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New associations between the invasive coniferous pest, *Lamprodila festiva* and natural parasitoids *Spathius erythrocephalus* and *Rhaphitelus maculatus*

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Abstract

The cypress jewel beetle *Lamprodila (Palmar) festiva* (L.) (Coleoptera Buprestidae) is a wood-boring pest posing major threat to the phytosanitary condition of several species of Cupressaceae. It has spread northwards in Europe over the last few decades and has recently become a major concern for plant health. The suppression of its rapid invasion can be expected to be greatly facilitated by the identification and potential application of its natural enemies. This is the first report of *Spathius erythrocephalus* Wesmael (Hymenoptera Braconidae) and *Rhaphitelus maculatus* Walker (Hymenoptera Pteromalidae) emerging from larvae of *L. festiva* in Hungary. Parasitised larvae of this insect were collected in the garden of a private house in Hungary. Based on this finding, these parasitoids are a less known beneficial organism, which their thorough cognition can be contributed as a means to counteract the rapid Palearctic population number of moderating the devastating impact of *L. festiva*.

Key words: cypress jewel beetle, host-parasitoid association, larvae, natural enemy, parasitoid wasps.

Introduction

The origin of the cypress jewel beetle (CJB) *Lamprodila (Palmar) festiva* (L.) (Coleoptera Buprestidae) is the Eastern Mediterranean Basin (Balkan Peninsula and Asia Minor) (Volkovich, 2017) where it is part of the fauna associated with its widely distributed primary hosts *Thuja* spp. and *Cupressus* spp. (Volkovitsh and Karpun, 2017). The range of this species has dramatically expanded northward over recent decades driven by global warming and numerous plantings of its host trees in gardens, parks and cemeteries, (Rabl *et al*., 2017).

L. festiva is typically an oligophagous pest because its larva develops in the woody species of the Cupressaceae family such as *Chamaecyparis*, *Cupressus*, *Juniperus*, *Thuja* etc. (Volkovich, 2017). As a result of larval feeding, in the trunk and branches, individual parts of plant wither and turn brown in otherwise healthy-appearing coniferous trees.

There are relatively few references to natural enemies of *L. festiva* in the literature, although there are some reports of Hymenopterans parasitizing beetles from Buprestidae. *Oobius agrili* Zhang et Huang was reported to parasitise emerald ash borer *Agrilus planipennis* Fairmaire. *Sclerodermus harmandi* (Buysson) is a non-specialised parasite of several families of beetles. It was reported to also parasitize the genus *Lamprodila* (Lim *et al*., 2006).

In the present paper, *Spathius erythrocephalus* Wesmael and *Rhaphitelus maculatus* Walker reared from *L. festiva* on *Chamaecyparis lawsoniana* (A. Murray) Parl., are described as new association to host-parasitoid relationship.

Materials and methods

Parts of *C. lawsoniana* damaged by *L. festiva* were collected on 15 January 2020. The samples derived from the garden of a private house located in the city centre of Kaposvár (Somogy county, Hungary; Latitude: 46.348247; Longitude: 17.764196). The sampled trees formed 4-5 m high ornamental structure with conspicuous branches withering separately. Five branches and trunks per tree (40-50 cm pieces originated from 4 trees) were collected and subsequently placed in isolators ensuring seasonal

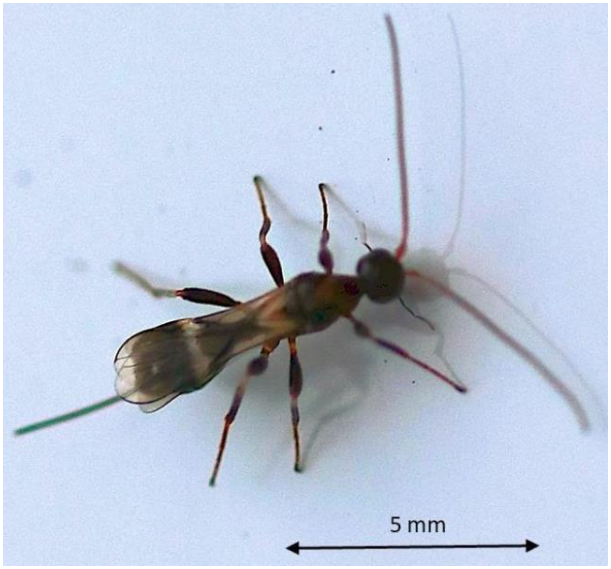

Figure 1. *Spathius erythrocephalus*.

climatic conditions. Identification of the pest and its natural enemies were implemented by rearing the overwintering stages in the isolator (30 × 30 × 70 cm rectangle-shaped covered with mosquito nets). The exact times of the emergence of adults of both the buprestid pest and its parasitoids were recorded.

The emerged parasitoids were stored in 70% ethanol and examined under a stereomicroscope for morphological analyses. For the identification of braconid and pteromalid wasps, the methods of Papp (1991) and Askew (2018) were used, respectively.

Results and discussion

The emergence of *L. festiva* adults was recorded on 13-15 June 2020, whereas that of its natural enemies occurred in an isolator 2 weeks earlier, on 29-30 May 2020.

One female (figure 1) and one male *S. erythrocephalus* were identified as parasitoids of *Lamprodila* larvae.

S. erythrocephalus is widespread in west Palaearctic and common in Hungary (Papp, 1991). The entire host range of *S. erythrocephalus* is not known; this wasp is known as primary parasitoid of several xylophagous insects such as Sesiidae, Xiphydriidae, Cerambycidae, Buprestidae, Curculionidae (Papp, 1991; Bonsignore *et al*., 2008).

The *Spathius* genus is already known as a potential parasitoid of some buprestid species. Results of Yang *et al.* (2008) showed that *Spathius agrili* Yang can parasitize several buprestid larvae -even *Lamprodila* species- but attack rates were significantly lower than those in its natural host, emerald ash borer, *A. planipennis*. According to the Kotenko and Proxorov's (2012) study, *Spathius polonicus* Niezabitowski can be a natural population regulator element of *Agrilus*, *Cratomerus*, *Lamprodila*, *Sphenoptera*, *Trachypteris* genus in Ukraine.

Based on the field works of Bonsignore *et al.* (2008) in Sicilian orchards, *S. erythrocepalus* is a gregarious ectophagous parasitioid of peach flat headed root borer *Capnodis tenebrionis* (L.) (Coleoptera Buprestidae). The adult wasps successfully find the larvae of the rootborer in the soil up to 20 cm depth and the percentage of parasitisation was up to 35% in host larvae.

One female *R. maculatus* emerged from the branches infested by *L. festiva*. The characteristic antennae of *R. maculatus* are short with apical protrusions, the forewing marginal vein is thickened and has brown patches under marginal vein in forewings (Askew and Mifsud, 2018). *R. maculatus* is mainly known as idiobiont ectoparasitoid of larvae of bark beetles (Curculionidae Scolytinae) albeit other groups of Curculionoidea may also be hosts (figure 2). This supposition (Askew and Mifsud, 2018)

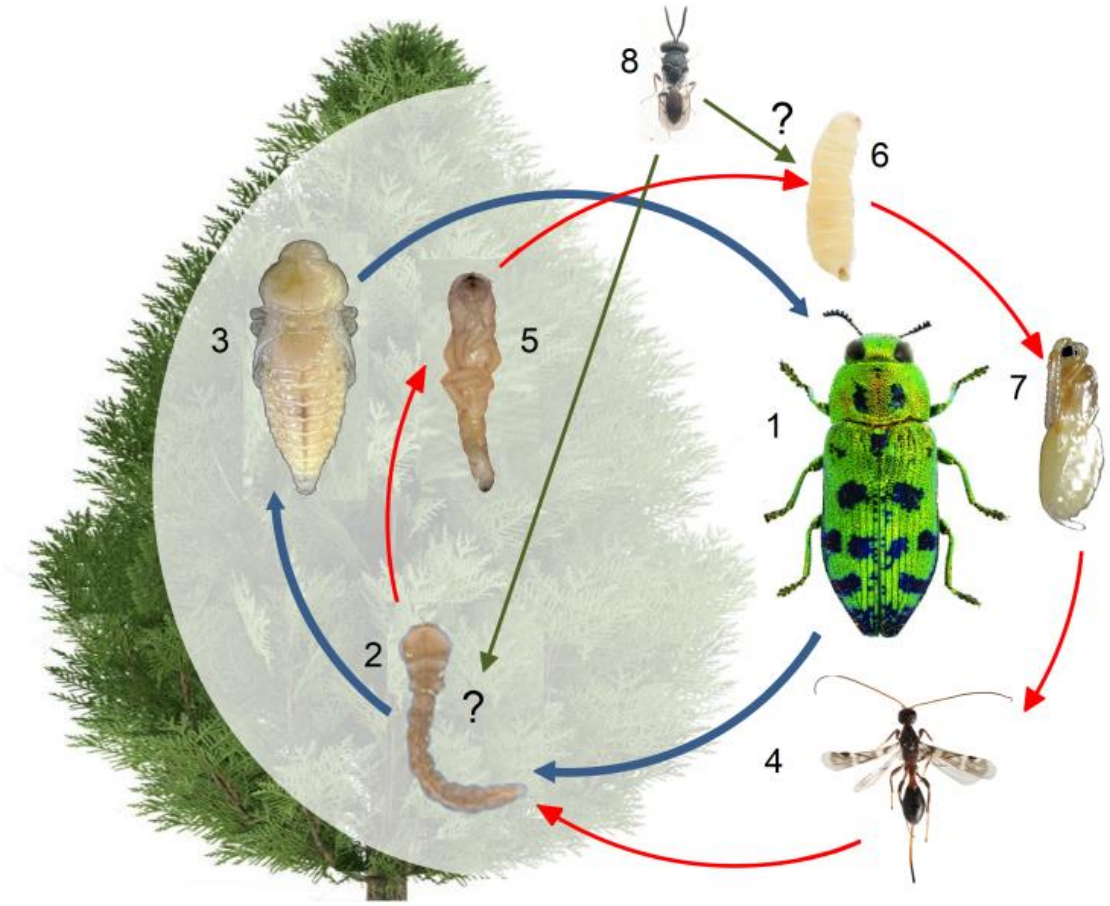

Figure 2. Life cycle and developmental stages of *L. festiva* and its potential parasitoid wasps, *S. erythrocephalus* and *R. maculatus.* 1: adult of *L. festiva*, 2: larvae of *L. festiva*, 3: pupa of *L. festiva*, 4: adult of *S. erythrocephalus*, 5: buprestid larva parasited by braconid wasp larvae, 6: larva of *S. erythrocephalus*, 7: pupa of *S. erythrocephalus*, 8. adult of *R. maculatus*.

could be confirmed by our results, namely that insects belonging to other taxa were also attacked by this pteromalid wasp. It is important to note that we only observed *L. festiva* in the branches and trunks examined in order to exclude other xylophagous host species. According to Herting (1977) *R. maculatus* can behave as a hyperparasitoid on braconid wasps. Consequently, *R. maculatus* might be a primary parasitoid of *L. festiva* or secondary parasitoid on *Spathius* primary parasitoid wasps. More detailed observations are required to clarify the biology of that wasp. The *Rhaphitelus* genus appears to be basically Palaearctic, although *R. maculatus* now has an almost world-wide distribution; presumably the result of accidental introductions. Laboratory studies on *R. maculatus* have been performed, aimed at exploring its potential usefulness in biological control of bark-beetles. The larva and pupa were briefly described by Asma *et al.* (2015).

Based on our preliminary results, *S. erythrocephalus* is a potential beneficial organism, which could be contributed as a means to counteract the rapid Palearctic population number of moderating the devastating impact of *L. festiva* (Mills and Getz, 1996; Jeffs and Lewis, 2013). In this respect, more research is needed to understand the trophic role of *R. maculatus*, which is also a potential natural enemy of several wood boring pests (Asma *et al*., 2015).

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