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Scolytus koenigi Schevyrew, 1890 (Coleoptera: Curculionidae): new bark beetle for the Czech Republic and notes on its biology

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ABSTRACT: In November 2013, *Scolytus koenigi* Schevyrew, 1890 was recorded for the first time in the territory of the Czech Republic (Southern Moravia, at two localities near the village of Lednice). This finding represents the northernmost occurrence of this species in Central Europe. Because the knowledge of the *S. koenigi* bionomy is very limited, the characteristics of 52 galleries on 10 different host tree fragments were studied. The species was found to develop on dead or dying branches and thin trunks of maples *Acer campestre* L. and *Acer platanoides* L. with diameters of 3–12 cm. All of the galleries comprised a 1.6–2.9 mm wide and 8–67 mm long single egg gallery oriented parallelly to the wood grain, with 18–108 larval galleries emerging almost symmetrically on both sides of the egg gallery.

Keywords: *Acer,* first record, galleries, maple, Scolytinae

Scolytus Geoffroy, 1762, a cosmopolitan genus of the subfamily Scolytinae within the family Curculionidae (order Coleoptera), includes at least 61 species from the Palaearctic region (Michalski 1973; Knížek 2011). *Scolytus koenigi* Schevyrew, 1890 occurs in the Mediterranean region and in the warmest regions of Central Europe, with the northernmost occurrence recorded in Austria (Sarikaya, Knížek 2013). In the east, this bark beetle is distributed throughout the steppe regions of Ukraine and southern Russia and from the South Caucasus (cf. Coope 1990; Knížek 2011; Terekhova, Salniitska 2014) up to Turkmenistan and the Baikal region of Russia (Michalski 1973).

The species develops on several species of the genus *Acer* (Michalski 1973; Pfeffer 1995). The galleries of this species are similar to those of other members of the genus *Scolytus* that produce an egg gallery oriented parallelly to the wood grain (longitudinal type) (Sarikaya, Knížek 2013). The bionomy of this species is poorly known, and the gallery system of this beetle has not been properly described yet. To summarise the existing descriptions (Knotek 1892; Engler, Drude 1899; von Nüsslin 1905; de Peyerimhoff 1919; Escherich 1923; Balachowsky 1949; Stark 1952; Schwerdfeger 1957; Michalski 1973; Postner 1974), the breeding system of *S. koenigi* is longitudinal monoramous, either excavated or not excavated in the sapwood, depending on bark thickness. The egg gallery is 10–60 mm long and approximately 3 mm wide, associated with 10–120 larval galleries that reach up to 120 mm in length. However, there are many discrepancies between the characteristics of

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Table 1. Overview of previously published characteristics of the galleries of *Scolytus koenigi*

Source	Length/width of egg galleries	Number of larval galleries
Knotek (1892)	15–50 mm/over 3 mm	up to 110
Engler, Drude (1899)	up to 60 mm (often shorter)	up to 120 (sometimes only 3–4)
von Nüsslin (1905)	up to 65 mm/–	–
de Peyerimhoff (1919)	50 mm/1.5 mm	–
Escherich (1923)	15–30 mm/over 3 mm	up to 110
Balachowsky (1949)	50 mm/ –	–
Stark (1952)	10–50 mm (average 20 mm)/ –	10–112
Schwerdfeger (1957)	15–30 mm/3 mm	–
Michalski (1973)	10–50 mm/approximately 3 mm	–
Postner (1974)	15–30 mm/up to 3 mm	–

the breeding system described by specific authors, and some variables (e.g. the number of larval galleries) have not been properly examined yet (Table 1).

Additionally, our knowledge of developmental phenology and breeding substrate requirements of this species is very limited. *S. koenigi* has generally been reported to develop on dead branches and trunks with thin bark (e.g. Knotek 1892; Escherich 1923; Balachowsky 1949; Postner 1974). De Peyerimhoff (1919) documented the development of this species on branches of *Acer obtusatum* (Wildenow) Garns with a diameter of 5–6 cm. Based on our understanding of this beetle's developmental phenology, its larvae overwinter, and it most likely exhibits a univoltine life cycle (Knotek 1892; Pfeffer 1955). The aim of the present paper is to report the first occurrence of *S. koenigi* in the Czech Republic and precise measurements of characteristics of the galleries of this bark beetle.

MATERIAL AND METHODS

The study area was located in southern Moravia (Czech Republic) near the village of Lednice. The first examined locality was in the area surrounding the Rybniční zámeček chateau (48°47'04.54"N, 16°47'44.31"E, 180 m a.s.l.), and the second was in the Květné Jezero Natural Monument (48°49'47.52"N, 16°47'44.94"E, 160 m a.s.l). Both study localities are characterised by the warm climate with mean annual temperature of 9.8°C and mean annual rainfall of 490 mm, with the growing season of approximately 175 days (Tolasz 2007). The habitat of study localities is characterised as small patches (approximately 1 ha) of secondary woody plant vegetation dispersed on agricultural land. These semi-open habitats are vertically diversified, with the stratification formed by trees as well as shrubs. The prevailing woody plant species are *Tilia cordata* Mill, *Acer campestre* L., *Acer platanoides* L., *Prunus spinosa* L. and *Quercus robur* L.

On November 8th, 2013, galleries of bark beetles (Scolytinae) were found on *Acer campestre* (first and second locality – 4 and 2 trees, respectively) and *A. platanoides* (first and second locality – 2 and 0 trees, respectively) at both localities. Subsequently, 10 half-meter long fragments of branches and trunks with bark beetle galleries were sampled in December 2013. Five of these samples were debarked immediately, whereas the remaining samples were left outdoors until debarking in March 2014. The beetles found on the trees were identified according to the literature (Pfeffer 1995; Sarikaya, Knížek 2013). All of the breeding systems of *S. koenigi* were characterised in detail, and the following data were recorded: (*i*) diameter of the breeding substrate, (*ii*) bark thickness above the galleries, (*iii*) the orientation, shape, width and length of the egg gallery, and (*iv*) the number of larval galleries. The documented specimens (16 ex.) were stored in the collection of the Faculty of Forestry and Wood Technology of Mendel University in Brno, Czech Republic.

Box-plot graphs were used to illustrate the quantitative characteristics of the galleries. The data were analysed for a normal distribution (Shapiro-Wilk test). The associations between the variables were analysed by Pearson's correlation indices All analyses were conducted with the STATISTICA 10 (SPSS, Tulsa, USA).

RESULTS

In total, 52 bark beetle breeding systems were found on the sampled branch and trunk fragments: 39 breeding systems on *Acer campestre* and 13 on *A. platanoides*. All of the galleries were bored by *S. koenigi*, which was documented by identifying 2 and 27 living beetles and 15 and 9 dead adults of

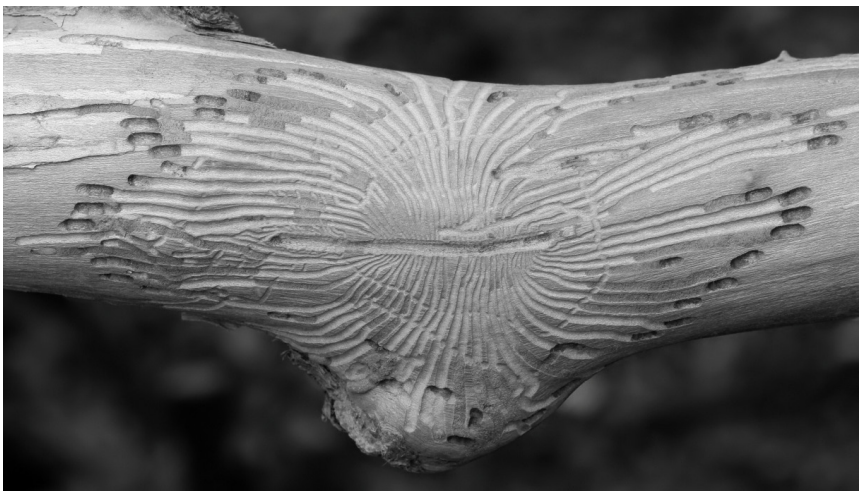

Fig. 1. Galleries of *Scolytus koenigi* on *Acer campestre* found at the locality Lednice – Rybniční zámeček chateau (Czech Republic) (November 8, 2013)

this species on the two debarking dates (December 13th, 2013 and March 15th, 2014), respectively. This finding represents the first record of this species in the Czech Republic and the northernmost recorded occurrence of this species in Central Europe.

The galleries (Fig. 1) were present on substrates with a diameter of 30–125 mm (without bark) and bark thickness of 2.5–14.0 mm. The egg and larval galleries were markedly bored and were therefore readily visible in both the bark and the sapwood. There was always a single egg gallery oriented longitudinally. The egg galleries were 8–67 mm long (median = 29 mm) and 1.6–2.9 mm wide (median = 2.4 mm) (Fig. 2), and a total of 18–108 (median = 53) larval galleries emerged densely and symmetrically on both sides of the egg gallery. The larval galleries, reaching a maximum length of 15 cm, first ran almost perpendicularly to the egg galleries and subsequently diverged radially. In two cases, the larval galleries were missing on short sections of the central portion of egg galleries (2.5 and 4.0 mm), representing regeneration feeding. The pupal chambers were mostly bored into the sapwood (up to 2.5 mm deep). The width of the egg gallery was strongly correlated with its length ($r = 0.808$, $P < 0.05$) and with the number of larval galleries ($r = 0.370$, $P < 0.05$).

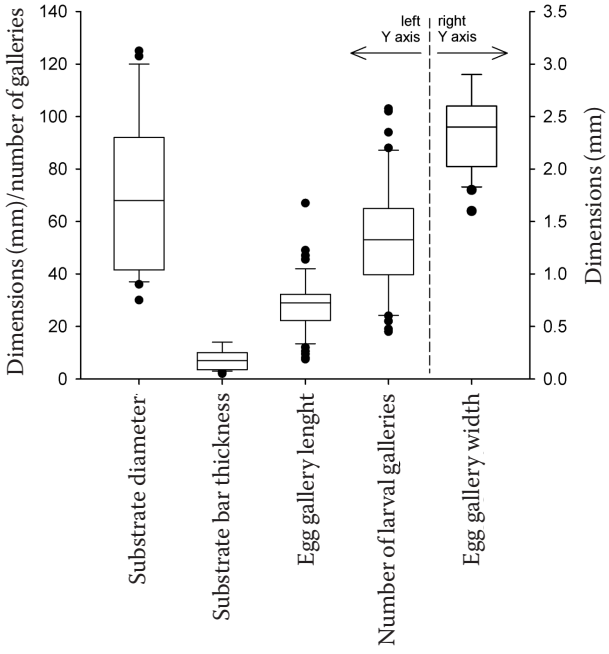

Fig. 2. Quantitative measurements of 52 *Scolytus koenigi* galleries. The box-plots consist of the minimum, lower quartile, median, upper quartile and maximum values. Outliers are shown as black dots

Among the 52 analysed galleries, 42 were abandoned, whereas 10 still contained *S. koenigi* in different developmental stages. In the four galleries from the December 2013 analysis that were not abandoned, only two brood adults were found, with the remaining individuals having already emerged or still in the larval stage (31 specimens). In the March 2014 six samples analysed after winter diapause, 27 brood adults, 32 pupae and 38 larvae were found.

DISCUSSION AND CONCLUSIONS

The occurrence of *S. koenigi* documented in the present study represents the northernmost record of this species in Central Europe (see Sarikaya, Knížek 2013). Although the occurrence of this species in the Czech and Slovak Republics was predicted by Pfeffer (1989), there were no records of *S. koenigi* north of Austria until this report (Knížek 2011; Sarikaya, Knížek 2013). Be-

cause apparently well-established and numerous populations of *S. koenigi* were found at two different localities, we may consider this species to be an established component of the fauna of the Czech Republic. The species was previously found not too distantly in Austria (Knotek 1892; Haselbarth 1973; Schedl 1980; Freude et al. 1981), and the natural conditions are relatively uniform throughout the northern part of the Pannonian lowland (with a continuous occurrence of the host trees). Therefore, it is possible that *S. koenigi* was present in the Czech Republic long before it was found and was simply not identified.

Alternatively, this finding of *S. koenigi* in the Czech Republic might be evidence of the range expansion to the north, possibly reflecting global climate change, as has been documented for many other animal species (Quante 2010), including several saproxylic beetles whose survival rates have increased on the borders of their northern ranges (e.g. Logan, Powell 2001; Bentz et al. 2010; Marini et al. 2012; Buse et al. 2013). However, the exact temperature requirements of *S. koenigi* are not known to support this hypothesis.

In the present study, we found *S. koenigi* to be a strongly secondary species that developed on dead or dying branches, either lying on the ground or still attached to the tree, and on the thin trunks of *Acer* spp. These findings are in accord with information reported by Engler and Drude (1899), de Peyerimhoff (1919), Escherich (1923), Balachowsky (1949) and Postner (1974). Furthermore, we found that this species developed mostly in substrates ranging from 30 to 125 mm (interquartile range = 42–92 mm) in diameter (Fig. 2), which was not specified previously.

The range of egg gallery lengths recorded in the present study was much greater than often reported in the literature (Table 1, Fig. 2). In comparison with some previous findings (Escherich 1923; Schwerdfeger 1957; Postner 1974), the egg gallery lengths recorded in this work were up to twice longer. In contrast, our measurements of the widths of the egg galleries did not exceed 2.9 mm, with the most frequent width being approximately 2.5 mm (Fig. 2), which is markedly smaller than the widths reported in the literature, of 3 mm (Schwerdfeger 1957; Michalski 1973) or more than 3 mm (Knotek 1892) (see Table 1). Moreover, the maximum number of larval galleries (110–120) registered by Knotek (1892), Engler and Drude (1899) and Stark (1955) did not characterise well the breeding system of *S. koenigi*. Although several galleries with more than 100 larval galleries were also found in the present study, the most frequent number of larval galleries was approximately 50 (Fig. 2).

In the most intensively studied bark beetles (i.e. the tree-killing species of the genera *Ips* and *Dendroctonus*), body size is associated with overall fitness. The larger individuals of these species exhibit greater fat reserves (Atkins 1967; Thompson, Bennett 1971), higher dispersal capability (Robertson, Roitberg 1998), higher pheromone production (Pureswan, Borden 2003), and higher survival rates during extreme temperatures (Safranyik 1976), and they lay more eggs (Clarke et al. 1979). Accordingly, in the present study, larger females of *S. koenigi* were found to lay more eggs, corresponding to the greater numbers of larval galleries emerging from the wider egg galleries (see Results).

The available information on the developmental phenology of *S. koenigi* is fragmentary, and neither duration of development nor number of generations per year is known. However, some observations have suggested that this species might exhibit two generations per year (Knotek 1892). In the present study, some of the individuals completed their development and emerged from the galleries before the end of the vegetation period, which suggested that this species might in fact display a partial second generation per year. In the present work, almost exclusively larvae were found to overwinter, in agreement with the Pfeffer (1955), and the larvae subsequently pupated in the spring.

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