



New Records of Pteromalid Parasitoids (Hymenoptera: Pteromalidae) Reared from the Spruce Bark Beetle *Ips typographus* (L., 1758) from Serbia

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Abstract: The parasitoids of the family Pteromalidae (Hymenoptera: Chalcidoidea) attacking the spruce bark beetle *Ips typographus* were studied in Tara National Park, Serbia. Nine pteromalid species were reared. Among them, five species were previously recorded for the Serbian fauna (*Dinotiscus eupterus*, *Mesopolobus typographi*, *Rhopalicus tutela*, *Roptrocercus mirus* and *Roptrocercus xylophagorum*). Four species are reported for the first time from this country (*Tomicobia seitneri*, *Rhopalicus quadratus*, *Roptrocercus brevicornis* and *Heydenia pretiosa*). Most numerous in our samples were the larval parasitoids (i.e., *R. tutela*), while *D. eupterus* was overall the dominant species.

Key words: Chalcidoidea, Curculionidae, Scolytinae, Tara National Park, faunistics, Europe.

Introduction

The Pteromalidae (Hymenoptera) is a large family that includes 641 genera and more than 3,400 described species (NOYES 2019). They are solitary or gregarious parasitoids of huge range of hosts of various orders. Over 20 species are associated with bark beetles (Coleoptera: Curculionidae: Scolytinae), including the European bark beetle *Ips typographus* (Linnaeus, 1758) (KENIS et al. 2004). So far, detailed studies on this family for Serbia are lacking.

The influence of multiple abiotic factors (droughts, wind, etc.) is responsible for the increas-

ing tree decay in spruce forests across the globe (e.g., TABAKOVIĆ-TOŠIĆ & MILOSAVLJEVIĆ 2016, TABAKOVIĆ-TOŠIĆ et al. 2016). Changes in the trees induced by these events significantly reduce their natural resistance to the attacks of various xylophagous insect pests and cause economical damage in millions of Euro per year (BRADSHAW et al. 2016). The European bark beetle is considered to be currently the most devastating insect pest of the conifer forests across Europe (BIEDERMANN et al. 2019). Based on the recently published results, the population density of *I. typographus* in Serbia increased considerably since 2013 (TOMIC & BAZAREVIC 2015). The development

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of bark beetles is bound to the host tree and it is significantly influenced by the occurrence of their predators and parasitoids (KENIS et al. 2004). According to previous studies, growth rates and velocity of bark beetle parasitoid populations follow the population dynamics and patterns of their hosts (WERMELINGER et al. 2013). The braconid and pteromalid wasps are considered the most significant parasitoids of the bark beetles (WERMELINGER et al. 2012). However, only limited studies have been carried out on parasitoids of *I. typographus* in Serbia. Five species of pteromalid parasitoids of this host have been recovered so far. In the spruce forest area of Kopaonik National Park, MARKOVIC & STOJANOVIC (2010) confirmed the occurrence of the following pteromalids: *Dinotiscus eupterus* (Walker, 1836), *Mesopolobus typographi* (Ruschka, 1924), *Rhopalicus tutela* (Walker, 1836), *Roptrocerus mirus* (Walker, 1834) and *Roptrocerus xylophagorum* (Ratzeburg, 1844).

The present note provides the results of a study on pteromalid parasitoids of the European bark beetle in the Tara National Park where four species were recorded for the first time in Serbia.

Materials and Methods

The Forest Management Unit Tara, one of the three forest management units situated in Tara National Park (Fig. 1), consists of naturally distributed and mixed

spruce-fir-beech stands. It occupies some parts of the Tara Mountain range, which is located in western Serbia. Natural spruce stands at altitude between 953 and 1211 m were examined. The materials were collected from a freshly-felled trap spruce tree (av. diameter 27.2 cm, length 17.8 m) in each of 20 selected plots. Sampling was conducted twice, in early July and September and upon the completion of the entrance holes digging by the imago of the overwintering (I) and summer (II) generations. To increase the diversity of recorded parasitoids, the sampling was done in two seasons, after the boring of each generation of *I. typographus*. Five samples per tree (20 x 20 cm) were taken from the infested spruces on which numerous entrance holes were observed. The samples were transported to the Institute of Forestry (Belgrade, Serbia) and put in photoelectors at room temperature (18–22 °C). The photoelectors were observed every day and the newly emerged parasitoids were individually placed in plastic Eppendorf tubes for identification.

The emerged *I. typographus* adults were identified using the keys of GRÜNE (1979).

The obtained values of the dominance of the sample collected (Table 1) were assessed using TISCHLER'S (1949) scale: 10–100 % – eudominant (ED); 5–10 % – dominant (D); 2–5 % – subdominant (SD); 1–2 % – recedent (R); < 1 % – subrecedent (SR).

The emerged parasitoids and *I. typographus* adults were deposited in the authors' collections.

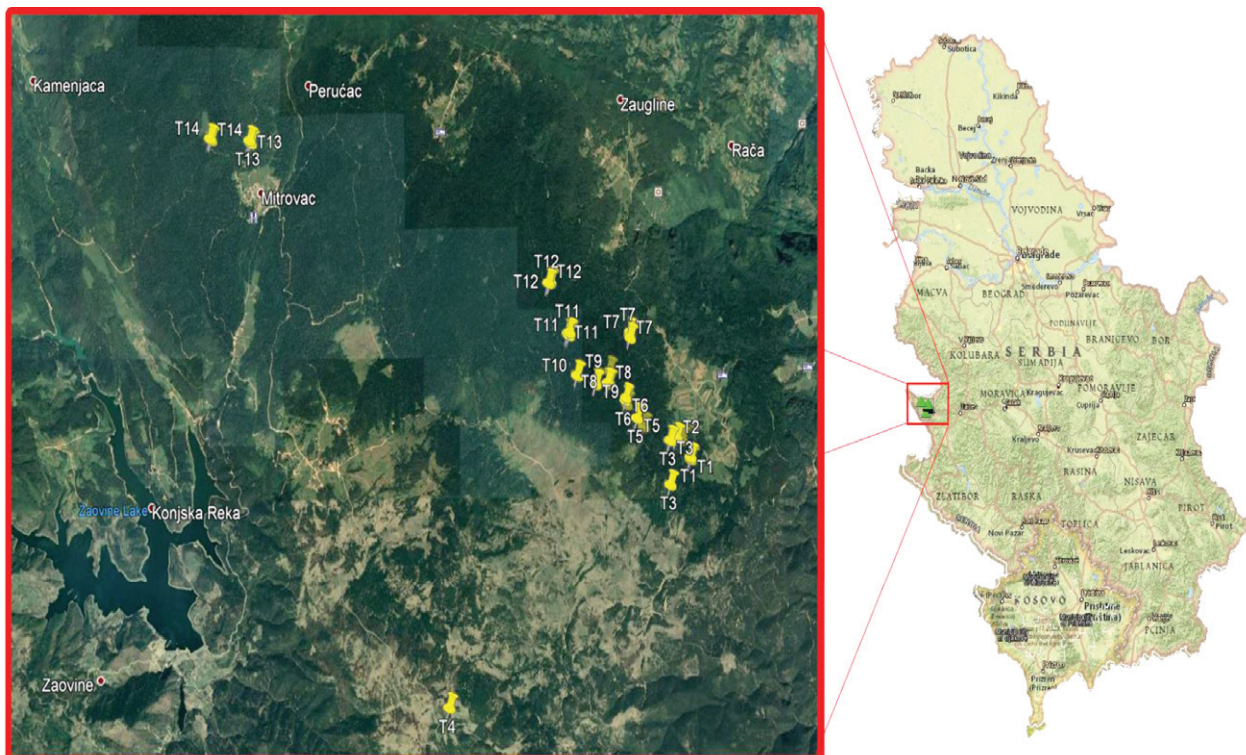


Fig. 1. Map of the sampled location in Tara National Park, Serbia.

Table 1. Pteromalid parasitoids of *Ips typographus* and their relative abundance in our samples. New records for the Serbian fauna are marked with one asterisk (*).

| Species | Sampling date | Emergence period | Insect numbers | | D** (%) | TISCHLER'S scale |
|----------------------------------|-------------------|-------------------------|----------------|-----|---------|------------------|
| | | | ♀/♂ | Σ | | |
| <i>Dinotiscus eupterus</i> | 8 July 2016 | 9 July – 1 August 2016 | 79/134 | 213 | 71.7 | ED |
| | 22 September 2016 | 24–25 September 2016 | 2/6 | 8 | | |
| <i>Rhopalicus tutela</i> | 8 July 2016 | 9 July – 1 August 2016 | 17/17 | 34 | 11.4 | ED |
| | 22 September 2016 | 24 September 2016 | 0/1 | 1 | | |
| <i>Roptrocerus mirus</i> | 8 July 2016 | 9–21 July 2016 | 7/18 | 25 | 8.8 | D |
| | 22 September 2016 | 25 September 2016 | 1/1 | 2 | | |
| * <i>Roptrocerus brevicornis</i> | 8 July 2016 | 13 July – 1 August 2016 | 7/5 | 12 | 4.0 | SD |
| * <i>Tomicobia seitneri</i> | 8 July 2016 | 9 July – 1 August 2016 | 1/5 | 6 | 1.9 | R |
| <i>Roptrocerus xylophagorum</i> | 8 July 2016 | 9 July – 1 August 2016 | 1/2 | 3 | 1.0 | R |
| <i>Mesopolobus typographi</i> | 8 July 2016 | 9–16 July 2016 | 2/0 | 2 | 0.6 | SR |
| * <i>Heydenia pretiosa</i> | 8 July 2016 | 16 July 2016 | 0/1 | 1 | 0.3 | SR |
| * <i>Rhopalicus quadratus</i> | 8 July 2016 | 1 August 2016 | 0/1 | 1 | 0.3 | SR |
| Total | | | 117/191 | 308 | 100 | |

Results

We recorded nine species of pteromalid parasitoids from our tree samples (Table 1). Four species were recorded for the Serbian fauna for the first time: *Tomicobia seitneri* (Ruschka, 1924), *Rhopalicus quadratus* (Ratzeburg, 1844), *Roptrocerus brevicornis* Thomson, 1878 and *Heydenia pretiosa* Förster, 1856. They are well known as parasitoids of curculionid hosts, including bark beetles (Coleoptera: Curculionidae: Scolytinae), and especially *I. typographus* (NOYES 2019). The results of the ecological dominance assessment revealed that eudominant species were *D. eupterus* and *R. tutela*, a dominant species in our samples was *R. mirus*, a subdominant species was *R. brevicornis*, recedents were *R. xylophagorum* and *T. seitneri* and subrecedents were *H. pretiosa*, *R. quadratus* and *M. typographi*.

Discussion

Our study confirms the occurrence of previously recorded pteromalid parasitoids in Serbia (MARKOVIC & STOJANOVIC 2010). In addition, we have found four species new for the Serbian fauna. Based on the ecological dominance of emerged parasitoids, the most numerous parasitoid species in our samples is *D. eupterus*. This species has been reported as a eudominant in previous studies as well (WERMELINGER et al. 2013); however, it has mistakenly been listed as a parasitoid of bark beetles together with *M. typographi*. Currently, both species are treated as hyperparasitoids (KENIS et al.

2004, WEGENSTEINER et al. 2015). The rarest parasitoids in our samples are the newly recorded *R. quadratus* and *H. pretiosa*. Our results highlighted that most of the recorded bark beetle parasitoids are parasites on the second and third stage of the host's life cycle. Only *T. seitneri* is a parasite of imagoes of the bark beetle.

This study provides a summary of the European bark beetle parasitoids in Serbia, including several first records of parasitoid species for Serbia. It fills the gap in the knowledge on the diversity of hymenopteran parasitoids, which is currently heavily understudied. It can also serve as an important starting point for future studies of the host-parasitoid interactions in bark beetles.

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References

- BIEDERMANN H. W. P., MÜLLER J., GRÉGOIRE J. C., GRUPPE A., HAGGE J., HAMMERBACHER A., HOFSTETTER W. R., DINESHKUMAR K., KOLARIK M., KOSTOVCIK M., KROKENE P., SALLÉ A., SIX L. D., TURRINI T., VANDERPOOL D., WINGFIELD J.M. & CLAUS B. 2019. Bark Beetle population dynamics in the Anthropocene: challenges and solutions. *Trends in Ecology & Evolution* 34: 914–924.
- GRÜNE S. 1979. Brief illustrated key to European bark beetles. Hannover, Verlag M. & H. Schaper, 182 p.
- KENIS M., WERMELINGER B. & GRÉGOIRE J. C. 2004. Research on parasitoids and predators of Scolytidae in living trees in Europe – a review. In: LIEUTIER F. et al. (Eds): *Bark and*

- wood boring insects in living trees in Europe, a synthesis. Dordrecht: Kluwer, pp. 237–290.
- MARKOVIĆ C. & STOJANOVIĆ A. 2010. Differences in bark beetle (*Ips typographus* and *Pityogenes chalcographus*) abundance in a strict spruce reserve and the surrounding spruce forests of Serbia. *Phytoparasitica* 38: 31–37. doi: 10.1007/s12600-009-0076-x
- NOYES J.S. 2019. Universal Chalcidoidea database. The Natural History Museum, London, UK (Last update March 2019). <http://www.nhm.ac.uk/entomology/chalcidoids/>.
- TABAKOVIĆ-TOŠIĆ M. & MILOSAVLJEVIĆ M. 2016. The correlation between the changes in climate, the intensity of spruce decline and the abundance of spruce bark beetles in “Golija” Nature Park. *Sustainable Forestry* 73–74: 59–68.
- TABAKOVIĆ-TOŠIĆ M., MILENKOVIĆ I. & RADULOVIĆ Z. 2016. The coniferous and anthropogenic and natural forests decline in Serbia driven by different abiotic and biotic factors. *Sustainable Forestry* 73–74: 49–57.
- TISCHLER W. 1949. *Grundzüge der terrestrischen Tierökologie*. Braunschweig: Friedrich Vieweg und Sohn, 219 p.
- TOMIC M. & BEZAREVIC B. 2015. Control of bark beetle population at the Tara National Park by pheromone traps. In: MARČIĆ D., GLAVENDEKIĆ M. & NICOT P. (Ed.): Proceedings of the 7th Congress on Plant Protection. Plant Protection Society of Serbia, IOBC-EPRS, IOBC-WPRS, Belgrade, pp. 217–223.
- WERMELINGER B., EPPER C., KENIS M., GHOSH S. & HOLDEN-RIEDER O. 2012. Emergence patterns of univoltine and bivoltine *Ips typographus* (L.) populations and associated natural enemies. *Journal of Applied Entomology* 136: 212–224.
- WERMELINGER B., OBRIST M. K., BAUR H., JAKOBY O. & DUELLI P. 2013. Synchronous rise and fall of bark beetle and parasitoid populations in windthrow areas. *Agricultural and Forest Entomology* 15(3): 301–309.
- WEGENSTEINER R., WERMELINGER B. & HERRMANN M. 2015. Natural enemies of bark beetles: predators, parasitoids, pathogens and nematodes. In: VEGA F. E. & HOFSTETTER R. W. (Ed.): *Bark beetles. Biology and ecology of native and invasive species*. pp. 266–274.

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