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Biometry of adult rosalia longicorn *Rosalia alpina* (L.) (Coleoptera: Cerambycidae) from the Polish Carpathians: a preliminary study

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ABSTRACT. The body size of xylophagous beetles is determined by the host plant species, as well as by the amount and quality of breeding material. Consequently, the biometric traits of adults can be used as an indicator of the attractiveness of the breeding material and the quality of a habitat. The paper presents selected biometric traits of rosalia longicorn *Rosalia alpina* (L.) imagines in three populations from the Beskid Niski Mts (Carpathian Mts, south-eastern Poland). Two populations of this beetle from managed forests and one from a protected area in the Magura National Park were compared. The former developed on two different host plants (European beech *Fagus sylvatica* and wych elm *Ulmus glabra*), the latter on European beech. No significant differences were found between the biometric traits of imagines from the three populations. No intersexual differences were found for the width of the pronotum in any of the populations, but females had longer elytra than males in all the populations. The lack of body size differences in these populations potentially indicates that this species occurs only in favourable habitat conditions. The limited species range and the patchy distribution of the rosalia longicorn are indications of its stringent habitat requirements and its dependence on forest management. Habitats supplying a sufficient amount and quality of suitable breeding material for the development of the rosalia longicorn should be protected.

KEY WORDS: Coleoptera, Cerambycidae, *Rosalia alpina*, biometry, morphology, body size, Carpathians.

INTRODUCTION

The biometric traits of imagines of cambio- and xylophagous insects can be a valuable source of information on a population inhabiting a given territory. The body size of insects may depend on the host plant species, the size/volume of breeding material and the conservation status of a habitat (STARZYK & STROJNY 1985, GUTOWSKI 1986, HANKS et al. 1993, HANKS et al. 2005, NAVES et al. 2006). Consequently, body size can be used as a potential parameter determining the attractiveness of the breeding material and the quality of a habitat.

The rosalia longicorn *Rosalia alpina* is one of the most recognizable rare species of saproxylic beetles in Europe. In Central Europe, it occurs mainly in old mountain beech forests (BURAKOWSKI et al. 1990), where it is associated mainly with the genus *Fagus*, but other species have also been reported as its larval host plants (ŠVÁCHA & DANILEVSKY 1988, BURAKOWSKI et al. 1990, BENSE 1995, SLÁMA 1998, SAMA 2002, BENSE et al. 2003, BINNER & BUSSLER 2006, CIACH et al. 2007, CIZEK et al. 2009). In Poland, until recently, the European beech *Fagus sylvatica* L. was the only known host plant of rosalia longicorn larvae (STARZYK 2004). Recently, in the Beskid Niski region, this beetle has been observed to be associated with wych elm *Ulmus glabra* HUDS. and European ash *Fraxinus excelsior* L., which indicates an extension of the species' niche (CIACH et al. 2007, CIACH & MICHALCEWICZ 2009, MICHALCEWICZ et al. 2011, MICHALCEWICZ & CIACH 2012a).

The rosalia longicorn is regarded as a symbol of mountain wildlife and its protection (GUTOWSKI 2004). However, managed forests offer different conditions for the development of populations of cambio- and xylophagous species compared with those offered by protected areas. The removal of dead and dying trees, as well as their parts, from the former depletes the nutritional resources of cambio- and xylophagous species. As a result, there might be differences in the sizes of insects inhabiting these two types of areas. Moreover, populations occurring at their range limit or isolated populations may differ from populations occurring in the central part of the range.

The paper compares the biometric traits of rosalia longicorn imagines in three populations from the Beskid Niski Mts (Carpathian Mts, SE Poland). The research covered populations living in similar geographical conditions: two of them are from logged forests, where they use different host plants – European beech and wych elm, and one population comes from the protected area of the Magura National Park, where European beech has been observed as the host plant. Our hypothesis was that the biometric characteristics of the imagines from these populations would differ from each other: individuals living in the protected area would be larger than those in the logged forests, which in turn would differ from each other due to the colonization of different host plants.

MATERIAL AND METHODS

The study area

The study was carried out in three populations of the rosalia longicorn located in the Beskid Niski mountain range (Carpathian Mts, SE Poland) (Fig. 1). All the populations used habitats located in similar geographical conditions, in areas where the European beech and silver fir *Abies alba* MILL. are the main tree species.

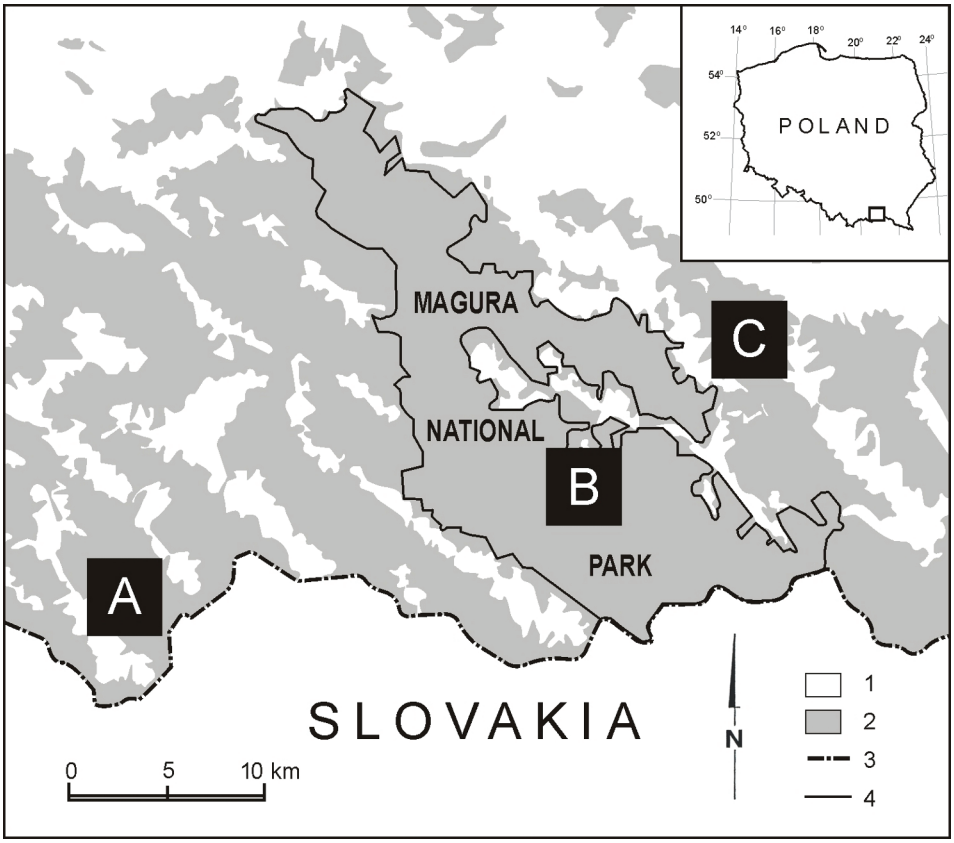

Fig. 1. Location of the study area; the squares show the sampling localities: A – Łosie Forest Division, B – Magura National Park, C – Dukla Forest Division (1 – farmlands, 2 – forests, 3 – state frontier, 4 – Magura National Park border).

A) The Łosie Forest Division is situated mostly in the western part of the study area, between 49°24' and 49°39'N, and between 21°00' and 21°19'E (300-994 m). Rosalia longicorn imagines were caught on Mount Gródek near the village of Wysowa-Zdrój,

where fertile Carpathian beech forest *Dentario glandulosae – Fagetum* occurs over most of the area. Here, European beech is regarded as the only host plant of the beetle. At this site, other potential host species and the amount of their dead wood are limited. Forests in this area are logged.

B) The Magura National Park is situated in the centre of the study area, between 49°25' and 49°38'N, and between 21°17' and 21°39'E (400-850 m). It has an area of 19 439 ha and is mostly covered by a mosaic of woodlands, which constitute 96% of the total area, and meadows. Fertile Carpathian beech forest is the dominant forest plant community. Rosalia longicorn imagines came from different sites within the park. There, the European beech is dominant and rosalia longicorn larvae use this tree as host plant. Although other potential host species are available, the amount of their dead wood is limited. Part of the forest in this area is subject to a strict conservation regime.

C) The Dukla Forest Division is situated in the eastern part of the study area, between 49°23'N and 49°44'N, and 21°24'E and 21°52'E (310-727 m). Imagines of the rosalia longicorn came from a recently described habitat of the species, consisting of a forest clearing community in a sere with partly dying and dead wych elm. The development of the longhorn beetle in the elm wood was reported there (MICHALCEWICZ et al. 2011). At this site, other potential host species of dead wood is very limited. The forests in this area are logged.

The rosalia longicorn may use several hosts, often at a single site, and, being active and undertaking regular movements (DRAG et al. 2011), may have developed on a tree other than the one it was collected from. However, based on host species occurrence and the availability of dead wood at all the sites visited, the above host associations are the most probable. Exit-holes, a possible indicator of the occurrence of these beetles and of the host association (CIACH & MICHALCEWICZ 2013), were recorded in all areas studied.

Field methods

Free-living adults of rosalia longicorn were captured at all the study sites. Biometric traits were measured in the field between 8 July and 10 August 2011. The width of the pronotum at the widest point and the maximum length of the left elytron were measured (Fig. 2) to an accuracy of 0.1 mm. The sex of the imagines was determined on the basis of morphological traits and behaviour. In order to avoid repeated measurements, the insects were marked and photographed before being released. Altogether 127 exx. of the rosalia longicorn were measured: 50 exx. from the Łosie Forest Division, 35 exx. from the Dukla Forest Division and 42 exx. from the Magura National Park.

Data analysis

The statistical procedures were performed using Statistica 8.0 software (StatSoft 2008) according to ZAR (1999). The data distribution of the biometric parameters did not differ from the normal distribution (Shapiro-Wilk W test). The error variance in the biometric

parameters was similar among all categories of sex and location (Levene's test of equality of error variance). Two-way ANOVA was applied to compare the rosalia longicorn's biometric parameters. Sex, location and interaction sex*location were used as independent variables. All tests were considered significant at $p < 0.05$.

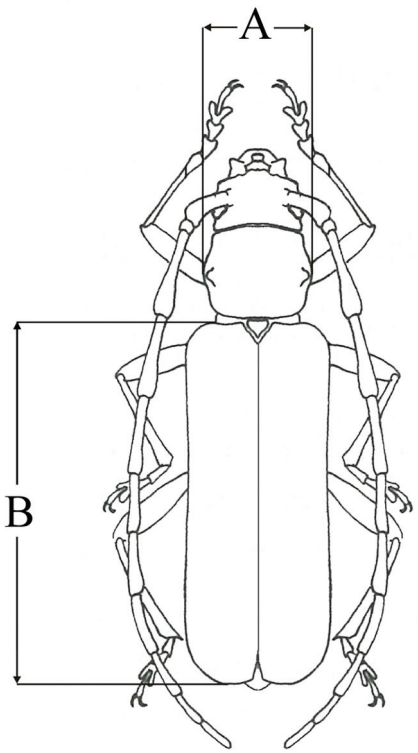

Fig. 2. The measurement method applied to selected body parts of rosalia longicorn *Rosalia alpina* (L.) imagines: A – the width of the pronotum, B – the length of the left elytron (figure drawn by Przemysław Szwałko).

RESULTS

Mean pronotum width was 5.58 (±0.64 SD, range 4.0-7.3, N = 84) in males and 5.58 (±0.40 SD, range 4.7-6.2, N = 43) in females. Mean elytron length was 19.44 (±1.96 SD, range 14.6-23.9, N = 84) in males and 21.36 (±1.56 SD, range 17.6-24.5, N = 43) in females. No inter-population differences in body size were found (Fig. 3, Table 1 and 2). There were no intersexual differences in pronotum width, but elytron length was significantly shorter in males (Fig. 3, Table 2).

Table 1. Biometric parameters of rosalia longicorn *Rosalia alpina* (L.) males and females at different locations in the Beskid Niski Mts.

	Dukla Forest Division			Łosie Forest Division			Magura National Park		
	mean	SD	range	mean	SD	range	mean	SD	range
	males (N = 25)			males (N = 30)			males (N = 29)		
pronotum width	5.61	0.56	4.4-6.6	5.55	0.66	4.2-7	5.60	0.71	4-7.3
elytron length	19.56	1.85	15.4-23.1	19.46	1.96	14.6-23.2	19.33	2.12	15-23.9
	females (N = 10)			females (N = 20)			females (N = 13)		
pronotum width	5.63	0.49	4.7-6.2	5.54	0.36	4.9-6.2	5.60	0.39	4.8-6.1
elytron length	21.61	1.90	17.6-23.6	21.20	1.25	18.5-23.7	21.42	1.79	18.2-24.5

Table 2. Influence of sex and location on pronotum width and elytron length in rosalia longicorn *Rosalia alpina* (L.) in populations from the Beskid Niski Mts.

	pronotum width			elytron length		
	F	df	p	F	df	p
intercept	9966.24	1	0.000	12940.05	1	0.000
sex	0.00	1	0.983	29.71	1	0.000
location	0.19	2	0.831	0.18	2	0.837
sex*location	0.01	2	0.991	0.11	2	0.897

DISCUSSION

The body size of xylophagous insects is influenced by the quality and amount of material in which the larva developed. Climatic conditions, such as irradation and humidity, or the presence of specific wood-rotting fungi may play a significant role in larval development (GUTOWSKI 2006). The amount of host material can be regarded as an indicator of the quality and natural condition of forest habitats. GUTOWSKI (1986) reported differences in body size of adult *Alosterna tabacicolor* (DE GEER) between logged and virgin stands in the Białowieża Forest: the specimens collected in the latter woodland were larger than those collected in the former. This is a consequence of the considerable numbers of large, dead trees in natural or primeval forests. Large body size could thus be an indicator of a good habitat. In *Cerambyx cerdo* L. body size and adult weight also increased with increasing circumference and diameter of the trees from which the beetles were reared or collected (STARZYK & STROJNY 1985).

The size of adult *Phoracantha semipunctata* (F.) beetles emerging from a log was positively correlated with the age and size of the logs (HANKS et al. 2005). In consequence,

local differences in host material size and quality may cause variation in beetle size at one locality. However, the mean body size of a given population can be a potential indicator of habitat quality. The body sizes of imagines from populations living in highly natural areas, areas with a strict conservation regime, or the recognized centre of the species' range, can be regarded as reference sizes. This then permits the assessment of the preservation status and quality of populations in logged forests, or of isolated, relict or marginal populations on range peripheries. A decrease in rosalia longicorn body size could be the first measurable sign of deteriorating host plant quality in a habitat. In this context, a study of body size may supply important information on the ecology and protection of this beetle.

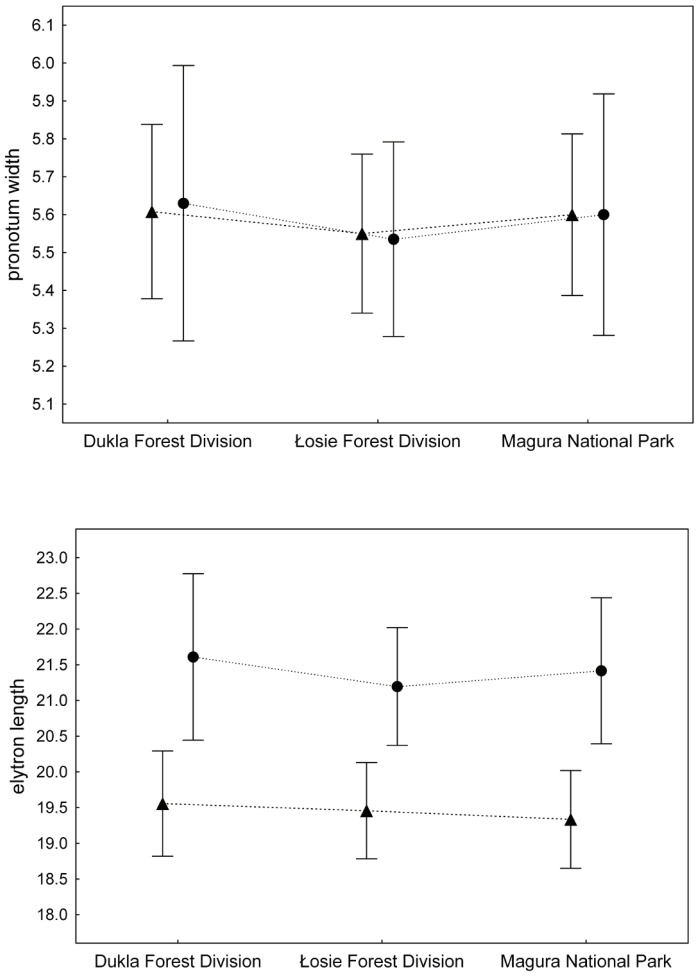

Fig. 3. Average (±CL) pronotum width (top) and elytron length (bottom) of males (triangles) and females (circles) of the rosalia longicorn *Rosalia alpina* from three localities.

The strict conservation regime in the Magura National Park and the habitat conditions there, including rich trophic resources in the form of dead beech wood, could in theory be a factor favourably influencing the size of rosalia longicorn imagines. The results of the present study indicate, however, that there are no differences in body size (in either sex) between the populations inhabiting logged and protected areas. This may indicate that the population inhabiting the logged forest only occupies there a habitat patches with favourable conditions or indicate an unsufficient conservation results within national park.

The body size of imagines can also be determined by the host species. Adults of *P. semipunctata* emerging from field logs were significantly longer for *Eucalyptus camaldulensis* DEHNHARDT and *E.* ×*trabutii* (hybrid) than for *E. grandis* HILL ex MAIDEN. However, the size of adults emerging from laboratory logs did not differ significantly among the host species (five *Eucalyptus* species) (HANKS et al. 1993). *Monochamus galloprovincialis* (OLIVIER) beetles emerging from *Pinus pinaster* AITON were slightly bigger than those from other species (NAVES et al. 2006). Therefore, the rosalia longicorn's switching to the wych elm as host plant could theoretically affect adult sizes. The results of the present study, however, indicate that there were no differences between the studied localities with different host plants. The population using wych elm does not differ in body size from the one using European beech either in the logged forests or in the protected area.

The population of the rosalia longicorn from the Magura National Park, known to be the most numerous in Poland, can be treated as a reference population with the best conditions for development. On this basis, one can assume that this beetle finds equally favourable living conditions (compared with the area subject to a strict conservation regime), both at its newly discovered locality where wych elm is the host plant (MICHALCEWICZ et al. 2011), and in the logged forest stands of the Łosie Forest Division. However, the limited range and patchy distribution of the rosalia longicorn indicate that such favourable conditions are available only locally and to a limited extent. Having specific and narrow habitat requirements (RUSSO et al. 2011), the rosalia longicorn is closely dependent on forest management practices.

Protection of the rosalia longicorn would be best achieved by the total exclusion of the aforementioned forest stands from exploitation, with appropriate species conservation methods also being applied in adjacent areas. Measures taken to protect the rosalia longicorn should focus on maintaining the species' habitats in favourable condition. It is important to leave very old trees, as well as dead and dying ones, in the forest, and to ensure their high insolation. The continuous presence of older age classes in the forest, as well as the continuity of forest regeneration in time and space, are both crucial. In summer, it is very important not to leave beech wood (stacked wood, large-size wood) in and near tree stands where the species' presence has been confirmed (MICHALCEWICZ & CIACH 2012b). It seems appropriate to include parts of the forest with rosalia longicorn

habitats in a conservation programme in the form of nature reserves, or at least to exclude them from economic exploitation. Monitoring of this species seems necessary in order to ensure the sustainable metapopulation structure of the rosalia longicorn in the Beskid Niski Mts, as well as within the whole current range of the species in the Carpathians.

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