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POTENTIALLY IMPORTANT INSECT PESTS OF *CELTIS AUSTRALIS* IN SLOVENIA, CROATIA AND HUNGARY

POTENCIJALNO ZNAČAJNI ŠTETNI KUKCI NA *Celtis australis* U SLOVENIJI, HRVATSKOJ I MAĐARSKOJ

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Summary

We have collected published data and carried out pilot studies on European nettle tree (*Celtis australis*) entomofauna in Croatia, Slovenia and Hungary. Seven taxa of Lepidoptera (*Libythea celtis*, *Nymphalis polychloros*, *Archips xylosteana*, *Erannis defoliaria*, *Caloptilia fidella*, *Phyllonoricter millierella* and *Hyphantria cunea*), one cerambycid (*Neoclytus acuminatus*) and one hemipteran (*Metcalfa pruinosa*) were found. Two species of Lepidoptera (*L. celtis* and *P. millierella*) are monophagous on the leaves of *C. australis*. The other recorded species are also known on other woody hosts. For *N. polychloros*, *A. xylosteana*, *E. defoliaria*, *C. fidella* and *N. acuminatus* European nettle tree is a new host plant. The monophagous species of butterflies on *C. australis* have appeared more frequently in the last decade. The results are intended to predict whether this tree species is suitable for introduction on a wider scale in pine plantations of *Pinus nigra* affected by climatic extremes, pests and diseases, such as sphaeropsis blight (*Diplodia pinea*). Taking into the account the potential rise and growing impact of European nettle defoliators, which, according to some projections will prosper in the future due to global warming, some reservations arise and reduction of *C. australis* viability are to be expected.

KEY WORDS: *Celtis australis*, Southern/Central Europe, insects, defoliators, Lepidoptera, Coleoptera, Hemiptera

INTRODUCTION
UVOD

European nettle tree (*Celtis australis* L., Urticales, Ulmaceae) is a deciduous tree native to the Mediterranean region (Southern Europe, North Africa), and it also appears in Asia Minor, the Crimea and in the area from the Caucasus to Iran (Potočić et al. 1983). The northern boundary of its area is Switzerland, where it appears from 800 to 900 meters above sea level (Jovanović 1971). On warm South Tyrolean slopes it can even be found up to 1,150 m above sea level (Brus 2005). *C. australis* is a popular ornamental tree in the cities of the Sub-Mediterranean area.

C. australis is resistant to drought, wind and air pollution in cities and is able to withstand temperatures as low as –15 °C (Potočić et al. 1983). It prefers light, sandy soil and warm, dry limestone terrain. *C. australis* is a light-loving species. Hence, it is suitable for the afforestation of karstic and dry terrain (Jovanović 1971, Matić et al. 2011).

In Slovenia its habitats are sunny, rocky slopes in the Pre-Alpine (probably introduced) and Sub-Mediterranean

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phytogeographic regions (Martinčič et al. 2010). It is common in the Mediterranean area (Kraški rob, Dragonja Valley), but more rare in the Karst area, where it appears in a valley between Brestovica and Gorjanski near Solkan and in the Vipavska Valley. In warmer Mediterranean and Sub-Mediterranean forests, *C. australis* grows as an individual tree or in groups with *Quercus pubescens* Willd., *Fraxinus ornus* L., *Pistacia terebinthus* L. and other thermophilic tree species. It grows on steep, rocky, dry karst areas, protecting the soil against erosion (Brus 2005).

In Croatia *C. australis* is indigenous in Istria and throughout the whole Mediterranean area (Potočić et al. 1983; Matić et al. 2011).

In Hungary there are some monumental introduced *C. australis* trees in the central part of the country (in Dég, at the Danube river shores in Adony, in Mezőhegyes, Kajdacs, Alsóhídvégpuszta (county of Tolna)), (Monumental trees at Alsóhídvégpuszta… http://www.monumentaltrees.com/en/hun/dunantul/tolna/3920_alsohidvegpuszta/).

C. australis is a long-lived, 15–20 m tall tree, reaching a diameter of 1–2 m and an age of 1,000 years, with quality wood (the genus name derives from the Greek word *kello* – driven, because of its hard wood used for whips). The wood is stiff, with gray colored hardwood and yellow sapwood and is suitable for carving, making musical instruments, sports equipment, paddles, etc. The young shoots are slender and wiry, suitable for whips and rods. The root system is strong and deep. The leaves alternate; they are 5–12 cm long, simple, with serrate edges; the leaf surface is asymmetrical and with three stronger vessels. The flowers are polygamous or hermaphroditic, small, apetalic, with 4–5 stamens, appearing on young shoots. The fruit is round, up to 1 cm thick, with a sweet and edible wrapper (Jovanović 1971; Brus 2005).

Interestingly, according to literature data, *C. australis* has only a few diseases. Some earlier authors, such as Kišpatić (1983) (Potočić et al. 1983), note that *C. australis* is rarely infected by fungi, such as *Laetiporus sulphureus* (Bull.) Murrill (1920) and *Ganoderma applanatum* (Pers.) Pat., which cause rot in old trees. In the monograph Insects and diseases damaging trees and shrubs of Europe (Zúbrik et al. 2013) only one species (*Phyllonoricter millierella* (Staudinger, 1877)) from *C. australis* is listed. Aside from these few observations, very little is known about the herbivore insect assemblages of *C. australis*, and, to our best knowledge, no reports on the health condition of *C. australis* in recent years exist from other countries within its range.

Afforestation of the Karst region in south-western Slovenia began in the 19th century, when the first successful black pine (*Pinus nigra* Arnold) plantations were established and over time, black pine plantations improved site conditions considerably (Škulj 1988). Black pine was also irreplaceable in the processes of degraded site re-cultivation in the Croatian Mediterranean area (Matić et al. 2011). Climatic extremes, especially drought, can be considered the basic adverse factor causing stress and physiological weakening of pine trees and simultaneously improving the conditions for attacks of various types of pests.

The conversion of old black pine plantations into ecologically more stable broadleaf forests is an important goal in many Mediterranean countries. Some native deciduous species as *C. australis*, *Quercus petraea* (Matt.) Liebl., *Prunus avium* L., *Juglans regia* L. and other were used experimentally to achieve this gool. Based on their high survival rates after the first growing season, all tested species showed promising potential for future conversion of old pine stands in the Slovenian and Croatia (Topić 1997, Gajšek et al. 2015).

This paper aims to summarize the literature data and the results of our own pilot studies on herbivorous entomofauna on *C. australis* in Slovenia and Croatia, where this tree species is native in Mediterranean area, and in Hungary, where the *C. australis* has been introduced and planted. The results are intended to give some deciding whether this tree species could be introduced on a wider scale in plantations of *P. nigra* in Slovenian and Croation Mediterranean.

MATERIALS AND METHODS
MATERIJAL I METODE

Observations of health status on C. australis in the studied area – *Opažanja zdravstvenog stanja C. australis u području istraživanja*

On September 8, 2011 on the Dekani location near Koper (Slovenia), we collected 15 branches of *C. australis* with visibly damaged leaves (mines), and on the basis of the symptoms of the damage, the pest species was identified. In 2013 we screened a wider area of the Sub-Mediterranean zone in Slovenia and assessed various symptoms of biotic damage on *C. australis*. On May 5, 2014, in the Brseč location near Opatija (Croatia) (Figure 1), a similar screening procedure was conducted in an urban environment during a strong outbreak and total defoliation of European nettle tree crowns. We collected 18 branches of *C. australis* with heavily consumed leaves with different species of lepidopteran larvae. The diameter of twigs averaged 0.8 cm, and total length was 3.9 m. They were grown in entomological rearing containers at room temperature until October 1, 2014. All insects present on the twigs (number / diameter / length of twigs, dead larvae, left pupal exuviae, dead pupae, adult moths) were analyzed and species identified. Some lepidopteran species were identified in larval stages according to their specific caterpillar features (Csóka 2003) and on the basis of photos taken at the Brseč location.

Figure 1. Nearly totally defoliated *C. australis*, May 5, 2014, Brseč, Croatia (Photo: M. Jurc).
Slika 1. Gotovo potpuno obršten *C. australis,* 5. svibnja 2014, Brseč, Hrvatska (Foto: M. Jurc).

LITERATURE DATA
LITERATURNI PODACI

We gathered accessible publications of pests on *C. australis* in Slovenia, Croatia and Hungary (Karsholt and Razowski 1996; Maceljski et al. 1995; Maček 1999; Harapin and Jurc 2000; Sama 2002; Beccaloni et al. 2003; Hrašovec 2009; Polak 2009; Matošević et al. 2009; Lesar and Govedič 2010; Verovnik et al. 2012; Torkar et al. 2013; Jurc 2013; Jurc 2014; Moths and Butterflies of Europe and North Africa, www.leps.it; European Butterflies and Moths, http://lepidoptera.eu/; Fauna Europaea, http://www.faunaeur.org/; Prirodoslovni muzej Slovenije-Natural History Museum of Slovenia, http://www1.pms-lj.si/animalia/galerija.php; *Neoclytus acuminatus*, M. Hoskovec, http://www.cerambyx.uochb.cz/neoclyt.htm).

RESULTS
REZULTATI

For Slovenia, the first report of a potentially serious defoliator on *C. australis* describes the leaf miner *Phyllonoricter millierella* (Staudinger, 1877) in the localities of Portorož (1971) and Ljubljana (1975) (Maček 1999) (Figure 2).

On 8.9.2011 mines on the leaves of young European nettle trees were noticed in the location Dekani (Jurc 2013), and on 03.12.2013 injuries from *P. millierella* were found on adult trees in Piran and in the Rastelli Art Nouveau park in Portorož (Jurc 2014). Injuries at the Dekani location were individual, but in Piran the mass occurrence of mines on leaves was recorded (Figure 3).

In Croatia *P. millierella* was observed in 2005 on the island of Krk (location Šilo) (Matošević et al. 2009). Another piece of information on *C. australis* pests in Croatia relates to the sampling and data collection of M. Hoskovec (http://www.cerambyx.uochb.cz/neoclyt.htm). In August 2006 Hoskovec collected a dead piece of *C. australis* wood with cerambycid larvae and after rearing identified them as *Neoclytus acuminatus* (Fabricius, 1775). In 2008 a heavy attack and total die-back of *C. australis* trees in street plantings in Novi Vinodolski (Croatia) were caused by the same cerambycid (Hrašovec 2009).

The outcome of the laboratory experiment of rearing field sampled larvae from European nettle trees taken in Brseč on May 5, 2014, was 40 dead caterpillars, 48 dead undeveloped pupae, 90 left pupae exuviae (87 *Libythea celtis* and 3 *Archips xylosteana*) and 90 developed adult Lepidoptera (85 *Libythea celtis,* 3 *Archips xylosteana,* 2 *Nymphalis polychloros*).

In the following text a brief overview of our results of the herbivorous entomofauna on *C. australis* is given with the data from the countries in which they occur:

- Lepidoptera: Nymphalidae: *Libythea celtis* (Laicharting, 1782) (present in SI*, CRO*, H*), *Nymphalis polychloros* (Linnaeus, 1758) (present in SI**, CRO*, H**); Tortricidae: *Archips xylosteana* (Linnaeus, 1758) (present in SI**, CRO*, H**); Geometridae: *Erannis defoliaria* (Clerck, 1759) (present in SI**, CRO*, H**); Gracillariidae: *Caloptilia fidella* (Reutti, 1853) (present in SI**, CRO**, H*), *Phyllonoricter millierella* (Staudinger, 1877) (SI*, CRO*); Arctiidae: *Hyphantria cunea* (Drury, 1773) (present in SI**, CRO**, H*);
- Coleoptera: *Neoclytus acuminatus* (Fabricius, 1775) (present in SI**, CRO*, H**);
- Hemiptera: Flatidae: *Metcalfa pruinosa* (Say, 1830) (present in SI**, CRO*, H**).

* found on *C. australis* in nature
** the literature data on the presence of the species in the country

Below we describe in more detail the herbivorous insects of *C. australis* which are likely to seriously damage this tree species (Csóka 1997; Hrašovec 2009; Jurc 2014).

Phyllonoricter millierella (Staudinger, 1877), Gracillariidae, nettle-tree leaf miner

During regular surveys of the condition of tree species' health in Slovenia, we did not observe any signs of diseases or pests on *C. australis* until 2011. In August 2011, in a stand of Aleppo pine (*Pinus halepensis* Miller) in Dekani near Koper, we observed mines on the leaves of *C. australis* (Figure 2). The agent of the damage was determined to be *Phyllonoricter millierella* (Staudinger, 1877), Gracillariidae (Jurc 2013).

The species is present in Switzerland, Italy, France, Greece, Croatia, Bulgaria, Russia, Slovenia (Karsholt and Razowski 1996; Fauna Europaea, http://www.faunaeur.org/; Maček 1999; Matošević et al. 2009; Lesar and Govedič 2010).

Figure 2. *Phyllonoricter millierella* (Staudinger 1877), Dekani, 8.9.2011 (Photo: left M. Jurc, right G. Csóka).
Slika 2. *Phyllonoricter millierella* (Staudinger, 1877), Dekani, 8.9.2011. (Foto: lijevo M. Jurc, desno G. Csóka).

P. millierella is a monophagous species which feeds and thereby creates mines in the leaves of *C. australis*. Mines are visible on the lower leaf surface (Figure 2). On the upper leaf surface mines are tent-shaped in form and without visible wrinkles. The lower leaf epidermis is grayish silver and densely covered with coppery brown or dark gray freckles of hairs. The upper leaf surface is convex and discolored, with the exception of the central part of mines, which is green. Often more than one mine can be found on a single leaf (Csóka 1995). Larvae pupate in the leaf, with one or two generations per year (data from Croatia suggest that *P. millierella* has two generations per year, which is common for many species of the *Phyllonorycter* genus, Matoševič et al. 2009). Mines appear in June, July and August. We also discovered that *P. millierella* is expanding in the Sub-Mediterranean area of Slovenia (Jurc 2014).

Figure 3. *Celtis australis* in Piran attacked by *P. millierella*, 3.12.2013 (Photo: M. Jurc).
Slika 3. Stablo *Celtis australis* napadnuto od *P. millierella* u Piranu, 3.12.2013 (Foto: M. Jurc).

Libythea celtis (Laicharting, 1782), Nymphalidae, nettle-tree butterfly

The total distribution of *L. celtis* extends from northwestern Africa across Southern Europe and parts of Asia to Japan. It occurs in Albania, Austria, Bosnia and Herzegovina, Bulgaria, Corsica, Crete, Croatia, Cyprus, European Turkey, the French mainland, Germany, the Greek mainland, Hungary, the Italian mainland, Macedonia, the North Aegean Islands, the Portuguese mainland, Romania, Sardinia, Slovakia, Slovenia, the Spanish mainland, Switzerland and Ukraine. In Southern Europe it is quite widespread (Karsholt and Razowski 1996; Maček 1999; Fauna Europaea, http://www.faunaeur.org/). In Slovenia *L. celtis* was found at the edge of a deciduous forest east of the village of Polje on December 25, 2011. This locality is warm and of southern exposition with a Mediterranean tree species assemblage, such as *Cotinus coggygria* Scop. and *Fraxinus ornus* L. This extraordinary finding in the winter confirms a mild climate and the presence of temperature inversions on the Šentvid Plateau (Torkar et al. 2013). This is also one of the northernmost findings of this species in Slovenia.

L. celtis is a monophagous species, with trees from the genus *Celtis* acting as its host plant (Tolman and Lewington 1997) (Figure 1, 4, 5).

The adults overwinter and can be observed in the spring, around April and May (Figure 6). Young caterpillars appear in May (in Southern Europe) and are usually quite numerous on the lower leaf surface; however, the later instars are on both sides (Figure 7). During our research,

Figure 4. European nettle tree completely defoliated by *Libythea celtis*, near Labin, Istra, Croatia, 20.05.2004 (Photo: B. Hrašovec).
Slika 4. Defolijacija koprivića uslijed napada *Libythea celtis,* blizu Labina, Istra, Hrvatska 20.5.2004 (Foto: B. Hrašovec).

the last instar caterpillars were found exclusively on the upper leaf surface. Pupation also takes place on both sides of the leaves.

The literature (Polak 2009) indicates that the adults that hatch in June reproduce at least partially, so that the larvae are observed again in late June/early July (Figure 7). The resulting adults then overwinter. This second generation is, as already mentioned, only partial. In Slovenia *L. celtis* has one generation, with the occurrence of adults during June to September; adults overwinter and the next year fly from March to April. In Slovenia this species reproduces only in the Primorska region, which coincides with the distribution of its host species in Slovenia (Prirodoslovni muzej Slovenije-Natural History Museum of Slovenia, http://www1.pms-lj.si/animalia/galerija.php). Adults can fly to other parts of the country in summer.

Figure 5. Detail from a *Libythea celtis* defoliated tree, the only green parts that remain are the leaf stalks and fruit (Photo: B. Hrašovec).
Slika 5. Detalj u krošnji koprivića obrštenoj od *Libythea celtis,* jedini preostali zeleni dijelovi su lisne peteljke i plodovi (Foto: B. Hrašovec).

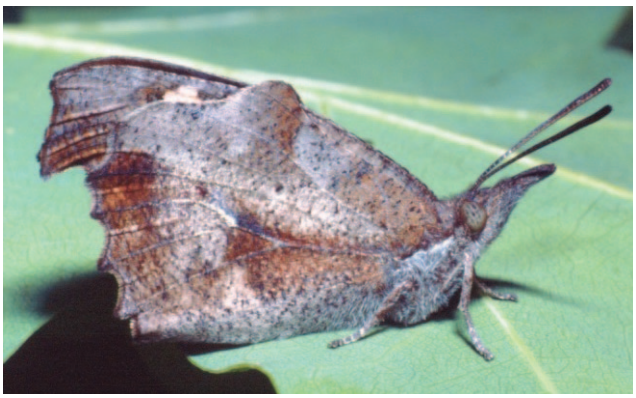

Figure 6. *Libythea celtis* (Laicharting, 1782) (Photo: left M. Jurc, right G. Csóka).
Slika 6. *Libythea celtis* (Laicharting, 1782) (Foto: lijevo M. Jurc, desno G. Csóka).

Figure 7. *Libythea celtis*, high interindividual variability of larvae (Photo: D. Jurc).
Slika 7. *Libythea celtis*, velika individualna varjabilnost ličinki (Foto: D. Jurc).

Nymphalis polychloros (Linnaeus, 1758), Nymphalidae, large tortoiseshell butterfly

The species is widespread in Europe, the East Palearctic and North Africa (Karsholt and Razowski 1996; Fauna Europaea, http://www.faunaeur.org/; Polak 2009).

Adults are active from June to August in one generation. They overwinter and fly again from March to April (European Butterflies and Moths, http://lepidoptera.eu/). In Slovenia there are two generations of butterflies occurring from May to September (Polak 2009). Caterpillars feed on *Salix*, *Ulmus*, *Prunus*, *Pyrus communis*, *Malus domestica*, *Populus*, *Sorbus* and *Crataegus* (Butterflies of Britain & Europe. http://www.learnaboutbutterflies.com/Britain%20-%20Nymphalis%20polychloros.htm). According to our findings, *C. australis* should be added as a new host (Figures 8, 9, 10).

Figure 8. *Nymphalis polychloros* (Linnaeus, 1758) (Photo: M. Jurc).
Slika 8. *Nymphalis polychloros* (Linnaeus, 1758) (Foto: M. Jurc).

Figure 9. *Nymphalis polychloros*, caterpillar, (Photo: D. Jurc).
Slika 9. *Nymphalis polychloros,* ličinka, (Foto: D. Jurc).

Figure 10. *Nymphalis polychloros*, caterpillars (Photo: D. Jurc).
Slika 10. *Nymphalis polychloros,* ličinke (Foto: D. Jurc).

Archips xylosteana (Linnaeus, 1758), Tortricidae, the brown oak tortrix

The wide distribution area of *A. xylosteana* includes Europe, Asia Minor, Eastern Russia, China, Korea and Japan. (Karsholt and Razowski 1996; Fauna Europaea, http://www.faunaeur.org/; Jurc 2006). Development is relatively fast, with only one generation per year. Adults are active from May to August. The rather long flight period might suggest a partial 2nd brood (Szabóky and Csóka 2010). The females are attracted to males with sexual pheromones (Frérot et al. 1983). The fertilized female lays eggs on the bark of trunks or branches and covers them with secretions of the gonads. Larvae feed on the leaves of deciduous trees and shrubs of the genera *Acer*, *Crataegus*, *Quercus*, *Castanea*, *Corylus*, *Fagus*, *Fraxinus*, *Lonicera*, *Betula*, *Tilia*, *Sorbus*, *Salix*, *Myrica*, *Hypericum*, *Ulmus*, *Malus*, *Pyrus*, *Rubus* and *Prunus* (Jurc 2006). *C. australis* is a new host for this species (Figures 11, 12, 13).

Figure 11. *Archips xylosteana* (Linnaeus, 1758), the brown oak tortrix (Photo: M. Jurc).
Slika 11. *Archips xylosteana* (Linnaeus, 1758), smeđi hrastov savijač, (Foto: M. Jurc).

Figure 12. The brown oak tortrix (*Archips xylosteana*), 19.6.2006, location Kastelec (Photo: M. Jurc).
Slika 12. Hrastov savijač (*Archips xylosteana*), 19.6.2006, lokacija Kastelec (Foto: M. Jurc).

Figure 13. The brown oak tortrix: young caterpillars initially feed on the lower portion of young leaves; later they tightly curl the edges of the fully developed leaves in the top branches. Pupation takes place in cross-rolled leaves or between two spun leaves, 19.6.2006, location Kastelec (Photo: M. Jurc).
Slika 13. Smeđi hrastov savijač: mlade gusjenice se prvo hrane s donje strane mladih listova, kasnije uvijaju rubove u potpunosti razvijenih listova. Kukuljenje je u unakrsno savijenim listovima ili između dva zapredena lista, 19.6.2006, lokacija Kastelec (Foto: M. Jurc).

Erannis defoliaria (Clerck, 1759), Geometridae, mottled umber moth

E. defoliaria is present in Europe, the East Palearctic and the Near East (Fauna Europaea, http://www.faunaeur.org/).

Male wingspan is 30 to 40 mm. Females are wingless. Adults are active from October to December. The moth overwinters in egg stadium (Csóka 1995; Polak 2009). Caterpillars feed on a wide range of shrubs and trees: *Salix*, *Betula*, *Quercus*, *Prunus*, *Crataegus*, *Alnus*, *Corylus*, *Malus*, *Rubus*, *Carpinus*, *Tilia*, *Lonicera*, *Sorbus*, *Ribes*, *Rosa* (Moths and Butterflies of Europe and North Africa, www.leps.it) (Figures 14, 15, 16). *C. australis* is a new host for this species. It is a major contributor to the species-rich spring defoliator assemblages of broadleaved forests (Zúbrik et al. 2013).

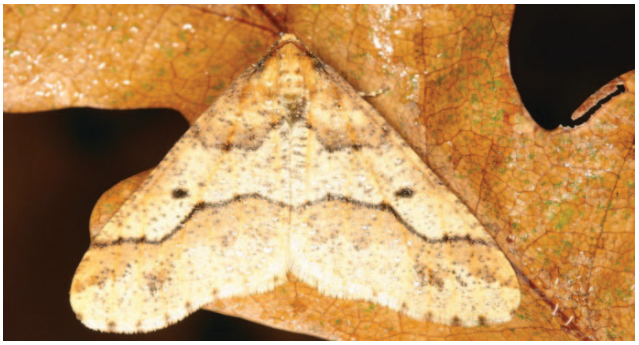

Figure 14. *Erannis defoliaria* (Clerck, 1759) male (Photo: G. Csóka).
Slika 14. *Erannis defoliaria* (Clerck, 1759) mužjak (Foto: G. Csóka).

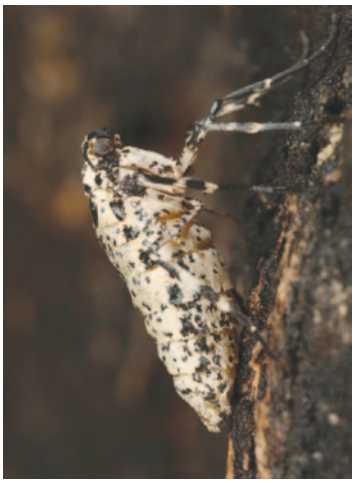

Figure 15. *Erannis defoliaria* females are wingless (Photo: G. Csóka).
Slika 15. Ženke *Erannis defoliaria* su beskrilne (Foto: G. Csóka).

Figure 16. *Erannis defoliaria* larva (Photo: M. Jurc).
Slika 16. *Erannis defoliaria,* ličinka (Foto: M. Jurc).

Caloptilia fidella (Reutti, 1853) Gracillariidae

The species is present in Austria, Croatia, the Czech Republic, the Danish mainland, the French mainland, Germany, Hungary, the Italian mainland, Macedonia, Moldova, Poland, the Portuguese mainland, Romania, Russia, Slovakia, Slovenia, Switzerland, the Netherlands, Ukraine, Near East and Asian Turkey (Fauna Europaea, http://www.faunaeur.org/; Lesar and Govedič 2010). The species was found in Sečovlje (Slovenia), on October 22, 1977 on the leaves of *Humulus lupulus* (Maček 1999). *C. australis* is a new host record for this species (Figure 17). They mine the leaves of their host plants.

Figure 17. *Caloptilia fidella* (Reutti, 1853) (Photo: G. Csóka).
Slika 17. *Caloptilia fidella* (Reutti, 1853) (Foto: G. Csóka).

Neoclytus acuminatus (Fabricius, 1775), Cerambycidae, redheaded ash borer

A native Nearctic species, *N. acuminatus* was introduced to northeastern Italy from North America in the wood of North American ash. It eventually expanded into the western Balkans, central and northern Italy, and Switzerland (Brelih et al. 2006). It is present in Croatia, Hungary and Slovenia. It is currently quite common in the southwestern part of Slovenia, which is where Schmidt found it in the mid-19th century (Brelih et al. 2006). It is present in Slovenian Istra, Primorska and Notranjsko (Brelih et al. 2006). Well-known Croatian coleopterologist Petar Novak mentions *N. acuminatus* from the area of Zadar in June 1891 (Hrašovec 2009). There are also quite important research outcomes in the field of semiochemical communication, also related to the redheaded ash borer: the existence of an aggregation pheromone produced by males of *N. acuminatus* has recently been proved as being the first known pheromone amid cerambycids as a group (Hrašovec 2009). It is extremely polyphagous in deciduous trees (*Carpinus, Betula, Corylus, Ostrya, Quercus, Fagus, Castanea, Juglans, Salix, Populus, Ficus, Morus, Ulmus, Prunus, Pyrus, Rosa, Ro-*

Figure 18. Dead or dying *C. australis* trees heavily attacked by *Neoclytus acuminatus* (Fabricius, 1775), Novi Vinodolski, October 24, 2008 (Photo: B. Hrašovec).

Slika 18. Potpuno osušeni ili venući koprivići u drvoredu žestoko napadnuti cvilidretom *Neoclytus acuminatus* (Fabricius, 1775) u Novom Vinodolskom 24. listopada 2008. (Foto: B. Hrašovec).

Figure 19. Cross section of dead nettle tree stem showing peripheral discoloration in connection with a dense network of *N. acuminatus* galleries tightly packed with larval frass. Numerous adults that superficially (by color and behavior) resemble some hymenopterans are readily observed on the bark of visually affected trees (Photo: B. Hrašovec).

Slika 19. Na poprečnom prerezu napadnutog debla koprivića vidi se promjena boje uz vanjski rub debla u zoni gusto premreženom larvalnim hodnicima *N. acuminatus* čvrsto nabijenih larvalnim grizotinama. Brojna imaga koja izgledom i ponašanjem imitiraju neke opnokrilce nalažena su na kori vizualno problematičnih stabala (Foto: B. Hrašovec).

binia, Cercis, Hibiscus, Tilia, Acer, Aesculus, Euonymus, Vitis, Fraxinus, Lonicera) and exceptionally in conifers (*Abies*) (Brelih et al. 2006). *C. australis* is a new host for this species. The larvae initially develop under the bark, and afterwards in the wood of dying or dead branches and the tree trunk. In Europe it takes one year for a full life cycle, exceptionally 2, whereas in the southern part of the USA, where the species originates, it takes only 3 months. Adults are active during the day, when they are usually frequent on their food plants, and occasionally also in the blossoms of bushes (Brelih et al. 2006; Sama 2002).

The only available information connecting this cerambycid with *C. australis* in the studied area are data given by M. Hoskovec (*Neoclytus acuminatus*, http://www.cerambyx.uochb.cz/neoclyt.htm). He reared adult beetles from the larvae found in a dead trunk of *C. australis* collected in Šušnjevica (15 km east of Pazin, Istrian peninsula, Croatia) in August 2006. Hrašovec (2009) documented a case of *Celtis* related problems resulting from a secondary but intensive attack of *N. acuminatus* on water stressed *Celtis* trees planted along a street in Novi Vinodolski (Figures 18, 19).

From Hungary Fetykó et al. (2013) report on the mass occurrence of the alien (likely native to Asia) and invasive scale insect *Coccus pseudomagnoliarum* (Kuwana, 1914) (Hemiptera: Coccidae) on urban *Celtis occidentalis* L. trees. In addition, in Hungary Bozsik (2015) mentioned *C. occidentalis* on which adults and waxy secretion of *Metcalfa pruinosa* (Say, 1830) (Hemiptera: Flatidae) were observed. Although only known from *C. occidentalis* (native to North America) in Hungary, there is good reason to assume that *C. pseudomagnoliarum* and *M. pruinosa* are potentially able to develop on *C. australis* also (the opinion of G. Csóka).

DISCUSSION
RASPRAVA

Forest insects, which are of significant economic importance, are divided into four feeding guilds: phloemophages, leaf-chewers, leaf-miners and leaf-suckers (Jurc 2007). Current climate change scenarios predict different impacts on insects (Csóka 1997; Grégoire and Evans 2004; Hirka and Csóka

2010). Droughts in particular would have a positive influence on phloemophages and leaf-chewers, both indirectly through nutritional changes in plants and directly through better survival and/or more generations. It is proven that the increasing frequency and severity of droughts may result in increasing frequency of outbreaks and an increasing area affected by them (Csóka 1996; 1997; Jurc 2007). It is also evident that some earlier neglected native species are becoming increasingly important through the growing incidence of biotic disturbances in European forests (Grégoire and Evans 2004; Hirka and Csóka 2010). In the last years the impact of changing environmental conditions on the latitudinal and altitudinal distribution of some native forest insects has been well documented (Jurc 2007). In the Sub-Mediterranean area of Slovenia, the damage due to leaf-chewers – defoliators (*Tortrix viridana* Linnaeus, 1758 and *Aleimma loeflingiana* (Linnaeus, 1758)) has been increasing, and in the forest region of Koper in the period from 1995 to 2005, large scale defoliations were recorded on a total area of 14,374 ha. Starting in 2003, there was an increasing trend in damaged area (Jurc 2007). Many major defoliator species also show a similar trend in Hungary (Hirka et al. 2011; Klapwijk et al. 2013) and Croatia (Matošević et al. 2009).

In line with general trends, we are witnessing the appearance of new defoliator and wood-boring insects on *C. australis*, which until recently had been considered as a particularly disease and pest resistant species (Kišpatić 1983 in Potočić et al. 1983; Zúbrik et al. 2013). In the last ten years in Slovenia, Croatia and Hungary, a number of new pests affecting European nettle tree have been recorded, some even to the extent of local outbreaks (Jurc 2014, Hrašovec 2009). It may be that the recent trends in albeit unknown *Celtis* pests are actually related to the results of recent studies of insect population ecology. They can be part of global and multi-year processes of population development of individual insect species about which we know very little (Tenow et al. 2013). Recent research on the population ecology of *Operophtera brumata* and other early-season geometrids shows that the population ecology of a 9- to 10-year cycle cannot be fully understood on a local scale unless population behavior is known on a larger, European scale (Tenow et al. 2013). Bearing this in mind, the occurrence of harmful defoliators, including those that we are increasingly detecting on *C. australis*, are projected to prosper in the future due to global warming, and this needs to be taken into account (Tenow et al. 2013).

The results of our contribution are intended to provide additional insight into the question of whether or not this tree species should be introduced on wider scale in plantations of *P. nigra* affected by pests and diseases. However, large *P. nigra* plantations in Slovenia are now increasingly threatened by pests and diseases, such as sphaeropsis blight (*Diplodia pinea* (Desm.) J. Kickx), *Cenangium ferruginosum* Fr., and *Sydowia polyspora* (Bref. & Tavel) E. Müll., *Dothistroma* spp. (Jurc and Jurc 2014; Piškur et al. 2013). Also in Croatia, drought, as a trigger, weakened pines that were subsequently attacked by several species of pathogenic fungi. The largest damages were caused by attacks of the sphaeropsis blight (*D. pinea*) (Pernek et al. 2012).

The conversion of old *P. nigra* plantations into ecologically more stable deciduous forests in Craation and Slovenian Mediterranean areas is an important goal (Matić et al. 2011, Gajšek et al. 2015). Some studies indicate that *C. australis* is an appropriate species for the conversion of *P. nigra* plantations, it improved ecological conditions, it is appropriate for warmer and dry habitats (Topić 1997, Gajšek et al. 2015). The experiments with planting of *C. australis* on the sites of the *P. nigra* plantations in Croatia and Slovenia showed that the survival rates of *C. australis* in Slovenia (Gajšek et al. 2015) and Croatia (Topić 1997) were almost the same (91% and 92.5%, respectively) after the first year since planting. But planting large-scale monocultures of *C. australis* on dry and warm sites will likely increase the risk of insect outbreaks in these stands. The high concentration of any food plant might be a major triggering factor in insect outbreaks. In that scenario we might clearly expect that both specialist (*L. celtis* and *P. millierella*) and generalist herbivores (*N. polychloros*, *A. xylosteana*, *E. defoliaria*, *C. fidella* and *N. acuminatus* and other) would adapt to the more abundant availability of the new host, *C. australis*, by increasing their population densities to a more damaging level. Some reservations are expressed in this respect, and more careful planning of future afforestation or remediation strategies is encouraged in order to avoid future failures and new problems with *C. australis*, a tree species believed in general to be a highly resilient one.

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Sažetak

U radu se iznose sažete spoznaje o herbivornoj entomofauni običnog koprivića (*Celtis australis)* u Sloveniji i Hrvatskoj, gdje je autohton, te u Madžarskoj gdje ga je unio čovjeka. Smisao provedenog istraživanja temeljen je na ideji intenzivnijeg uvođenja koprivića u reforestaciji i zamjeni pionirskih vrsta na kraškim područjima u kojima recentno dolazi do značajnih zdravstvenih problema, primjerice u kulturama crnog bora koje se suše pod utjecajem suše, kukaca i fitopatogenih gliva (npr. *Diplodia pinea*). Imajući u vidu moguće rizike ovog pristupa, kroz prikupljene i konzultirane literaturne izvore i vlastita nova opažanja revidiran je status koprivića kao drvenaste vrste u svjetlu njegove štetne entomofaune.

Dobro su poznate opće spoznaje o rasprostranjenju i osnovnim ekološkim obilježjima običnog koprivića, pa u tom smislu znamo da je to bjelogorično drvo porijeklom iz Sredozemlja, Male Azije, Krima i područja od Kavkaza do Irana. Obični koprivić vrsta je otporna na sušu, vjetar i onečišćenje zraka u gradovima i može izdržati temperature do –15 ° C. Voli svjetlo, pješčana tla, suh i topao kraški teren. Prema svim svojim ekološkim zahtjevima spada u vrlo prikladnu vrstu drveća za pošumljavanje krša i suhih terena.

Raščlamba prikupljene i dostupne literature o štetnicima na običnom kopriviću u Sloveniji, Hrvatskoj i Madžarskoj definirali smo početnu bazu već opisanih vrsta, koje smo zatim procjenjivali u svjetlu vlastitih terenskih istraživanja. Na lokalitetu Dekani, u blizini Kopra (Slovenija), u rujnu 2011. godine uzorkovali smo 15 grana *C. australis* s vidljivo oštećenim lišćem (mine) radi determinacije uzročnika. 2013. godine pregledali je šire područje submediteranske zone Slovenije i Hrvatske i analizirali simptome napada štetnih organizama na *C. australis*. Iduće sezone, 5. svibnja 2014, u mjestu Brseč, u blizini Opatije (Hrvatska) u urbanom okolišu zabilježili smo jaku defolijaciju (Slika 1). Ponovno smo uzeli uzorke 18 grana koprivića zajedno sa zatečenim gusjenicama različitih vrsta leptira. Slijedio je laboratorijski uzgoj i determinacija do razine vrste.

Istraživanjem je sveukupno utvrđeno sedam vrsta leptira (*Libythea celtis*, *Nymphalis polychloros*, *Archips xylosteana*, *Erannis defoliaria*, *Caloptilia fidella*, *Phyllonoricter millierella*, *Hyphantria cunea*), jedna vrsta kornjaša (*Neoclytus acuminatus*) (Slika 6, 8, 11, 14, 17, 19) i jedna vrsta polukrilaca (*Metcalfa pruinosa*). Dvije vrste leptira (*L. celtis* i *P. millierella*) monofagne su na lišću *C. australis*, druge vrste utvrđenih istraživanjem imaju i druge vrste domaćina. Vrste *N. polychloros*, *A. xylosteana*, *E. defoliaria*, *C. fidella* i *N. acuminatus* po prvi puta su utvrđene kao štetnici *C. australis* i trebaju se dodati na već poznati popis štetnika običnog koprivića. Istraživanjem je također utvrđeno da su se monofagne vrste kukaca češće pojavljivale na kopriviću u posljednjem desetljeću. Prikupljeni rezultati predstavljaju bolji temelj strategiji zamjene problematičnih kultura crnog bora koje se suše pod utjecajem fitopatogenih gliva (npr. *Diplodia pinea*) s intenzivnijim pošumljavanjem običnim koprivićem. U posljednje vrijeme, a to je istraživanjem potvrđeno, javljaju se u povećanom intenzitetu neki već otprije poznati štetnici koprivića, ali i neke do sada nezabilježene štetne vrste. Povećana pojava defoliatora na *C. australis*, koji će, prema nekim projekcijama klimatskih kolebanja prosperirati u budućnosti zbog globalnog zatopljenja, mora se uzeti u obzir.

Sadnja monokultura *C. australis* na suhim i toplim pozicijama vjerojatno će i dodatno povećati rizik od prenamnažanja nekih vrsta kukaca u tim sastojinama. Visoka koncentracija biljke hraniteljica nerijetko je glavni čimbenik njihovih gradacija, bilo da je riječ o monofagnim štetnicima koji neposredno ovise o količini dostupne hrane za koju su specijalizirani (*L. celtis* and *P. millierella*) ili generalistima (*N. polychloros*, *A. xylosteana*, *E. defoliaria*, *C. fidella* and *N. acuminatus* i dr.), koji se lako prilagođavaju trofičnom izobilju u obliku novounešenog domaćina.

KLJUČNE RIJEČI: *Celtis australis*, Južna/Srednja Europa, kukci, defolijatori, Lepidoptera, Coleoptera, Hemiptera