

UNEXPECTED FAUNISTIC RECORDS OF *RHACOCLEIS ANNULATA*, *EYPREPOCNEMIS* *PLORANS*, AND *XYA PFAENDLERI* (ORTHOPTERA) FROM CROATIA AND SLOVENIA

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Interesting records of one bush-cricket and two grasshopper species are reported from Croatia and Slovenia. *Rhacocleis annulata* Fieber, 1853 (Tettigoniidae: Tettigoniinae) has been reported for the first time from Croatia (Dubrava by Šibenik), as well as for Slovenia (Borovnica SW of Ljubljana); *Eyprepocnemis plorans* (Charpentier, 1825) (Acrididae: Eyprepocnemidinae) is reported for the first time for Croatia, also from Dubrava; and finally, the *Xya pfaendleri* Harz, 1970 (Tridactylidae: Tridactylinae) record from Dubrava represents the first record of this species from Dalmatia. *Rhacocleis annulata* and *Eyprepocnemis plorans* are known to be spreading through Europe, so these records contribute to the understanding of their dispersal in Southern Europe. Croatian Orthopteran fauna now counts, with two species added, 187 species, while Slovenian Orthopteran fauna now counts, with one species added, 158 species.

Key words: *Rhacocleis annulata*, *Eyprepocnemis plorans*, *Xya pfaendleri*, Dalmatia, Dubrava by Šibenik, Borovnica, dispersal, allochthonous species

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Rad predstavlja zanimljive nalaze jedne vrste konjica i dviju vrsta skakavaca iz Hrvatske i Slovenije. Mramorni konjic grmušar *Rhacocleis annulata* Fieber, 1853 (Tettigoniidae: Tettigoniinae) po prvi je put zabilježen za Hrvatsku u Dubravi kraj Šibenika, a za Sloveniju u Borovnici sjeverozapadno od Ljubljane; plavonogi uplakani skakavac *Eyprepocnemis plorans* (Charpentier, 1825) (Acrididae: Eyprepocnemidinae) po prvi je put zabilježen za Hrvatsku također u Dubravi; i naposljetku nalaz crnog buhoskakavca (*Xya pfaendleri* Harz, 1970; Tridactylidae: Tridactylinae) u Dubravi prvi je nalaz ove vrste u Dalmaciji. Poznato je da se *Rhacocleis annulata* i *Eyprepocnemis plorans* šire Europom, tako da naši nalazi doprinose poznavanju širenja ovih vrsta po južnoj Europi. Hrvatska fauna ravnokrilaca sada, s dvjema novim vrstama, broji 187 vrsta, a slovenska fauna ravnokrilaca s jednom novom vrstom broji ukupno 158 vrsta.

Ključne riječi: *Rhacocleis annulata*, *Eyprepocnemis plorans*, *Xya pfaendleri*, Dubrava kraj Šibenika, Borovnica, širenje, alohtone vrste

INTRODUCTION

The Western Balkans is among the most diverse areas of Europe from the standpoint of Orthoptera diversity (HOCHKIRCH *et al.*, 2016a). Croatian orthopteran fauna counts 185 species (SKEJO *et al.*, 2018; STALLING *et al.*, 2021), while the Slovenian com-

prises 157 species (GOMBOC & ŠEGULA, 2014). For now, no alien grasshoppers or crickets have been reported to have arrived in Croatia or Slovenia in the last few decades (e.g., SKEJO *et al.*, 2018 reported only old records of the cave cricket *Tachycines asynamorus* Adelung, 1902 from Dalmatia, but no known populations). Because of the previous general lack of entomological research in the Balkans, new faunistic records and discoveries of new species can be expected in the future. It is even more likely considering that many native European Orthoptera (HOLUŠA *et al.*, 2014; PAVLOVIĆ, 2019; KALÁB *et al.*, 2021) are migrating northwards with global warming and even managing to establish populations in unexpected areas (MONNERAT *et al.*, 2020). Some exotic Orthoptera (ŽURAWLEW *et al.*, 2020) and Mantodea (VAN DER HEYDEN, 2021) have arrived to Europe as well, sometimes establishing populations (VUJIĆ *et al.*, 2021; MARTINOVIĆ *et al.*, under review), and sometimes not (e.g., REINHARDT & KÖHLER, 2014 reported *Acanthacris ruficornis* (Fabricius, 1787) in a flower shop in Germany). There is a curious case of *Phlugioloa dahlemica* (Eichler, 1938), a species belonging to a South American genus. It was originally described from the Botanical Garden Berlin-Dahlem, and its true distribution is not known to this day (HARZ, 1969).

In this study, three Orthoptera species are reported from unexpected places. Tunisia-, Sicily- and Italy-endemic *Rhacocleis annulata* Fieber, 1853 is reported from the Garden Center in Dubrava by Šibenik (Croatia) and from a garden in Borovnica near Ljubljana (Slovenia). Furthermore, *Eyprepocnemis plorans* (Charpentier, 1825) and *Xya pfaendleri* Harz, 1970 are reported from the Garden Center in Dubrava, as well.

MATERIAL AND METHODS

Most of the observations were originally uploaded to iNaturalist (Tab. 1), where they were identified by grasshopper specialists (Josip Skejo and Niko Kasalo). The identifications were later re-checked and confirmed using relevant keys (BELLMANN *et al.*, 2019; HARZ, 1969, 1975; MASSA *et al.*, 2013). Photographs of living specimens were uploaded to iNaturalist (altogether 7 specimens belonging to *R. annulata* (2 observa-

Tab. 1. Links to all the observations reported in this study and uploaded to iNaturalist. Abbreviations: N—number of the record, L—locality, obs.—observation, A—Borovnica, Slovenia, B—Dubrava, Croatia.

N	Species	Specimens	L	Obs. date	iNaturalist link
1	<i>Rhacocleis annulata</i>	an adult ♂	A	05.XI.2020.	inaturalist.org/observations/64978025
2	<i>Rhacocleis annulata</i>	an adult ♂	B	25.VIII.2021.	inaturalist.org/observations/93058972
3	<i>Eyprepocnemis plorans</i>	a young nymph	B	12.VII.2021.	inaturalist.org/observations/91415672
4	<i>Eyprepocnemis plorans</i>	last instar nymph	B	21.VIII.2021.	inaturalist.org/observations/93046101
5	<i>Eyprepocnemis plorans</i>	an adult ♂	B	26.VIII.2021.	inaturalist.org/observations/93060690
6	<i>Eyprepocnemis plorans</i>	last instar nymph	B	28.VIII.2021.	inaturalist.org/observations/93060747
7	<i>Eyprepocnemis plorans</i>	last instar nymph	B	31.VIII.2021.	inaturalist.org/observations/98101199
8	<i>Xya pfaendleri</i>	an adult	B	17.VIII.2021.	inaturalist.org/observations/91555575

tions), *E. plorans* (5), and *X. pfaendleri* (1)), and more specimens were collected in Dubrava Garden Center by Šibenik for examination and photography of the morphological details. All the specimens originate from two localities, (i) a garden in Borovnica by Ljubljana in Slovenia (45°55'16.7"N, 14°21'48.4"E) (A in Tab. 1), and (ii) Dubrava by Šibenik in Dalmatia, Croatia (43°73'60.5"N, 15.94'70.8"E) (B in Tab. 1).

RESULTS

family Tettigoniidae

subfamily Tettigoniinae

Rhacocleis annulata Fieber, 1853,

ringed bush-cricket,

Croatian: mramorni konjic grmušar

Slovenian: obročkasta slamnica

(Fig. 1)

Material examined:

SLOVENIA: **One live male**, Borovnica SW of Ljubljana (45°55'16.7"N, 14°21'48.4"E) 5.XI.2020. obs. D. Zagorac; CROATIA: six collected specimens, **three females and three males**, Dubrava near Šibenik (43°73'66.4"N, 15°94'73.6"E) 31. VIII.2021. leg. S. Čato; about **ten live specimens** (nymphs and adults; males and females) were seen, Dubrava near Šibenik (43.73°59.3'N, 15.94°70.0'E) 25. VIII.-5. IX.2021. obs. S. Čato.

Distribution in Croatia and Slovenia

In Croatia, only a population from Dubrava by Šibenik is known (the Mediterranean, Adriatic region: Dalmatia), while from Slovenia, a single specimen was reported from Borovnica near Ljubljana (this study).

Distribution in Europe

Rhacocleis annulata is endemic to Tunisia, Sicily and southern Italy (MASSA *et al.*, 2013), but it has occupied parts of France (BARDET & BOITIER, 2006), the Netherlands, the United Kingdom, Switzerland (MONNERAT *et al.*, 2020) and Austria (ESSL & ZUNAKRATKY, 2021), where it is considered an alien species. For the annotated distribution, please refer to Fig. 4.

Similar species

This *Rhacocleis* species is similar to its congeners *R. germanica* (Herrich-Schäffer, 1840) and *R. buchichii* Herman, 1974. It is, however, easily separated from the two by colouration (black hind knees, Fig. 1A,B,J); shape of cerci in males (Fig. 1D, shorter than in *R. buchichii*, with smaller inner teeth than *R. germanica*); shape of subgenital plate in females (Fig. 1F,G, square with typical U-shaped excision and two depressions; compare Fig. 1F,G to square-shaped subgenital plate without excision and with a median ridge in *R. buchichii* in PAVLOVIĆ *et al.*, 2020 and in FELIX *et al.*, 2020; and compare to elongated subgenital plate with a small apical excision in *R. germanica* in MASSA *et al.*, 2013). Colouration can sometimes be similar in *R. buchichii* (compare with WAGNER, 2015 and FELIX *et al.*, 2020).

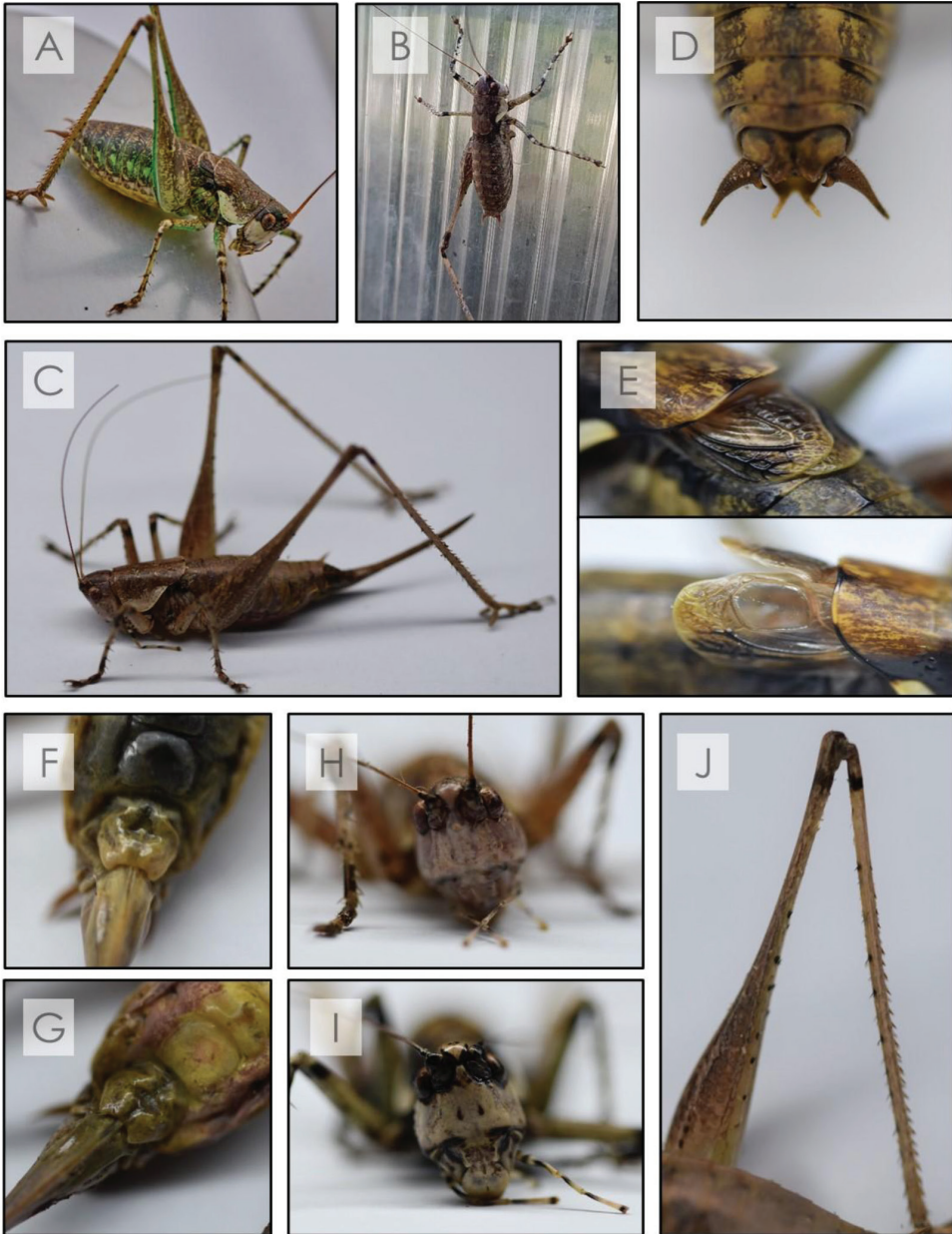


Fig. 1. First records of *Rhacocleis annulata* from Slovenia and Croatia. A) living male from Slovenia, B) living male from Croatia, C) female from Croatia, D) male cerci, E) male tegmina, F) and G) female subgenital plates, H) and I) head in frontal view, J) detail of the hind leg. Photo S. Ćato.

Notes

This is the first record of this alien species for Croatia, as it is for Slovenia. The species lacks a Croatian name, thus herewith, we propose “*mramorni konjic grmušar*”, because of its marble colouration (Croatian: *mramorna*) and Croatian names of other *Rhacocleis* species (Croatian: *konjici grmušari*) (SKEJO *et al.*, 2018).

family Acrididae

subfamily Eyprepocnemidinae

Eyprepocnemis plorans (Charpentier, 1825),

Croatian: **plavonogi uplakani skakavac**

(Fig. 2)

Material examined:

Three collected specimens, **two adults** (male and female) and one **last instar nymph** (female). Dubrava near Šibenik (43.73°59.3'N, 15.94°70.0'E) 24. VIII.-28.VIII 2021. leg. S. Čato; around **six** live specimens (nymphs and adults; males and females) were seen in Dubrava near Šibenik (43.73°59.3'N, 15.94°70.0'E) 2021. obs. S. Čato.

Distribution in Croatia

In Croatia, only a population from Dubrava by Šibenik is now known (the Mediterranean, Adriatic region: Dalmatia) (this study).

Distribution in Europe

The Lamenting Grasshopper inhabits Mediterranean Europe but does not reach the northern shores of the Mediterranean Sea (absent from the French and most of the Italian coast, also absent from the shores of the Adriatic Sea and Black Sea) (MASSA *et al.*, 2013; HOHCKIRCH *et al.*, 2016). For example, in Italy, the species is abundant in Sardinia and Sicily, while rare in the mainland (MASSA *et al.*, 2013). The species is common in coastal marshy habitats, orchards, and dunes with high vegetation (MASSA *et al.*, 2013). For the annotated distribution, please refer to Fig. 4.

Similar species

Because of the striped eyes (Fig. 2D) this species is visually similar to *Anacridium aegyptium* (Linnaeus, 1764), from which it is easily separated by smaller size and more flashy colours (e.g., blue hind tibiae). It is also similar to *Calliptamus italicus* (Linnaeus, 1758) in general colouration, but it can be easily distinguished from the latter by the blue hind tibiae and larger size.

Notes

This is the first record of this species from Croatia. The species lacks a Croatian name, thus herewith, we propose “*plavonogi uplakani skakavac*”. The first word refers to its blue hind tibiae (Croatian: *plave noge*), the second word refers to dark marking on the grasshopper's genae, reminiscent of crying (Croatian: *plakati*), and the last word is grasshopper (Croatian: *skakavac*).

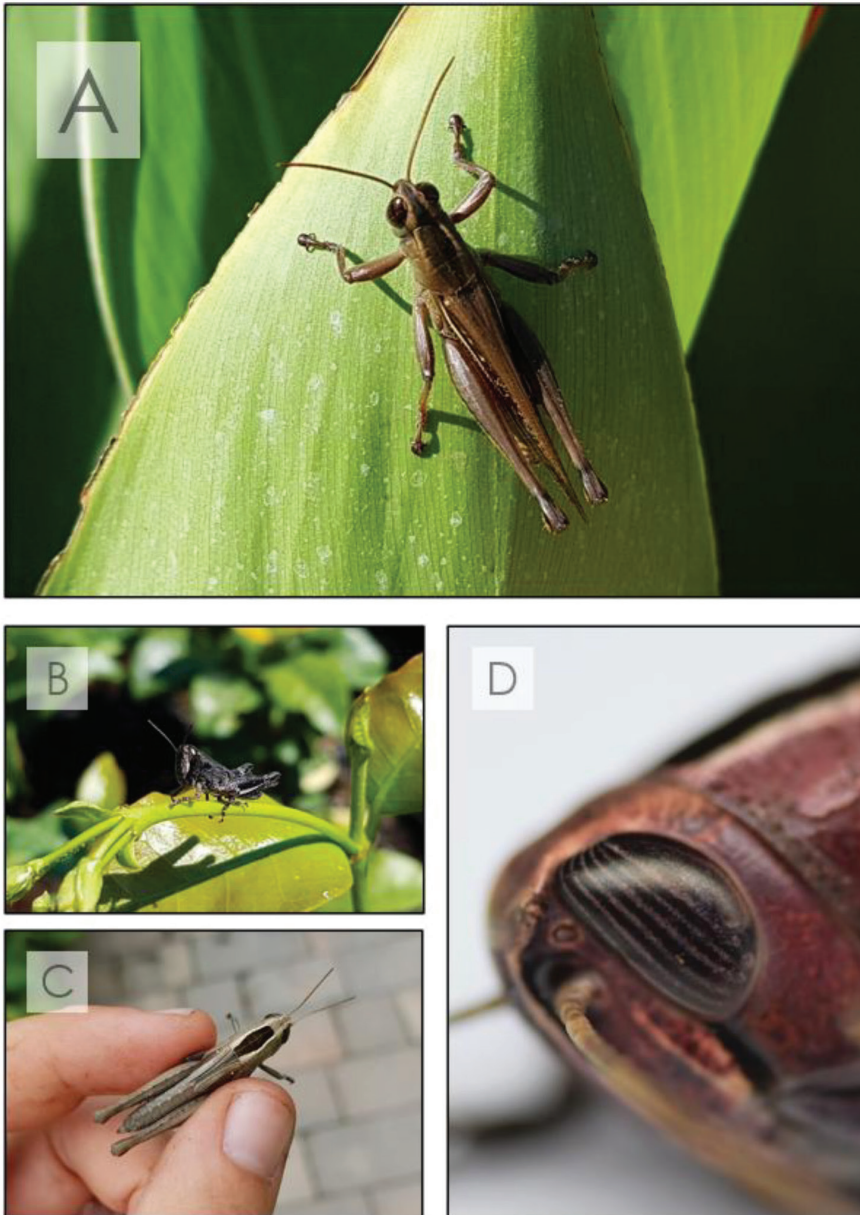


Fig. 2. First records of *Eyprepocnemis plorans* from Croatia. A) Adult male, B) Young nymph, C) Last instar nymph, D) Eye-macro. Dubrava by Šibenik, Dalmatia, Croatia. Photo S. Ćato.

family Tridactylidae

subfamily Tridactylinae

Xya pfaendleri Harz, 1970, hr. crni buhoskakavac
(Fig. 3)

Material examined:

Three collected specimens, Dubrava near Šibenik (43°73'59.6'', 15°94'66.4'') 17. VIII.2021. leg. S. Čato; around 10 live specimens were observed, Dubrava near Šibenik (43°73'59.6'', 15°94'66.4'') 19. VIII.2021.

Distribution in Croatia

The species was known previously in Croatia only from the Pannonian region (SKEJO *et al.*, 2018), from where it was reported in 2012 for the first time (SZÖVÉNYI & PUSKÁS, 2012), so with this record, the known distribution of *X. pfaendleri* in the country is expanded to the Mediterranean, Adriatic region: Dalmatia.

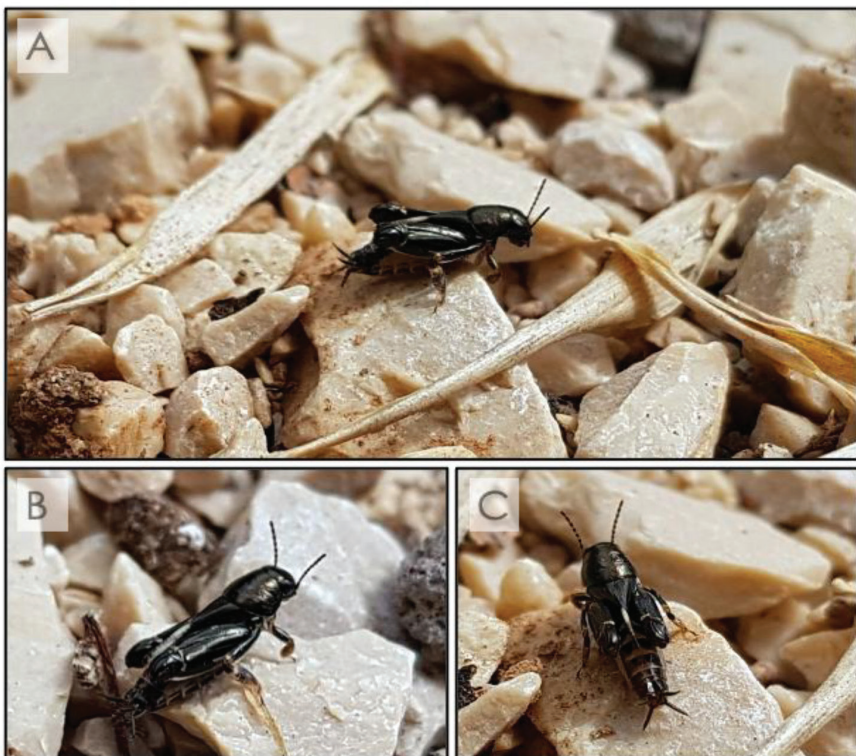


Fig. 3. First record of *Xya pfaendleri* from Dubrava by Šibenik, Dalmatia, Croatia. A) lateral view, B) dorsolateral view, and C) dorsal view. Photo S. Čato.

Distribution in Europe

The species inhabits large areas from the Eastern Mediterranean island of Cyprus to Czechia in the North, and from Slovenia in the west to Ukraine in the east (HOCHKIRCH *et al.*, 2016a). For the annotated distribution, please refer to Fig. 4.

Similar species

The species is similar to *Xya variegata* (Latreille, 1809), the only other false mole-cricket known to inhabit Croatia. Distinguishing it from *X. variegata*, which has a yellow marking on the paranota, the lateral lobes of the pronotum of *X. pfaendleri* are completely black (Fig. 3A, B).

DISCUSSION

In recent years, there is ample evidence that native European grasshopper species are extending their distribution ranges within Europe, and alien species have established population(s) in European countries (e.g., ESSL & ZUNA-KRATKY, 2021).

A good example is *R. annulata*, a species that has already been reported to have been spreading into the other countries close to its native range (MONNERAT *et al.*, 2020; ESSL & ZUNA-KRATKY, 2021). In Croatia, many adult individuals and last instar nymphs were observed in the greenhouses (Vrtni Centar Dubrava) or in the vegetation near them (e.g., *Canna* sp.). The presence of different stages at the locality suggests the species has an established population in Croatia. A single specimen record from Slovenia raises the question of whether the species has established a population in that country as well. In Dubrava, variation in colouration has been observed among the individuals of this species. For example, some had more green-and-white markings (males, some females), while other females had yellowish-brown colours (Fig. 1A, B, C). Also, the colouration pattern of the head was observed to vary within the population (Fig. 1H, I).

The next species of interest is *E. plorans*, with individuals of this species having been found taking shelter, like the previous species, in *Canna* sp. (Fig. 2A). Some nymphs were, however, also found in low growing vegetation nearby (Fig. 2B). Again, the presence of both nymphs and adults implies there is an established population of this species at the Garden centre in Dubrava.

Dubrava by Šibenik is a somewhat unusual place to find *X. pfaendleri*. This is the first record of this eastern European and Middle Eastern species (HOCHKIRCH *et al.*, 2016a, 2016c, see Fig. 4) in Dalmatia. Pannonian localities inhabited by this species usually have natural water sources, while the newly recorded locality is rather dry, especially during the long and hot summer months. Thus, the species here lives in close proximity to the irrigation system. The irrigation for the plants has arguably helped the population to establish itself regardless of the natural climate. The species has been observed in leaf litter under bamboo plants together with *Tetrix ceperoi* (Bolívar, 1887). High moisture is present at the spot, so both genera (*Xya* and *Tetrix*) have the required conditions to live in.

Both *R. annulata* and *E. plorans* have highly likely been introduced into the garden centre with the imported plant material. It seems reasonable to believe so because the plant material is mainly imported from Italy, one of the locations being Sicily (which

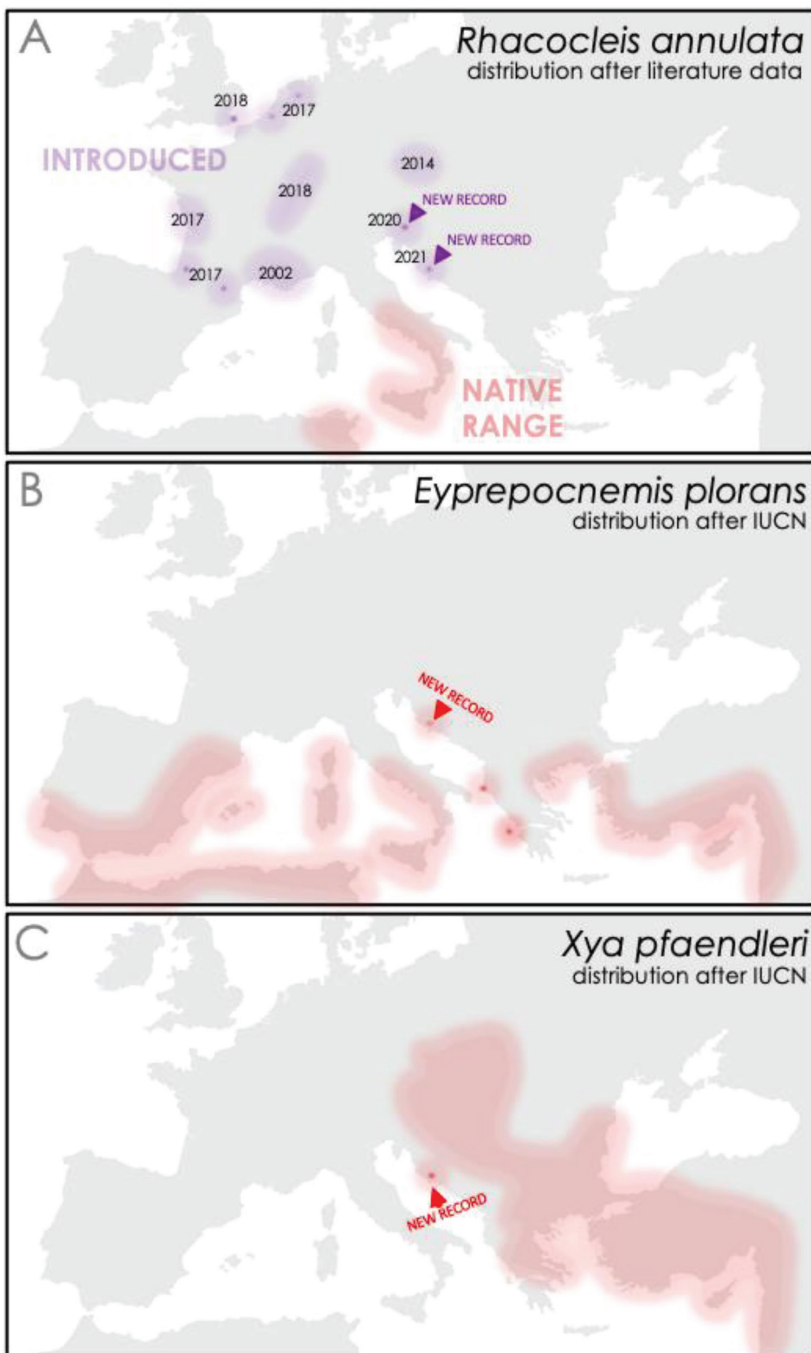


Fig. 4. Annotated distribution of A) *Rhacocleis annulata*, B) *Eyprepocnemis plorans*, and C) *Xya pfaendleri* in Europe. Distribution maps follow IUCN Red List (HOCHKIRCH *et al.*, 2016a), and for *Rhacocleis annulata* literature data (BARDET & BOITIER, 2006; ESSL & ZUNA KRATKY, 2021; MONNERAT *et al.*, 2020). Maps drawn by J. Skejo.

is the native area for both *Rhacocleis annulata* and *Eyprepocnemis plorans*, e.g., MASSA *et al.* (2013), see Fig. 4). In the case of *Xya pfaendleri*, two hypotheses can be provided to explain this unusual finding. The species is either (i) native to Dalmatia, but is very rare, and here it was observed because a part of the population had arrived from some neighbouring habitat or (ii) it has been imported from the cities of the Pannonian region (cities in Northern Croatia, such as Varaždin and Čakovec), which export plant material to Dubrava on a regular basis. When it comes to the occurrence of *R. annulata* in Slovenia, we can assume that the record is probably the result of a similar scenario as those in Croatia, i.e., the species has been introduced *via* plant material, although no garden centre is in proximity of the observation. It has happened several times in the past and will surely happen again in the future, as many new species have been introduced in this way (BARDET & BOITIER, 2006; REINHARDT & KÖHLER, 2014; ESSL & ZUNA-KRATKY, 2021).

We think that *R. annulata* and *E. plorans* will spread in the coming seasons either through purchases of plant material containing the eggs of the species, or from natural expansion to and through Dalmatia due to global warming (we have a similar expectation for the spread of *R. annulata* in Slovenia). For *Xya pfaendleri* our expectations are somewhat different – we believe that they will not spread as easily and rapidly as the other two mentioned species due to the lack of moisture in the neighbouring regions of Dalmatia. The lack of moisture represents harsh habitat conditions, and this water-dependent species may be unable to migrate even over small distances. It is important to look for these species in the surrounding area in order to monitor its potential spread into the natural habitats.

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