Introduction

Rhysodes sulcatus (Fabricius, 1787) has been recognised as a relict species, which is extremely rare, with very few known localities as well as an important indicator of old and well-preserved, even primary, forests (Speight 1989). Recently, Kostanjsek et al. (2018) have shown that in Central Europe the preferred habitat requirements of the species include the presence of fallen, decomposing trees with an intermediate humidity level, which can be linked to the presence of moulds and slime moulds – the probable food for the adults and the larvae of this species. According to Brustel (2004), it is a species severely distressed by the human activity and the climate changes in the past. Its geographical range is widely extending across Europe and reaching Asia (Iran and Turkey) but the species is always recorded in scattered localities (Löbl & Löbl 2017, Kostanjsek et al. 2018).

At the European level, the conservation importance of R. sulcatus has been assessed as follows: included in IUCN Red List under status – Europe (DD)/European Union (EN) (Cañiz et al. 2018); pri-meal forest relict species sensu stricto (Category I) (see Eckelt et al. 2018); included in the Habitats Directive 92/43/EEC (Annex II).
The species was reported for Bulgaria by Rambousek (1912) from Stara Planina Mts. Since then, it had not been found again. It was included in the Second Edition of the Red Data Book of Bulgaria (Gueorguiev 2015) as Endangered (EN).

In the present study, we report further records of *R. sulcatus* from Bulgaria and provide data on the characteristics of its habitats.

**Materials and Methods**

The new material was collected during field trips to the Stara Planina Mts. (Teteven region, May 2015) and Belasitsa Mts. (Petrich region, April 2019). The main forest characteristics in the two localities were as shown in Table 1.

The village of Vasilyovo (Stara Planina) is situated in the narrow valley along the banks of the Vasilyovska River. Deciduous beech forests (*Fagus sylvatica*) occupy the flanks of the surrounding hills and mountain ridges. Generally, the forest is in good condition, mainly dense and with an average age of 70 years. Larger old trees of age up to 140 years are also available higher up the slopes and on lower mountain ridges. The focus on firewood production, in combination with steep mountain flanks and the use of animal transport, has resulted into an extensive forest management targeting mainly trunks with limited size. The forest density is high (density 8). Trees with dimensions too large to haul down the slopes or to process at the cutting site are often left behind. Between the cutting periods, forest patches are left undisturbed to regenerate.

The collecting site near Skrat Village (Belasitsa Mts.) is on a path to the Mangaro Waterfall, with extremely steep slopes on both sides along the water course of Skrat River. It represents a typical forest of *Fagus sylvatica*, with some *Platanus orientalis* trees, and is in very good condition (density 7, age 100 years). Due to the difficult accessibility of the area, similarly to the site at Vasilyovo, this forest has not been regularly cut and is still rich of old beech trees and dead wood (Fig. 2).

At both sites, the humidity was high during the whole year, due to the steep and narrow valleys and the presence of small rivers.

The collected material is deposited in the National Museum of Natural History, Sofia, Bulgaria (NMNHS) and coll. K. Gielen (Antwerp, Belgium).

**Results**

The present study has confirmed that *Rhysodes sulcatus* (Fig. 1) occurs in Bulgaria. Two new localities of the species were recorded (Fig. 2, 3). Thus, the known localities of this species in Bulgaria are as follows:

Varshets Town, under bark of *Fagus*, 20.05.1909, 1 ex. leg. Rambousek (Rambousek 1912);

<table>
<thead>
<tr>
<th>Localities</th>
<th>Forest type</th>
<th>Mean age (years)</th>
<th>Density (1-10)</th>
<th>Mean height (m)</th>
<th>Mean diameter (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vasilyovo</td>
<td><em>Fagus sylvatica</em></td>
<td>70-140</td>
<td>8</td>
<td>19-25</td>
<td>20-42</td>
</tr>
<tr>
<td>Skrat</td>
<td><em>Fagus sylvatica</em></td>
<td>100</td>
<td>7</td>
<td>22</td>
<td>34</td>
</tr>
</tbody>
</table>

Fig. 1. Habitus of *Rhysodes sulcatus* from Vasilyovo Village (Stara Planina Mts.).

Fig. 2. Habitat in Skrat Village (Belasitsa Mts.) and the tree where *Rhysodes sulcatus* was collected.
One Hundred Years of Solitude: Rediscovery of the Rare and Protected Beetle *Rhysodes sulcatus*...

Stara Planina Mts., Vasilyovo Village, Kozi dol, N 42.8953 E 24.3817, 07.05.2015, in snag dead *Fagus sylvatica*, diameter 1 m, in advanced decay stage, in moist wood mould, 1 ♂, leg. L. Crevecoeur (NMNHS);


**Discussion**

Because of its rarity and hidden life cycle, the biology and ecology of *R. sulcatus* are still insufficiently known. The data available are related mainly to the collection localities showing that *R. sulcatus* is a stenotopic, silvicolous, saproxylic and corticolous species, found in deciduous or mixed forests (Speight 1989, Jurc et al. 2008). Only recently, a more detailed study was carried out by Kostanjsek et al. (2018). The presence of the beetle is affected mainly by the diameter of the dead wood and its humidity, and to a lesser extent by the presence of rotten wood and the fallen position of the wood. *R. sulcatus* was most often found in large, moist and well rotten fallen logs with a diameter over 60 cm. Our data confirm the habitat preferences of the species as these factors are also met in both new localities in Bulgaria.

Both new localities had similar habitat characteristics – steep beech forests with isolated old trees, relatively high humidity during the whole year, high quantities of dead wood and no regular logging.

All the known localities of the species in Bulgaria are included in Natura 2000 sites (BG0001040 Zadnja Stara Planina and Predbalkan; BG0001493 Centralen Balkan-buffer; BG0000167 Belasitsa). They possess a rich fauna of protected saproxylic beetles of the community interest. The beech forests of Belasitsa Mt. (BG0000167) are inhabited also by species such as *Osmotherma barnabita* Motschulsky, 1845, *Lucanus cervus* (L., 1758), *Morimus asper funeranus* Mulsant, 1863, *Rosalia alpina* (L., 1758), *Cerambyx cerdo* L., 1758, *Omoeglymmius germani* (Ganglbauer, 1892) (Bekchiev & Gueorguiev 2012, Bekchiev et al. 2018). In the beech forests of Vasilyovska Planina Mt. (BG0001493) *O. barnabita*, *L. cervus*, *M. asper funeranus*, *R. alpina* and *Cucujus cinnaberinus* (Scopoli, 1763) could be found (Bekchiev & Gueorguiev 2012, Bekchiev, unpublished data). In the forests around Varshets town (BG0001040), *L. cervus*, *M. asper funeranus*, *R. alpina* and *C. cerdo* are reported (Bekchiev & Gueorguiev 2012).

The two recent findings of *R. sulcatus* in very distant localities (Stara Planina and Belasitsa – more than 300 km distance in straight line) show that very little is known about this species and its distribution in Bulgaria. This probably indicates the possible high fragmentation and isolation of its populations. However, this speculation needs more detailed stud-

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**Fig. 3.** A map of the known localities of *Rhysodes sulcatus* in Bulgaria (based on a satellite map of Bulgaria from Sentinel 2; created by Geopolymorphic Cloud).
ies and searching of the species around the country to be proven or rejected.

The locality in the transboundary Belasitsa Mts. is of particular importance from a biogeographical point of view, as it considerably enlarges the known distribution area of the species in Bulgaria, and also because it suggests that *R. sulcatus* can be found in North Macedonia and Greece, where conditions for its presence exist but no published records from them.

According to Bussler et al. (2005), such diverse beetle communities are characteristic of still undisturbed forests, very similar to the Romanian and Ukrainian beech forests in the Carpathians, and could be considered the last real reference sites for complete saproxylic beetle communities of the temperate central and eastern European forest. All this clearly shows that the forests of the investigated mountain regions are of extremely high conservation value, and should be used only in an environmentally, economically and socially responsible way, and it is important to protect all suitable habitats for *R. sulcatus* – mainly old forests situated in the valleys of small and medium mountain rivers. As it is recommended for Central Europe by Müller et al. (2013), the conservation activities, such as protecting areas or increasing dead wood, should be undertaken in as many forest sites as possible, at different elevations and in different bioregions. In this way, it will be possible to protect the potential habitats of rare saproxylic beetles like *R. sulcatus*, to ensure their successful preservation, breeding, dispersal and stability of their populations.

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WWF 2019. The forests of Bulgaria. Available at: https://gis. wwf.bg/mobilz/