2006). The Záhorie lowland borders the Soutok Game Park in the east (Fig. 1). The population in Soutok Game Park therefore most likely originated there.

### 4.2. Host-plants

Two elm species are native to the Soutok Game Park. Although difficult to tell apart in this state of decay, the logs occupied by *R. alpina* were most likely European white elm (*Ulmus laevis*). The co-occurring smooth-leaved elm (*U. minor*) is more prone to Dutch elm disease, has thus become rare in the area, and usually only reaches a shrub-like appearance (Vicherek *et al.* 2000). It is likely, however, that *R. alpina* is able to use any elm species available since mountain elm (*Ulmus glabra*) has been recently reported from central Europe as its host plant (Binner & Bussler 2006, Ciach *et al.* 2007), and records of elm as a host

plant of *R. alpina* in Italy (Luigioni 1923, 1927) most likely refer to smooth-leaved elm.

Although *R. alpina* was always considered to be beech-associated in central Europe, there is considerable evidence suggesting that its host spectrum is broader than usually thought. Many authors have referred to its development in several other tree species, including conifers, but such records were considered aberrant and/or unreliable (Heyrovský 1955, Kaszab 1971, Sláma 1998, Czóka & Kovács 1999, Sama 2002, Starzyk 2004, Duelli & Wermelinger 2005). Regular exploitation of sycamore maple as a second host after beech was reported from the Alps (Zabransky 2001, Binner & Bussler 2006). Well documented reports of occasional development in trees other than beech in central Europe include mountain elm (Binner & Bussler 2006, Ciach *et al.* 2007), lime (*Tilia* spp.) (Merkl *et al.* 1996, Bense *pers. comm.*), sycamore maple (*Acer pseudoplatanus*) (Kovács 1998, Zabransky 2001, Bense *pers. comm.*), field maple (*Acer campestre*) (Merkl *et al.* 1996, Kovács 1998, Bense *pers. comm.*), Norway maple (*A. platanoides*) (Kovács 1998), ash (*Fraxinus* sp.) (Bense *pers. comm.*) and probably also hornbeam (*Carpinus betulae*) (Merkl *et al.* 1996).

### 4.3. Habitat use

All the above records, though, originated from sites traditionally occupied by *R. alpina* in montane and submontane beech forests. They show that the host spectrum of *R. alpina* in central Europe is wider than generally thought, but do not indicate any substantial changes in the habitat use of *R. alpina*, because occasional use of alternative hosts is common among xylophages feeding on dead wood (Hanks 1999).

On the other hand, *R. alpina* populations inhabiting alluvial and seashore forests with no beech present exist in southern and western Europe (Luigioni 1923, 1927, Sláma 1998, Simandl 2002, Lequet 2008), suggesting that host and habitat requirements of montane populations of central Europe differ from the requirements of lowland populations of southern Europe. The latter are either more polyphagous or prefer trees other than beech. The distribution of “lowland”

populations probably used to reach southern Hungary up to the 1980s (Horvatovich 1980 in Kovács *et al.* 2001). Kaszab (1971) notably observed that Hungarian *R. alpina* was associated with beech, but in the south of Hungary it was also observed on hornbeam, ash (*Fraxinus* spp.) and walnut (*Junglans* sp.). Present lowland localities of *R. alpina* in western Slovakia include the Zahorie lowland (where *Tilia* sp. was the reported host), Levice and the island of Kopáč near Bratislava (*Ulmus* sp. reported as host). All these localities are beech-free stands, and were noted as examples of the recent expansion of *R. alpina* into the lowlands of western Slovakia (Jendek & Jendek, 2006).

## 5. Conclusions

In central Europe the Alpine longhorn originally inhabited montane and submontane beech forests. Its occurrence in the Soutok Game Park and lowlands of western Slovakia supports the assumption that the species is spreading to lowlands of central Europe. Records of *R. alpina* in alluvial forests along the Danube and its tributaries in eastern Austria and northern Hungary are thus likely to appear soon. To explain the spread of *R. alpina* into the lowlands of central Europe, we propose two alternative hypotheses: (i) The populations inhabiting lowlands in the south have expanded northwards, possibly in association with recent climate change (e.g. Konvička *et al.* 2003, Dennis & Sparks 2007); (ii) a shift in host preferences occurred in the originally beech-associated submontane and montane populations of the Carpathians, allowing down-slope expansion. Studies employing methods of molecular phylogeography are necessary to test the above hypotheses. Regarding host plant use, the spectrum of host plants regularly exploited by *R. alpina* is wider than generally thought. The beetle develops in wood of several distantly related families (i.e. Aceraceae, Betulaceae, Fagaceae, Oleaceae, Tiliaceae, Ulmaceae).

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