

The brown lacewing *Hemerobius schedli* Hölzel, 1970 in the Balkan Peninsula

(Neuroptera, Hemerobiidae)

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New findings of the brown lacewing *Hemerobius schedli* in Montenegro (the first record for the country), North Macedonia (occurrence on the second mountain in the country), and Austria are presented. In contrast to Central European populations of *H. schedli* that develop on *Pinus cembra*, plant substrate of the Balkan populations is *Pinus peuce*. In this study, the records of *H. schedli* are horizontally and vertically compared to the distribution of both *Pinus* species. The maximum and minimum altitudes in the whole range of *H. schedli*, as well as the minimum altitudes in the Pyrenees, Alps, and Balkan Peninsula are based on the original material. The single locality of *H. schedli* in the Pyrenees is localized. It is also the only locality in which the species does not occur on tree species of the subgenus *Strobos* of genus *Pinus*. Possible new discoveries are discussed in the context of the known distribution of the plant substrates. The populations of *H. schedli* in the Balkan Peninsula seem to be stable and no special measures are needed to protect them.

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Fig. 1. Forewing of *H. schedli*.

Introduction

Brown lacewings, Hemerobiidae is the third largest family of order Neuroptera (Insecta: Neuropterida), with more than 550 known extant species (Monserrat 1990, Oswald 1993, Aspöck et al. 2001, Tauber et al. 2009). Adults are small to medium-sized, brown, and inconspicuous.

While the larvae of hemerobiids feed on soft-bodied arthropods, adults are omnivorous, feeding on honeydew, insects, and mites (review: Devetak & Klokočovnik 2016). The larvae of many brown lacewings feed on insect and mite pests of cultivated plants. Because of their value in biological control, hemerobiids are economically important (New 1975, Stelzl 1991, Canard 2001, Devetak & Klokočovnik 2016).

In Europe there are 62 brown lacewing species known (Aspöck et al. 2015), and among them, *Hemerobius schedli* is one of the rarest. In 1970 Herbert Hölzel described *H. schedli* as a new species, originating from the Ötztal Alps and Dachstein, both in Austria (Hölzel 1970). Later, this rare species was found in a few European countries (for critical review of the distribution of the species see Popov et al. 2018). Popov (1986) reported on the first Balkan finding of the species in Rila (Bulgaria).

Forty-three species of brown lacewings in 7 genera are recognized in the Balkan Peninsula (Popov & Letardi 2010). Despite of this relatively high species number, the knowledge on the distribution of Hemerobiidae for most Balkan countries is still poor. Only in two countries, in Bulgaria and Romania, the hemerobiid fauna is well known (Kis et al. 1970, Popov 1986, 1991, 1996, 2002, Dobosz & Popov 2018). In July and September 2017, June 2018,

and June 2019, zoologists from the Department of Biology of the University of Maribor, Slovenia, conducted four neuropterological collecting trips to North Macedonia. The aim of this paper is to present new findings of *H. schedli* in North Macedonia and older samples from Montenegro and Austria as well as to summarize the new and existing records of the species in the Balkan Peninsula.

Material and methods

Brown lacewings were collected by sweeping with insect net. Insects were preserved in 70 % ethanol and deposited in the first and third author's collection. Genital preparations were made by clearing the apex of the abdomen in saturated KOH solution. Micrographs were made using a stereoscopic zoom microscope Nikon SMZ800 with a mounted Nikon DS-Fi2 digital camera and processed with NIS-Elements D 4.20 software. Digital images captured at different focal planes were assembled using the Helicon Focus 4.62 Lite software.

Results

Individuals of *Hemerobius schedli* (Figs. 1, 2) were found in the Prokletije Mountains (in Albanian: Bjeshkët e Nemuna) in Montenegro and in two mountains in North Macedonia, in the Shar Mountains (or Šar Planina, Sharr Mountains, Malet e Sharrit) in the northwest of the country and in Baba Mountain within Pelister National Park in the south west of the country. We already briefly reported on the finding of the species in Baba Mountain, without providing detailed information on the habitat (Devetak et al. 2019).

Material examined

(1) Montenegro: Prokletije Mountains: Locality:

Rožaje Municipality, SE Rožaje, near the highest point of the pass, near to the border with Kosovo; 1600 m; 42°46'59"N, 20°15'23"E; 11.VI.1979; leg. H. Rausch, R. Rausch, P. Ressler; 1 ♂, 1 ♀ (collected together with *H. handschini*, 1 ♂, 1 ♀).

(2) North Macedonia: Baba Mountain, Pelister National Park (Pelagoniski region): *H. schedli* was collected in four localities:

Kopanki; forest with *Pinus peuce*; 1629 m; 41°01'59.8"N, 21°13'09.3"E; 6.VII.2017; leg. T. Klenovšek, J. Podlesnik, F. Janžekovič & D. Devetak; 23 ♂, 7 ♀.

Near Jorgov Kamen; meadow/forest with *Pinus peuce*; 1738 m; 41°01'35.6"N, 21°12'44.0"E; 6.VII.2017; leg. T. Klenovšek, J. Podlesnik, F. Janžekovič & D. Devetak; 6 ♂, 5 ♀.

Jorgov Kamen; meadow/forest with *Pinus peuce*; 1733 m; 41°01'17.1"N, 21°13'21.3"E; 6.VII.2017; leg. T. Klenovšek, J. Podlesnik, F. Janžekovič & D. Devetak; 2 ♂, 12 ♀.

Near Golema Livada; dry meadow with sporadic *Pinus peuce*-trees; 1205 m; 41°02'40.5"N, 21°12'44.1"E; 6.VII.2017; leg. T. Klenovšek, J. Podlesnik, F. Janžekovič & D. Devetak; 4 ♂, 8 ♀.

(3) North Macedonia: Shar Planina Mountains (Polshki region): Locality:

Jelachki Crn Vrv; coniferous forest with *Pinus peuce* and *Pinus sylvestris*; 1780–1814 m; 42°02'13.0"N, 20°51'20.5"E; 24.VI.2019; leg. V. Krpač, T. Klenovšek, V. Klokočovnik, J. Podlesnik & D. Devetak; 4 ♂, 9 ♀.

Additional material

(4) Austria: Zillertal Alps: Locality:

Tirol, Schwaz Municipality, Kleiner Kaserer; 3090 m; 47°04'06"N, 11°38'45"E; 16.VIII.1980; leg. K. Thaler; 1 ♂, 1 ♀.

The specimens from North Macedonia are preserved in Dušan Devetak collection and the specimens from Montenegro and Austria are kept in Hubert and Renate Rausch collection (Scheibbs, Austria).

In both North Macedonian mountains, *H. schedli* occurred exclusively on five-needle pine *Pinus peuce* (Fig. 3A,B) at elevations of 1205–1814 m a. s. l. This represents the minimum altitude of *H. schedli* in its whole range. Before the species was collected at 1450 m (Heiligenblut, Carinthia, Austria; Hölzel & Wieser 1999). In the Shar Mountains the habitat was a mixed forest of *Pinus peuce*, *P. sylvestris*, *Juniperus* sp., and *Picea abies* (Fig. 3D). In the Pelister National Park, forests were pure *P. peuce*-stands (Fig. 3C) representing the type locality of *P. peuce*.

After the first finding in the Rila Mountains (Popov 1986), the Shar Planina, Prokletije, and Baba are further locations in mountain ranges in

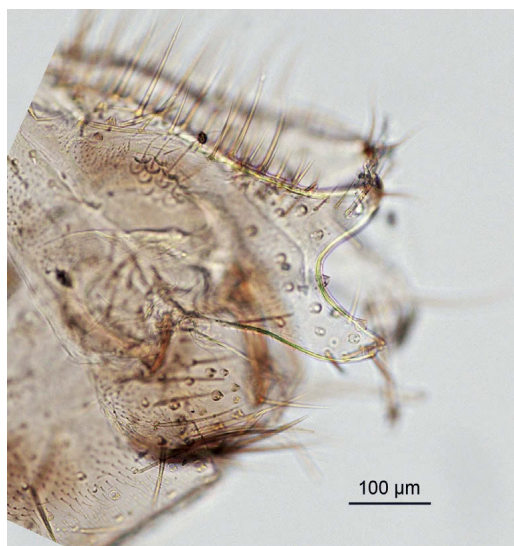


Fig. 2. Ectoproct of *H. schedli*, lateral view.

the Balkan Peninsula where this interesting species was collected.

Males of *H. schedli* are clearly distinguished from males of the closely related *H. handschini* Tjeder, 1957 and *H. nitidulus* Fabricius, 1777 by the shape of the ectoproct (Fig. 2) (see Hölzel 1970, Aspöck et al. 1980, Devetak et al. 2019). Contrary to males, discrimination of *H. schedli*-females from the closely related species is difficult and not always reliable. In all localities in Baba Mountain and in Jelachki Crn Vrv in the Shar Mountains no closely related *H. handschini*-neither *H. nitidulus*-males were found at the time of collecting, so we assume that our identification of females is correct.

The distinction of the only female in our material from Montenegro was made on the basis of weak eidonomic but somewhat uncertain differences. The veins and the wing membrane of the syntopically collected specimens of *H. handschini* are more intensely yellowish-brown and slightly darker, while those of *H. schedli* are paler. Further investigations on the distinguishing characters of the females, also with the help of molecular methods, are required.

Discussion

Range and habitat of *Hemerobius schedli*

The brown lacewing *H. schedli* is a rare species, known from montane areas in France, Switzerland, Liechtenstein, Italy, Austria, Slovakia, Bulgaria, and North Macedonia (Aspöck et al. 2001, Popov et al.

2018, Devetak et al. 2019). Musala Ridge in the Rila Mountains in Bulgaria was the first area in the Balkan Peninsula where this species was recorded (Popov 1986, Beron 1999). With the new locality, the range also includes Montenegro.

Many brown lacewing species appear to be bound to certain plant substrates, like conifers or broad-leaved trees (Monserrat & Marín 1996, Gruppe 2008). Some species are associated with a particular tree genus, e.g. *Pinus* (*Hemerobius stigma* Stephens, 1836), *Picea* (*Hemerobius pini* Stephens, 1836), *Larix* (*Hemerobius atrifrons* McLachlan, 1868), *Quercus* (*Hemerobius gilvius* Stein, 1863). Very rarely hemerobiids are specialized only in some species of a genus. This is exactly the case with *H. schedli*. It occurs on Swiss stone pine (*P. cembra*) in Central Europe (Hölzel 1970, Schedl 1970), while the plant substrate in the Balkan Peninsula is Balkan or Macedonian pine, *P. peuce* (Popov 1986, Popov et al. 2018, Devetak et al. 2019, present paper). These two pines are the only European representatives of the five-needle pine species in the section *Quinquefoliae*, of the subgenus *Strobos* of genus *Pinus* (Gernandt et al. 2005).

Distribution of *Hemerobius schedli* in the range of *Pinus cembra*

Swiss stone pine (*P. cembra*) has a limited range compared to most other species of this genus in Europe. It covers 300 km² of the Alps and Carpathians (Caudullo et al. 2017) in the upper forest zone mainly between 1700 and 2100 m, reaching the timberline (Holzer 1972), with isolated trees down to 900 m (Casalegno et al. 2010) and up to the treeline at 2850 m (Ulber et al. 2004). The published records of *H. schedli* in the Alps are from 1450 m (Heiligenblut; Hölzel & Wieser 1999) to 2200 m (Gurgltal above Peilstein; Hölzel 1970, Schedl 1970), both in Austria. The record in the current study in the Zillertal Alps (Austria) at 3090 m has the highest altitude in the whole range of the species. The published male from Heiligenblut, as well as another specimen from the same locality but with a different collection date, are labelled in the Hölzel collection with an altitude of 1300 m and not 1450 m (S. Randolf in litt. to AP, 25 March 2020). This is the lowest altitude at which *H. schedli* was found in the range of *P. cembra*. These records, except for specimens from the Zillertal Alps, fall entirely within the horizontal as well as the vertical range of *P. cembra*, whether it is noted or not that they were collected on this tree species. The highest number of localities of *H. schedli* is known from the Austrian Alps (Popov et al. 2018), where the main part of the range of *P. cembra* is located.

In the Carpathians, the area of *P. cembra* is smaller than in the Alps, but occupies a similar part of the mountain range. Its main part is located in Romania in the Southern Carpathians (Transylvanian Alps) and in the Eastern Carpathians. The localities in 11 mountain ranges in Romania are described in detail and the areas are mapped by Blada (2008). The altitude is predominantly between 1300 and 1700 m (Ulber et al. 2004) at extreme altitudes of 900 m (Holzer 1972) and 2244 m (Blada 2008), i.e. it is lower compared to the Alps. The fauna of Neuroptera in Romania and especially of the Carpathians has been very well explored thanks to the work of Béla Kis. He actively collected in the 1960s until 1970, when the volume on Neuroptera in Fauna of Romania was published (Kis et al. 1970). At that time, *H. schedli* was not yet described. An excellent taxonomist as B. Kis could distinguish the undescribed species from the closely related *Hemerobius nitidulus* and *Hemerobius handschini*, which are found in the Carpathians, but perhaps he has not collected material on *Pinus cembra*. We think that the occurrence of *H. schedli* in the Romanian Carpathians is possible. The Eastern Carpathians continue to the northwest on the territory of Ukraine. There, in Chornohora and Gorgany mountain ranges, marginal populations of *P. cembra* create isolated islands where other tree species are unable to cope with harsh conditions (Mohytych et al. 2019). Therefore, we do not consider the occurrence of *H. schedli* in Ukraine likely.

In the Western Carpathians, *P. cembra* occurs autochthonously in a limited area in the Tatra Mountains on both sides of the border between Slovakia and Poland. We regard the occurrence of *H. schedli* in the Slovak Tatra as certainty (see Popov et al. 2018). In the Polish Tatra, *P. cembra* has survived the abrupt warming of the climate on the threshold of the Holocene in a small number of relict areas under severe climatic and soil conditions (Środoń 1966). Dwarf shrub-like trees of this species have been artificially introduced in Babia Góra Mountains (Pawłowski 1967). R. Dobosz (in litt. to AP, 31 March 2020) has collected in the Polish Tatra a male of *Hemerobius handschini* in the area of Czarny Staw Gąsiennicowy area, 1624 m a.s.l., but did not search for hemerobiids on *P. cembra*. He has collected intensively in Babia Góra on *Pinus mugo* Turra, but has found only *H. handschini*. R. Dobosz thinks that *H. schedli* certainly occurs in the Polish Tatra but its presence in Babia Góra is rather unlikely.

Distribution of *Hemerobius schedli* in the range of *Pinus peuce*

Pinus peuce is a Balkan endemic conifer, native to the central parts of the Balkan Peninsula and occurring

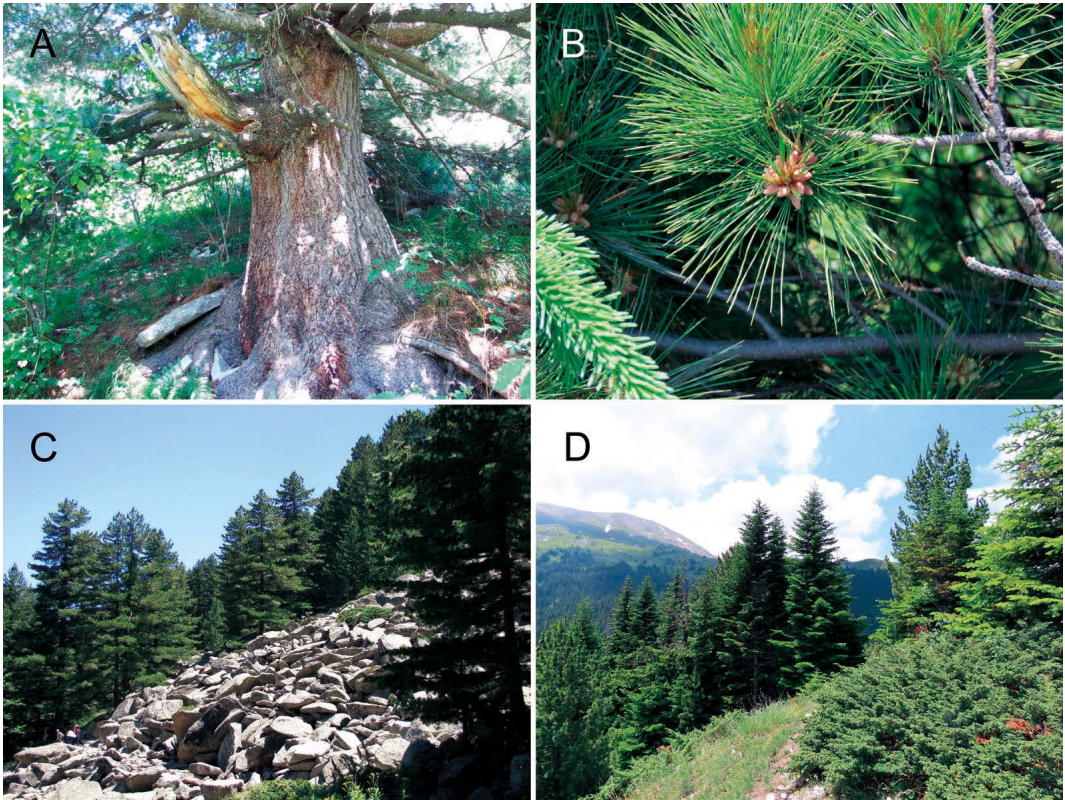


Fig. 3. Habitats of *H. schedli*. A. Primeval forest of old Balkan pines (*Pinus peuce*) in Baba Mountain (Pelister National Park, N Macedonia). B. Branches of a Balkan pine, *P. peuce*. C. Baba Mountain with pure *P. peuce*-stands. D. Shar Planina Mountains (N Macedonia), peak Jelackki Crn Vrv with *P. peuce* and *P. sylvestris*. All photos: DD.

in the mountains of Eastern Montenegro, Eastern Albania, Western Kosovo, the extreme southwest of Serbia, North Macedonia, Southwestern Bulgaria, and the extreme north of Greece (mapped by Alexandrov & Andonovski 2011, Caudullo et al. 2019). The map of Farjon (2017a) is incorrect for many localities. An isolated, autochthonous population exists in Western Bosnia, 300 km far from the closest locality of the species, consists of 350 trees over an area of 4.6 hectares (Bucalo et al. 2012). The area of *P. peuce* is smaller than that of *P. cembra* and is about 200 km², of which 140 km² in Bulgaria. The largest compact forests of *P. peuce* are in the Pirin Mountains, Rila Mountains, Prokletije Mountains, and Baba Mountain (between 72 and 25 km² in each), while in every of the other mountains in the range the area does not exceed 5 km² (Alexandrov & Andonovski 2011). *Pinus peuce* occupies the uppermost part of the forest with a closed canopy in the mountains. In Rila and Pirin, it forms the upper sub-belt of the coniferous belt above the sub-belt of *Picea abies* and below the subalpine belt with *Pinus mugo*. The main

forests are located at altitudes between 1600 and 2200 m (Holzer 1972, Alexandrov & Andonovski 2011, Roussakova 2015). Isolated trees grow up to 2600 m in Montenegro (Holzer 1972) and down to 800–900 m (Alexandrov & Andonovski 2011). The two closely related species, *P. cembra* and *P. peuce*, are similar in their occurrence in areas with harsh conditions of low temperatures and high humidity. No other tree species in Europe can grow under such conditions.

All specimens of *Hemerobius schedli* in North Macedonia and Bulgaria were collected on *P. peuce* at the altitudes between 1205 m in Baba Mountain and 1814 m in the Shar Mountains. A specimen collected in the alpine belt at 2740 m on Marishki Chal in Maritsa area of Musala Ridge in Eastern Rila Mountains represents an exception, but most likely it has been drifted there by wind (Beron 1999, Popov et al. 2018). There is no information about the tree substrate of the specimens in Montenegro. Syntopic occurrence of *H. schedli* and *H. handschini* is observed in the Rila Mountains in Bulgaria (Popov 1986) and in the

Prokletije Mountains in Montenegro (present paper). Like *P. peuce* (and *P. cembra*), *H. schedli* is adapted to the severe climatic conditions of the upper sub-belt of the coniferous belt. Only two species among the hemerobiids as well as among all Neuroptera have so far not been found in Bulgaria below 1800 m: *Hemerobius schedli* and *Wesmaelius tjederi* (Kimmins, 1963). Taking into account the known distribution of *P. peuce* (Fig. 4), more findings of *H. schedli* in the Balkan Peninsula could be expected. Most likely they will be in the areas with compact forests of *P. peuce*, namely Pirin in Bulgaria and possibly in some other mountains in the central part of the Balkan Peninsula. *P. peuce* does not form distinct phytocoenoses in other four mountains in Bulgaria: Vitoshka (with restored population), Central Stara Planina Range, Rhodopes, and Slavyanka. Occurrence of *H. schedli* in these mountains is unlikely.

Hemerobius schedli in the Pyrenees

The only original information on *H. schedli* from the Pyrenees, France is reported in the monograph on the Neuropterida in Europe (Aspöck et al. 1980), repeated in the subsequent literature. The exact locality is not specified because no concrete localities are mentioned in this monograph, but it is mapped (Aspöck et al. 1980). This information comes from a record of *H. schedli* from Vernet-les-Bains in the French Pyrenees, reported by Herbert Hölzel to Hubert and Renate Rausch in 1977 for inclusion in the maps of the monograph (R. Rausch in litt. to AP, 21 March 2020). Indeed, in the Hölzel collection in the Natural History Museum in Vienna, two specimens of *H. schedli* from Southern France, Pyrénées-Orientales, environs of Vernet-les-Bains, 1000–1200 m, 5.–6.VI.1976, leg. Herbert and Gerlinde Hölzel, are preserved (S. Randolph in litt. to AP, 25 March 2020). These specimens have been collected at the lowest altitude in the entire range of the species.

All other localities of *H. schedli* (without two records in maximum altitudes) fall into the ranges of the European *Pinus* with five needles per fascicle: *P. cembra* and *P. peuce*. In the Pyrenees no *Pinus* with five needles occur. Therefore, the record in the Pyrenees deserves special attention. Undoubtedly, this is not a mislabelling or misidentification. The material was collected by H. Hölzel, identified by him personally, and kept in his collection. Future studies in the Pyrenees are needed to prove on which species of *Pinus* *H. schedli* occurs.

Need for conservation of *Hemerobius schedli*

Pinus cembra is globally assessed as Least Concern according to categories of the International Union for Conservation of Nature (IUCN), i.e. it is not

threatened as it is widespread, well protected, currently expanding its altitudinal extent and its population is slowly increasing (Farjon 2017b). *Pinus peuce* is assessed globally as Near Threatened, i.e. it is not included in the three IUCN categories with threatened species, because it is known from 17–20 subpopulations, some of which are isolated and small, however the population trend is not known (Farjon 2017a). In the Red Data Book of Bulgaria, it is not included as a species (Peev 2015) but as a habitat forests of *P. peuce* were assessed as Endangered due to the extremely aggressive anthropogenic impact in the past as a result of logging and fires (Roussakova 2015). The main damages, however, occurred 50–70 years ago. About 30 years ago, the forests of *P. peuce* were included in the Rila National Park (and also in the Pelister National Park in Baba Mountain) with strict conservation regimes. In recent years, these forests in Bulgaria have remained in stable condition. Thus, it can be assumed that the population of *H. schedli* in Bulgaria is also stable. Therefore, no special measures are needed to protect the species at least in the Balkan Peninsula.

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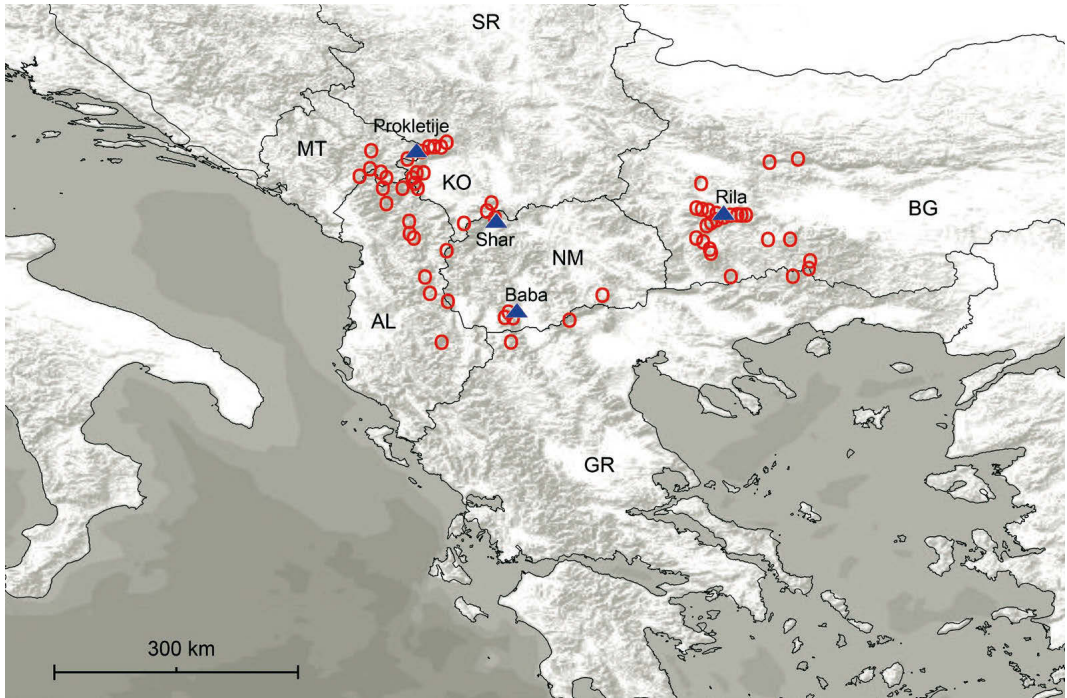


Fig. 4. Distribution of *H. schedli* (▲) and its plant substrate, *P. peuce* (○) in the Balkan Peninsula (distribution of *P. peuce* after Caudullo et al. 2019). Legend: AL, Albania; BG, Bulgaria; GR, Greece; KO, Kosovo; MT, Montenegro; NM, North Macedonia; SR, Serbia. Map: DD.

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