

FIG WASPS *BLASTOPHAGA PSENES* (L.) (CHALCIDOIDEA: AGAONIDAE) AND *PHILOTRYPESIS CARICAE* (L.) (CHALCIDOIDEA: PTEROMALIDAE): ADDITIONS TO THE FAUNA OF SERBIA

LJUBODRAG MIHAJLOVIĆ¹, ŽELJKO TOMANOVIĆ^{2,3*} and IVAN LEKOVIĆ⁴

¹ Faculty of Forestry, University of Belgrade, Kneza Višeslava 1, 11030 Belgrade, Serbia

² University of Belgrade, Faculty of Biology, Institute of Zoology, Studentski trg 16, Belgrade, Serbia

³ Serbian Academy of Sciences and Arts, Knez Mihailova 35, 11000, Belgrade, Serbia

*E-mail: ztoman@bio.bg.ac.rs (corresponding author)

⁴ Medical faculty, University of Defense, Military Medical Academy, Belgrade, Crnotravska 17, Serbia

Abstract

In Serbia, the presence of two species of fig wasps, *Blastophaga psenes* (L.) (Chalcidoidea: Agaonidae), and *Philotrypesis caricae* (L.) (Chalcidoidea: Pteromalidae: Oritesellini) was recorded for the first time. Both are trophically associated with wild figs (caprifig), *Ficus carica* L. In Europe, *B. psenes* has been documented in countries with a Mediterranean climate and, in recent years, has also been recorded in southern Hungary and southern Germany. This finding represents the third record from a European with a continental climate. It was recorded in the Belgrade area in 2025 at the following locations: Kumodraž, Beli Potok, and Jajinci. *B. psenes* is a fig pollinator and, under local climatic conditions, produces three generations per year. *Philotrypesis caricae* is not a fig pollinator but a kleptoparasitoid of *B. psenes*. In Europe, it has previously been reported only from the Mediterranean climate zone, including the Pyrenees, the Apennine Peninsula, Malta, and Crimea. Our finding represents the first record from a European with a continental climate and the first from the Balkan Peninsula. The species also has three generations per year and a life cycle similar to that of *B. psenes*.

KEYWORDS: Agaonidae, *Ficus carica*, pollination, kleptoparasitism, entomofauna, Serbia

Introduction

Species of the family Agaonidae (Hymenoptera: Chalcidoidea), primarily those from the subfamily Agaoninae, are almost exclusively associated with plants of the genus *Ficus*, with about 380 currently known species (Rasplus *et al.*, 2025). This relationship is a classic example of plant-insect coevolution. Each species of the genus *Ficus* is associated with a specific species from the subfamily Agaoninae. This interaction is an obligate mutualism between a plant and an insect. The insect pollinates the plant, enabling the production of viable seeds that allow the plant to reproduce sexually, expand its range, and enhance its survival. In return, the plant's fruits provide the conditions necessary for the development of the insect's offspring, resulting in mutual benefit for both partners (Bouček, 1988).

Plants of the genus *Ficus* belong to the mulberry family (Moraceae). About 850 species are recognized, most of which dominate tropical rainforest communities, while a much smaller number occur naturally in subtropical regions. Most species produce edible fruits that are an important food source for many animals, especially mammals and birds. The pollinated fruits contain numerous small seeds that, when the fruit is eaten by an animal, pass through the digestive tract, are excreted, and subsequently germinate at the site of deposition.

In Europe, only one species from the *Ficus* genus grows in nature, the well-known fig *Ficus carica* (F.). Its natural range extends from Greece through Turkey to northern India, from where it was long ago introduced to all Mediterranean countries, as well as to Central Europe and Serbia. Beyond Europe and much of Asia, it has also been introduced to North and South America, Africa, Australia, and New Zealand. In its natural range and in Mediterranean regions, the fig tree reproduces both generatively and vegetatively. Generative propagation is made possible by its sole pollinator, the wasp *B. psenes*. In continental Europe, where the fig is cultivated, reproduction occurs vegetatively (via cuttings or shoots), as the pollinator was absent until recently. However, in 2008, the fig pollinator *B. psenes* was recorded in southern Hungary (Fazekas & Schmidt 2018), and then in 2022 in southern Germany (Rehberger *et al.* 2024). The authors attribute the expansion of *B. psenes* to global warming.

Here, we investigated the possible presence of the fig pollinator *B. psenes* in Serbia, along with associated species.

Materials and Methods

Research was conducted in the Belgrade area, specifically in the Voždovac municipality (Kumodraž, Beli Potok, and Jajinci) (Fig. 1). During the year, fruits were collected from one wild fig tree in Kumodraž, two trees in Beli Potok, and one in Jajinci. Several fruits were collected in spring, summer, and autumn for further observation, and kept at room temperature for three weeks. Emerged fig wasp imagos were killed with ethyl acetate or by freezing and then mounted on triangular cards. Additional specimens were collected from the surface of fruits on the studied trees using an aspirator. All specimens were labeled after preparation and are deposited in the collection of one of the authors (Lj. Mihajlović). Photographs of the dissected specimens were taken with a Leica DM LS phase contrast microscope (Leica Microsystems GmbH, Wetzlar, Germany).



Figure 1. Wild fig trees (*Ficus carica*) in three locations in Belgrade where the fig wasps *B. psenes* and *P. caricae* were recorded: Kumodraž (a), Jajinci (b), and Beli Potok (c, d).

Results and Discussion

Two fig wasp species were found in certain areas of Belgrade: *Blastophaga psenes* and *Philotrypesis caricae*. Both are new to the fauna of Serbia. Based on field and laboratory monitoring of fig wasp bionomics, it was concluded that both species have three generations per year in Serbia.

Blastophaga psenes (Linnaeus, 1758) (Fig. 2)



Figure 2. *Blastophaga psenes*: female (a), female head (b), forewing (c), metasoma (d), and cut fig fruit with numerous females (e).

Material: Beograd, Kumodraž, 03.05.2025, 16 ♀♀, leg. IL; 07.07.2025, 18 ♀♀, leg. IL; 10.10.2025, 65 ♀♀, leg. IL; Beograd, Beli Potok, 03.05.2025, 3 ♀♀, leg. IL; Beograd, Jajinci, 12.05.2025, 1 ♀, leg. IL.

Diagnostic characters: The female is 1.7-2 mm long, black, and shiny. The head is prognathous, with antennae extending above the mouth opening. The scape is greatly thickened, the flagellum has five segments, and the clava is three-parted. The claws are well-developed. The radial vein of the forewings forms a 90° angle with the marginal and postmarginal veins. The metasoma is egg-shaped, with an ovipositor that is one-third the length of the metasoma (Fig. 2a, b, c, d). Males are brownish-yellow, wingless, and have a characteristic abdomen that is telescopically elongated and tucked under the body.

Biology: Phytophagous/pollinator gall wasp. Males appear first (protandry) and spend their entire short lives inside the fruit. When the females emerge (Fig. 2e), copulation occurs. Males then leave the fruit, fall to the ground, and soon die. Fertilized females move to the opening where the male flowers with pollen are located. The pollen sticks to their bodies, and they leave the fruit through the widened opening, flying to new flowers on the same or other trees. In the newly receptive flower, they enter through the opening (Fig. 3a) and move to the zone of female flowers, which they pollinate while attempting to lay eggs in the pistils of flowers with short styles. While laying her eggs, the female injects a cecidogenic substance that induces the pistil to form a gall around the egg. Inside the gall, the larva develops (Fig. 3b), subsequently pupates, and finally emerges as the imago of the next generation.

Swarming of the overwintering (third) generation occurs in spring, from mid-April to mid-May. Oviposition of the first generation takes place from mid-June to mid-July, so the first generation completes its development over approximately two months. Oviposition of the second generation occurs from mid-September to mid-October, and its development likewise lasts approximately two months. Larvae developing inside the galls reach full maturity before the onset of cold autumn conditions, overwinter in the galls, and pupate the following spring (late March to early April). Consequently, the third (overwintering) generation lasts 6-7 months. Our results are consistent with those reported for the Crimea region (Furtsov, 2008; 2009).

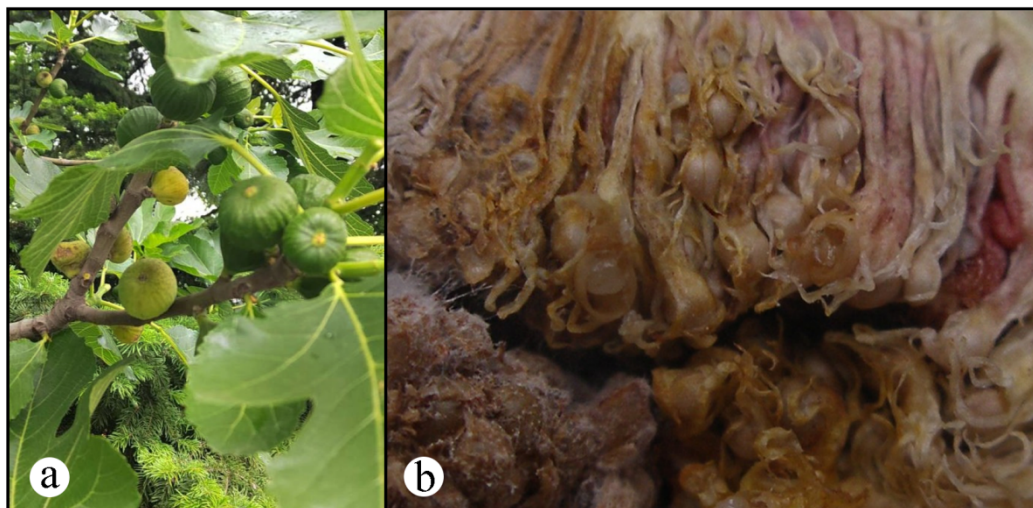


Figure 3. Male wild *F. carica* (caprifig) (a). Fruits galls with adult larvae of *B. psenes* (b).

Distribution of *B. psenes*: France, Greece, Croatia, Italy, Canary Islands, Hungary, Germany, Spain, Crimea, Turkey, Angola, Afghanistan, Algeria, Australia (New South Wales), Brazil, Central Asia, Eritrea, Ethiopia, India, Iran, Israel, Yemen, Armenia, South Africa, Caucasus, Morocco, Mauritius, Nepal, Oman, Pakistan, USA (Arizona, California, Texas), and North Africa (Noyes, 2019; www.gbif.org/species/1359057; UCD 2025 <https://ucd.chalcid.org/#/>). *P. caricae* was recently found in southern Hungary in 2008 and in southern Germany in 2022, making our finding the third record from Europe with a continental climate.

Philotrypesis caricae (Linnaeus, 1762) (Fig. 4)

Material: Beograd, Kumodraž, 07.05.2025, 1♀, leg. IL; 07.07.2025, 32♀♀; 15.10.2025, 2♀♀ 6♂♂, leg. IL; Beograd, Beli Potok, 07.07.2025, 3♀♀, leg. IL; Beograd, Jajinci, 07.07.2025, 1♀, leg. IL.

Diagnostic characters: The female (Fig. 4) is brownish-yellow and 2 mm long. The head has brown-black compound eyes. The antennae start just above the mouth opening with an elongated scapus, three anelli, and a five-segmented flagellum. The clava is three-segmented. The wings are well developed with normally developed brown nervures.

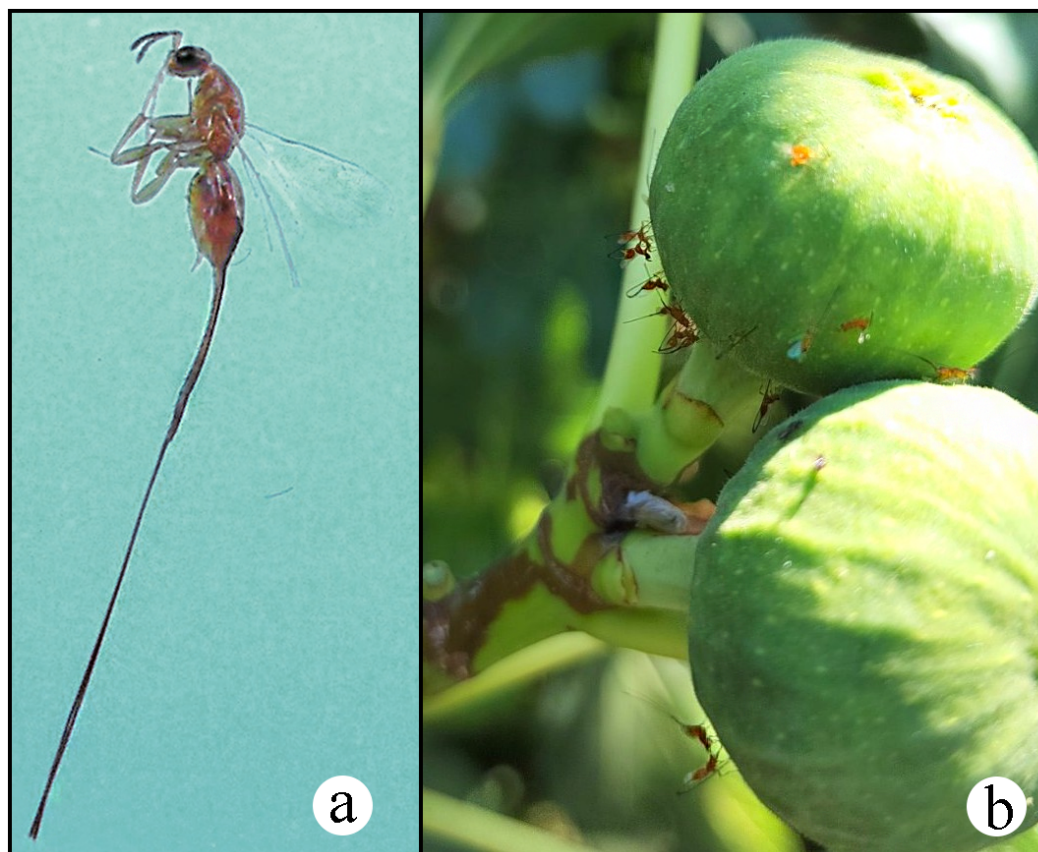


Figure 4. *Philotrypesis caricae*: female (a), females oviposit in wild figs fruit (b).

The metasoma is elongated and egg-shaped, with the last two segments narrow and telescopically extended, from which a long, black ovipositor emerges. The elongated terminal abdominal segments, together with the ovipositor, are approximately 3.5 times the body length. The wingless male is brown-yellow with a short metasoma. Copulation in this species also takes place inside the fig fruit, where both males and females develop. The males copulate with the females and soon die, while the females move to figs on the same or nearby trees where galls with *B. psenes* larvae are found. They do not enter the fruit but pierce the syconium with their long ovipositor and lay their eggs in the gall zone containing *B. psenes* larvae (Fig. 4b, c). The larvae feed on gall and syconium tissue, depriving *B. psenes* larvae of food and causing their death (Furtsov, 2009). Thus, *P. caricae* is a specific kleptoparasitoid of *B. psenes* (Vovlas & Larizza 1996). Some authors (Noyes, 2019; Furtsov, 2009) state that *P. caricae* is a parasitoid of *B. psenes*.

Biology: *Philotrypesis caricae* is also phytophagous but is not a fig pollinator. The life cycle of *Philotrypesis caricae* is like that of *B. psenes*. Oviposition of the overwintering (third) generation occurs from early to mid-May, the first generation in the first half of July, and the second during the first half of October. The third generation overwinters as a mature larva and swarms the following spring. Our observations corroborate the results reported by Furtsov (2009) for the Crimea region.

Distribution of *P. caricae*: France, Italy, Spain, Crimea, Turkey (Doğanlar, 2012), as well as Israel and the USA (Noyes, J., 2019; www.gbif.org/species/1358712). Our finding in Serbia represents the first record for the Balkan Peninsula and the first from a European region with a continental climate.

Both fig wasps were recorded in very high numbers in the Belgrade area, suggesting they are likely more widely distributed in Serbia; determining their broader distribution will be a focus of future research.

Acknowledgments

The article is supported by the Serbian Ministry of Science, Technological Development and Education (451-03-65/2024-03/ 200178) and the Serbian Academy of Sciences and Arts (grant no. F131).

References

- Bouček, Z. (1988). Australasian Chalcidoidea (Hymenoptera). A biosystematic revision of genera of fourteen families, with reclassification of species. C.A.B. International, 832 pp.
- Doğanlar, M. (2012). Occurrence of fig wasps (Hymenoptera: Chalcidoidea) in *Ficus carica* and *F. microcarpa* in Hatay, Turkey. *Turkish Journal of Zoology*, 36, 721-724.
- Fazekas, I., & Schmidt, C. (2018). The settlement of fig wasp (*Blastophaga psenes* Linnaeus, 1758) in the Mecsek Mountains, Hungary (Hymenoptera: Agaonidae). *Acta Naturalia Pannonica*, 10, 13-16.
- Fursov, V. N. (2008). On the study of *Blastophaga psenes* (L.) (Hymenoptera: Chalcidoidea: Agaonidae) obligate symbiont and pollinator of figs *Ficus carica* L. (Rosales: Moraceae) in Crimea. *Proceedings of the Kharkov Entomological Society*, 15, 174-184.
- Fursov, V. N. (2009). Life history of fig wasp *Blastophaga psenes* (L.) (Hymenoptera, Agaonidae) and its parasitoid *Philotrypesis caricae* (L.) (Agaonidae) developing in fig trees (*Ficus carica* L. In the Crimea, Ukraine. Simposiul "Protecția plantelor – lezări și perspective", 40, 58-59. Kișinev, Moldavia.
- Mifsud, D., Falzon, A., Malumphy, C., De Lillo, E., Vovlas, N., & Porcelli, F. (2012). On some arthropods associated with *Ficus* species (Moraceae) in the Maltese Islands. *Bulletin of the Entomological Society of Malta*, 5, 5-34.
- Noyes J. S. (2019). Universal Chalcidoidea Database. Available at <http://www.nhm.ac.uk/chalcidoids>. [Accessed on July 2021].
- Rasplus, J. Y., van Noort, S., Farache, F. H. A., & Cruaud, A. (2025). Agaonidae. In *Chalcidoidea of the World* (pp. 170-190). GB: CABI.
- Rehberger, S., Vogel, J., Müller, B., Vasilita, C., Krogmann, L., Schmidt, S. & Peters, R. (2024). The obligate fig-pollinator family Agaonidae in Germany (Hymenoptera, Chalcidoidea). *Deutsche Entomologische Zeitschrift*, 71, 177-183.
- Universal Chalcidoidea Database (UCD) 2025. <https://ucd.chalcid.org/#/>
- Vovlas, N., & Larizza, A. (1996). Relationship of *Schistonchus caprifici* (Aphelenchoididae) with fig inflorescences, the fig pollinator *Blastophaga*, and its cleptoparasite *Philotrypesis caricae*. *Fundamental and Applied Nematology*, 19, 443-448.
- www.gbif.org/species/1358712 *Philotrypesis caricae* (Linnaeus, 1762)
- www.gbif.org/species/1359057 *Blastophaga psenes* (Linnaeus, 1758)

СМОКВИНЕ ОСЕ *BLASTOPHAGA PSENES* (L.) (CHALCIDOIDEA: AGAONIDAE) И *PHILOTRYPESIS CARICAE* (L.) (CHALCIDOIDEA: PTEROMALIDAE) НОВЕ ВРСТЕ У ФАУНИ СРБИЈЕ

МИХАЈЛОВИЋ ЉУБОДРАГ, ТОМАНОВИЋ, ЖЕЉКО И ЛЕКОВИЋ, ИВАН

Извод

У Србији је забележено присуство две врсте смоквиних оса: *Blastophaga psenes* (L.) (Chalcidoidea: Agaonidae) и *Philotrypesis caricae* (L.) (Chalcidoidea: Pteromalidae). Обе су трофички везане за плодове тзв. Дивље (сврџи) смокве *Ficus carica* L. На подручју Европе *B. psenes* је била присутна у земљама са Медитеранском климом, а последњих година је констатована на југу Мађарске и југу Немачке. Наш налаз у Србији је трећи за подручје Европе са континенталном климом. Забележена је на подручју Београда 2025. године на локалитетима: Кумодраж, Бели Поток и Јајинци. *B. psenes* је полинатор смокве и у нашим климатским условима има три генерације. *P. caricae* није опрашивач смокве, већ клептопаразитоид *B. psenes*. До сада је у Европи била позната у Медитерану на Пиринејском и Апенинском полуострву, Турској и на Криму. Наш налаз је први за подручју Европе са континенталном климом и први за Балканско полуострво. Такође има три генерације и животни циклус сличан претходној врсти.

Received: December 2nd, 2025

Accepted: January 22nd, 2026