

CARDAMINE OCCULTA HORNEM. – A NEW CONCEALED ALIEN PLANT IN THE FLORA OF CROATIA

DARIO HRUŠEVAR¹, JOSIP MESAROŠ², DALIBOR VLADOVIĆ³, ANITA VUCIĆ⁴,
IGOR BELAMARIĆ⁵, LIDIJA SURAC⁶ & BOŽENA MITIĆ^{1*}

¹University of Zagreb, Faculty of Science, Department of Biology, Rooseveltov trg 6a, HR-10000, Zagreb, Croatia (*corresponding author: bozena.mitic@biol.pmf.hr)

²Colić-trade d.o.o. – Agrocentar; Kakma b.b., HR-23423, Polača, Croatia

³Natural History Museum, Poljana kneza Trpimira 3, HR-21000, Split, Croatia

⁴Institute of Public Health Zadar, Kolovare 2, HR-23000, Zadar, Croatia

⁵Parkovi i nasadi d.o.o., Kavanjinova 12, HR-21000 Split, Croatia

⁶Rasadnik Piket d.o.o.; Ulica 1, br. 30., HR-23222 Zemunik Donji, Croatia

Hruševar D., Mesaroš J., Vladović D., Vucić A., Belamarić I., Surac L. & Mitić, B.: *Cardamine occulta* Hornem. – a new concealed alien plant in the flora of Croatia. *Nat. Croat.*, Vol. 30, No. 1., 207–215, Zagreb, 2021.

In the last decade of the 20th and in the early 21st century a new plant from East Asia, *Cardamine occulta*, was recorded in many European countries, and evaluated as a potential invasive species. Prior to our research, it had not been observed in Croatia or the neighbouring countries. During 2017, the first plants of *C. occulta* were discovered in plant nurseries in Zemunik Donji (near the city of Zadar), and in the city of Split. Since then, both sites have been monitored continuously, and the populations in both nurseries are still present and getting denser every year. In this work we aim to present a short history of the discovery, list newly-detected sites and establish some features (taxonomical peculiarities, plant description, distribution, growth and invasive preferences) of the species *C. occulta* to make its identification easier. Because of its invasive potential and morphological similarity with two other taxa distributed in Croatia, *C. hirsuta* and *C. flexuosa*, the determination key for all three taxa, as well as photos of *C. occulta* have been prepared. This will probably increase the chance of early detection of this species outside of cultivation.

Key words: *Cardamine L.*, Europe, family Brassicaceae, invasive plants, non-native flora, weed

Hruševar D., Mesaroš J., Vladović D., Vucić A., Belamarić I., Surac L. & Mitić, B.: *Cardamine occulta* Hornem. – nova pritažena alohtona biljka u flori Hrvatske. *Nat. Croat.*, Vol. 30, No. 1., 207–215, Zagreb, 2021.

U posljednjem desetljeću 20. i početkom 21. stoljeća u mnogim je europskim zemljama zabilježena nova biljka iz istočne Azije, *Cardamine occulta*, koja je procijenjena potencijalno invazivnom vrstom. Prije našeg istraživanja nije opažena u Hrvatskoj ili susjednim zemljama. Tijekom 2017. godine otkrivene su prve biljke *C. occulta* u rasadnicima biljaka u Zemunik Donjem (u blizini grada Zadra) i u gradu Splitu. Od tada se oba nalazišta kontinuirano prate, a populacije na oba nalazišta i dalje su prisutne i svake su godine sve gušće. Ciljevi ovog rada bili su predstaviti kratku povijest istraživanja i obilježja novootkrivenih nalazišta te utvrditi neke značajke (taksonomske osobitosti, opis biljaka, rasprostranjenost, uzgojne i invazivne preferencije) vrste *C. occulta*, kako bismo olakšali njezinu identifikaciju. Zbog svog potencijalnog invazivnog karaktera i morfološke sličnosti s dvije vrste prisutne u Hrvatskoj, *C. hirsuta* i *C. flexuosa*, pripremljen je i ključ za determinaciju sve tri slične svojte te fotografije *C. occulta*. To će vjerojatno povećati mogućnost za rano otkrivanje ove vrste izvan uzgoja.

Ključne riječi: alohtona flora, *Cardamine L.*, Europa, invazivne biljke, korov, porodica Brassicaceae

INTRODUCTION

The large Genus *Cardamine* L. (family Brassicaceae) is distributed worldwide, except in Antarctica. It is the biggest genus under the tribe Cardamineae (AL-SHEHBAZ *et al.*, 2006), and due to the higher percentage of polyploidy and easy hybridization in the genus *Cardamine* (LIHOVÁ & MARHOLD, 2006) identification at species level is always difficult. However, it is estimated that there are about 200 species today (MANDÁKOVÁ *et al.*, 2019). The greatest diversity of the genus is in the Far East and the Himalayas, with around 70 taxa (AL-SHEHBAZ, 1988). A great number of taxa are also present in North and Central America, the European Mediterranean and the Caucasus – circa 50 taxa in each area (ROLLINS, 1993; LIHOVÁ & MARHOLD, 2006). Some taxa have cosmopolitan distributions and/or are invasive, e. g. *Cardamine impatiens* L. in USA (LOEB, 2009) or *C. hirsuta* L. in Japan (MATSUHASHI *et al.*, 2016). According to LIHOVÁ & MARHOLD (2006) 54 well-defined species have been identified for Europe. Furthermore, eight *Cardamine* taxa were alien outside their native European range. Additionally, as alien plants in Europe, three more taxa with non-European origins were recorded: *C. chelidonia* L., *C. corymbosa* Hook. f. and *C. parviflora* L. (DRAKE, 2009). However, this assertion is doubtful, because *C. chelidonia* is native in the north western part of South-Eastern Europe, eg. Croatia, Bosnia and Herzegovina, central and southern Italy (including Sicily) and Corsica (MARHOLD, 1996; MILOVIĆ, 2015). Furthermore, the taxon *C. parviflora* is also of uncertain origin, with molecular evidence that favours an infraspecific level of the Euroasian and North American populations (LIHOVÁ *et al.*, 2006; AL-SHEHBAZ *et al.*, 2010). Relatively recently a new taxon of this genus, *C. occulta*, was taxonomically resolved and recorded in many European countries (MARHOLD *et al.*, 2016; PLISZKO, 2020). Its native distribution is East Asia, but outside that area it has great invasive potential (MARHOLD *et al.*, 2016). The only areas so far without data on the presence of this species are Scandinavia and Southeast Europe.

In Croatian flora, 24 taxa of the genus are listed (NIKOLIĆ, 2020), out of which 7 are endemic (KUČERA *et al.*, 2010; NIKOLIĆ, 2020). Some *Cardamine* taxa are rarely noticed in Croatia, e. g. *C. resedifolia* L. and *C. glauca* Spreng., and some have been recorded in the last ten years, e. g. *C. fialae* Fritsch and *C. parviflora* L. (KUČERA *et al.*, 2010; PRLIĆ, 2015; NIKOLIĆ, 2020). The species *C. occulta* had not been observed in Croatia until 2017 (HRUŠEVAR *et al.*, 2018), when it was detected in a nursery near the Dalmatian city of Zadar (HRUŠEVAR *et al.*, 2018). After that, also in 2017, we realized that it was also present in at least one other Dalmatian area of Croatia, and decided to research the species in more detail. Therefore, the first aim of our study was to present a short history of the discovery and to explore two newly-detected sites of the new alien species in Croatia. Since *C. occulta* is unknown in Croatia, a further goal was to establish some features of the species to make its identification easier, specifically: taxonomical peculiarities and detailed plant description, with its distribution, growth and invasive preferences, and the creation of a determination key that will enable the differentiation of the new alien species *C. occulta* from similar species present in Croatia, i. e. *C. flexuosa* With. and *C. hirsuta*.

MATERIAL AND METHODS

The survey was conducted continuously between 2017 and 2021 at both sites at which the species *C. occulta* had been spotted. The sites were geocoded by a GPS device. Plant identifications were performed with specific determination keys and

scientific articles (VERLOOVE & GULLÓN, 2012; DIRKSE *et al.*, 2015; MANSANET-SALVADOR *et al.*, 2015; COOKE & HEATHCOTE, 2017; ŠLENKER *et al.*, 2019; VERLOOVE, 2020). The determination key was developed according to a comparison of the details of our field observations and the results of the work of other authors (MARHOLD *et al.*, 2016; ŠLENKER *et al.*, 2019). The nomenclature of the species *C. occulta* follows MARHOLD *et al.* (2016) and POWO (2021), and the nomenclature of other plants related to the presented research activities follows NIKOLIĆ (2020). Samples of several plant specimens of *C. occulta* were collected and deposited in the Herbarium Croaticum (ZA, voucher numbers 61756 – 61759) and in personal herbarium collections (Dario Hruševar, Dalibor Vladović).

RESULTS AND DISCUSSION

During the summer 2017, the first individuals of *C. occulta* were noticed in the plant nursery in Zemunik Donji, near the city of Zadar (Fig. 1), as a container weed of pine seedlings. The coordinates of the site are 44°06'35.2"N and 15°23'18.2"E. Plants were similar to *C. flexuosa* and at first, it seemed that they belong to the *C. flexuosa* agg. However, some small differences in the morphology of the vegetative and generative structures were observed, which prompted us to perform a more detailed determination through the use of more specific determination keys and articles (VERLOOVE & GULLÓN, 2012; DIRKSE *et al.*, 2015; MANSANET-SALVADOR *et al.*, 2015; COOKE & HEATHCOTE, 2017). Precise determination enabled us to reveal a new weed species *C. occulta*, discovered for the first time in Croatia (HRUŠEVAR *et al.*, 2018). The appearance of this species has caused concern, due to its dense abundance and potential competition with pine seedlings for soil nutrition. This was exacerbated because somewhat later, in the same year, we noticed the species at a new Dalmatian site in a nursery in the city of Split (Fig. 1). The coordinates of this site are 43°30'51.2"N and 16°29'58.8"E. There it grew in flowerpots with shoots of various perennials and palm trees. Since they appeared, the plants have been monitored continuously, and the populations in both nurseries are still present and getting denser every year. Nevertheless, individuals of them have not been discovered outside cultivation. However, due to their well-known and documented invasiveness and the fact that the most common pathway of its introduction into an area is horticulture (MANDÁKOVÁ *et al.*, 2019; PLISZKO, 2020 etc.), it is probably only a matter of time before it is recorded outside cultivation. Namely, although the containers with seedlings in both nurseries are regularly washed and exposed to temperatures exceeding 40 °C, *C. occulta* is still present, both in covered and open parts of the nurseries. In our opinion summer drought is probably the main barrier that makes it difficult for the species to spread to the surrounding areas. However, caution with this species is necessary because the nursery in Zemunik Donji is located relatively near the Vrana Lake Nature Park, which can be an ideal habitat for the spread of this species outside cultivation. During all the years of observation, we noticed an interesting phenomenon in the nursery in Zemunik Donji. Namely, conifers (*Pinus halepensis* Mill., *P. nigra* J. Arnold, *P. pinaster* Aiton, *P. pinea* L., *Cupressus sempervirens* L.) and deciduous trees (*Quercus pubescens* Willd., *Q. ilex* L., *Fraxinus ornus* L., *Robinia pseudoacacia* L.) are equally grown in the nursery from seed material. However, in containers with conifer seedlings, the coverage of *C. occulta* is incomparably higher than in containers with deciduous trees, although the same substrate was used, and the frequency of watering does not differ. At first, it seems to us that

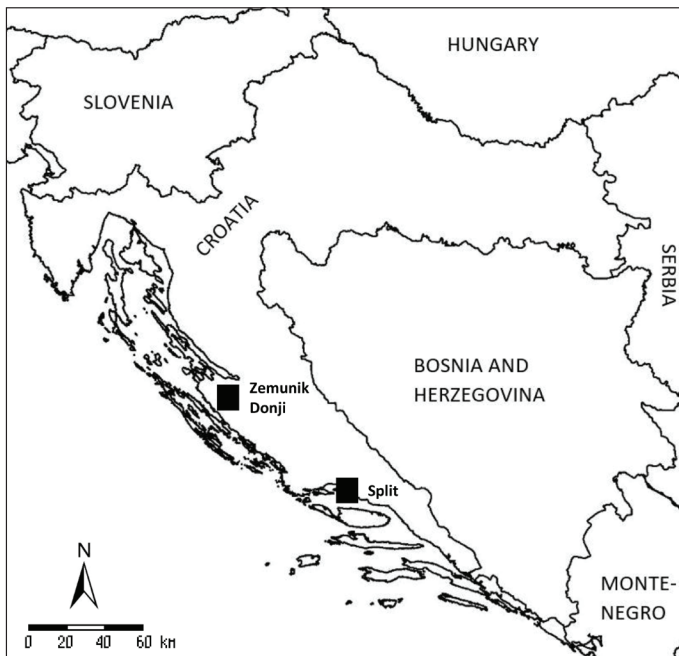


Fig. 1. Locations of the first sites of the species *Cardamine occulta* Hornem. in Croatia.

this may be because of an allelopathy effected by some deciduous species on *C. occulta* (maybe by oaks or black locust, eg. NASIR *et al.* 2005), and this speculation might be confirmed experimentally in the future. Even more so as we have not observed a similar phenomenon in the nursery in Split, and the fact is that oaks and black locust are not grown there. For now, since the plants of *C. occulta* occur in both places in containers and pots with different cultivated plants, we assume that these first occurrences of *C. occulta* in Croatia are rather the result of seeds imported to the nurseries in soil substrates than preferences related to specific cultivated plants. Also tending to support this assumption is the information that the species *C. occulta* has been observed and collected in flowerpots of unknown origin, but purchased in stores in the continental part of Croatia (ALEGRO, 2021; ŠEGOTA, 2021; personal communications).

Although the name *C. occulta* Hornem. is still not accepted by the World Checklist of Seed Plants (GOVAERTS, 1999 – therein it is treated as a synonym of *C. flexuosa*), it is accepted by the IPNI (2021) and the Plants of the World Online (POWO, 2021). According to POWO (2021) synonyms of the species are: *Barbarea arisanensis* (Hayata) S.S.Ying, *Cardamine arisanensis* Hayata, *C. autumnalis* Koidz., *C. brachycarpa* Franch., *C. debilis* D.Don, *C. decurrens* (Blume) Zoll. & Moritzzi, *C. flexuosa* var. *debilis* (O.E.Schulz) T.Y.Cheo & R.C.Fang, *C. flexuosa* subsp. *debilis* O.E.Schulz, *C. flexuosa* var. *occulta* (Hornem.) O.E.Schulz, *C. hamiltonii* G.Don, *C. nasturtioides* D.Don, *Pteroneurum decurrens* Blume. For example, it was frequently recorded under various names, such as *C. flexuosa* auct. non With, *C. flexuosa* subsp. *debilis* O.E. Schulz and *Cardamine hamiltonii*

G. Don (MARHOLD *et al.*, 2016). However, the latter two names are based on illegitimate name *C. debilis* D. Don, which must not be confused with *C. debilis* Banks ex DC. (MARHOLD *et al.*, 2016).

Plants of *C. occulta* (Figs. 2, 3a-c) are mostly annual (rarely biennial), usually less than 30 cm tall (ŠLENKER *et al.*, 2018). Stems are flexuous, branched, sometimes decumbent and rooting at the lowest nodes (RAAB-STRAUBE & VON RAUS, 2014; DIRKSE *et al.*, 2015), glabrous or pubescent in basal part (DIRKSE *et al.*, 2015; ŠLENKER *et al.*, 2018).



Fig. 2. *Cardamine occulta* Hornem.- plant habitus.



Fig. 3. *Cardamine occulta* Hornem.: a) lateral leaf; b) stem with leaves and flower buds; c) flowers and fruits.

Leaves are without auricles (DIRKSE *et al.*, 2015), the upper side is mainly glabrous (PLISZKO, 2020). Basal leaves do not form a rosette. The stem leaves have several to many sessile to petiolate leaflets (MANSANET-SALVADOR *et al.*, 2015). Terminal leaflet is reniform, broadly ovate or suborbicular, mostly 3 – 5 lobed, and lateral leaves are similar, but mainly 1–3 lobed. Inflorescence is racemus with an ascending rachis; petals are almost twice as long as sepals, six stamens are observed in flowers (ŠLENKER *et al.*, 2018). Floral pedicels are divaricate to ascending, mostly short (1 – 1.5 mm), fruiting pedicels 3 – 5 mm long (RAAB-STRAUBE & VON RAUS, 2014; MANSANET-SALVADOR *et al.*, 2015), linear silique is up to 18 (24) mm in length (RAAB-STRAUBE & VON RAUS, 2014; ŠLENKER *et al.*, 2018). Seeds are brown, oblong or sub-quadrate, without wings (ŠLENKER *et al.*, 2018).

The species *C. occulta* is a natural hybrid, an octoploid taxon with the chromosome number $2n = 8x = 64$, and probably originated from the tetraploid parents *C. scutata* and *C. kokoiensis* (ŠLENKER *et al.*, 2018; MANDÁKOVÁ *et al.*, 2019).

It naturally grows in East Asia and prior to molecular evidence that it should be treated as a separate taxon (LIHOVÁ *et al.*, 2006; MARHOLD *et al.*, 2016), the species was overlooked for Europe. However, although only much later recognized as a new taxon, *C. occulta* was first collected in Europe in Belgium in 1963 and in Italy in 1977 (MARHOLD *et al.*, 2016; ŠLENKER *et al.*, 2018; VERLOOVE, 2020). In other European areas, it was very often unnoticed due to morphological confusion with the similar species *C. hirsuta* and *C. flexuosa* (CRESPO *et al.*, 2013; MARHOLD *et al.*, 2016; ŠLENKER *et al.*, 2019; PLISZKO, 2020; VERLOOVE, 2020). Knowledge about the distribution of *C. occulta* in Europe was greatly increased by research into the “alien *Cardamine*” at Lake Constance (BLEEKER *et al.*, 2008). Today, this native East Asian taxon is recorded for almost the whole of Europe with the exception of Scandinavia and South-eastern Europe. It was recorded in Austria, Belgium, Canary Islands, Crete, Cyprus, Czechoslovakia, France, Germany, Ireland, Italy, Netherlands, Poland, Portugal, Sardinia, Spain, Switzerland, United Kingdom (MARHOLD *et al.*, 2016; ŠLENKER *et al.*, 2018; PLISZKO, 2020; POWO, 2021). It is also known as introduced species from areas of other continents, eg. Cuba, El Salvador, Mexico, Hawaii, New Zealand etc. (MANDÁKOVÁ *et al.*, 2019; POWO 2021).

The species *C. occulta* blooms from the beginning of spring until autumn, with several generations per year (MANSANET-SALVADOR *et al.*, 2015). Winter flowering has also been observed, enhanced by mild temperatures (BLEEKER *et al.*, 2008; DIRKSE *et al.*, 2015). After germination, the plants will flower within two weeks (DIRKSE *et al.*, 2015). The taxon is prolific and produces a large number of seeds that spread rapidly through the neighbouring plant containers (MANSANET-SALVADOR *et al.*, 2015), thanks to the explosive opening mechanism of the silique (cf. HOFHUIS *et al.*, 2016). The seeds are viable and able to germinate in the hot and humid conditions of the greenhouse, forming tapestries of small seedlings (MANSANET-SALVADOR *et al.*, 2015). It was also demonstrated that *C. occulta* seeds are much better adapted to flooding than *C. hirsuta* (YATSU *et al.*, 2003), and floating seeds are the main vector of their dispersal on the Lake Constance (BLEEKER *et al.*, 2008).

As a neophyte herbaceous plant *C. occulta* primarily occurs in anthropogenic habitats (COOKE & HEATHCOTE, 2017) and humid environments, mostly associated with crops (especially in rice fields), orchards (MANSANET-SALVADOR *et al.*, 2015), among cobblestones or paving stones, or on pavements, often in irrigated places (MARHOLD *et al.*,

2016). It is a common weed in plant nurseries and probably widely dispersed as a weed of container plants in many other parts of the world (VERLOOVE & GULLÓN, 2012; HEPENSTRICK & HOFFER-MASSARD, 2014), as is evidently the case with our recorded plants. However, this species is still very poorly known and probably overlooked in areas where it can be naturalised as an agricultural and horticultural weed (VERLOOVE & GULLÓN, 2012). For example, in Spain (VERLOOVE & GULLÓN, 2012), Italy (VERLOOVE & ARDENGHI, 2015) and Central Europe (BLEEKER *et al.*, 2008) it colonised natural habitats, and in the area of the Lake Constance *C. occulta* showed invasive potential (KLAUSMEYER, 2006; BLEEKER *et al.*, 2008). As well as seeds and soil, possible vectors of introduction to new areas might be birds or tourists (BLEEKER *et al.*, 2008; MANSANET-SALVADOR *et al.*, 2015).

We paid particular attention to the comparison of this new taxon with the species *C. flexuosa* and *C. hirsuta*, which are present and well known in Croatia (NIKOLIĆ, 2020), and could be confused with *C. occulta* species. Namely, although the first two species differ in the number of chromosomes and genome sizes (cf. ŠLENKER *et al.*, 2019), they are morphologically similar and therefore we suggest a key for their easier determination:

1. Plant with compact basal leaf rosette during anthesis and usually without or with only a few stem leaves, glabrous, terminal leaflet mostly entire, flowers with four stamens, fruit pedicels often erect. *C. hirsuta*
 Plant without basal leaf rosette during anthesis, flowers with six stamens, fruit pedicels mostly divaricate 2
2. Dark green plant, stem with many leaves (usually > 4), markedly hairy towards base; terminal leaflet partially toothed or lobed (up to seven) with shallow sinuses, floral pedicels > 3mm, siliqua 12 – 24 mm *C. flexuosa*
 Pale green plant, stem with a few leaves (usually < 4), most often hairless; terminal leaflet, at least in part, distinctly trilobed (up to five lobes), with deep and sharp sinuses, floral pedicels < 2,5 mm, siliqua 10–18 mm. *C. occulta*

To conclude, *C. occulta* has not been observed in the wild in Croatia or in most of the neighbouring countries (e. g. Slovenia, Serbia, Bosnia and Herzegovina and Montenegro) so far. Therefore, we hope that the proposed determination key and photos of plants will enhance possibilities of its recognition in cultivation, in the field and in herbarium material (e. g. in the case of re-determination of *C. flexuosa* and *C. hirsuta*, if necessary). The potential presence of the species *C. occulta* outside of cultivation must be taken into account, as it might become a future invasive species in the flora of Croatia, and, like most weeds, will be difficult or impossible to eradicate.

ACKNOWLEDGEMENTS

We would like to thank Antun Alegro and Vedran Šegota for sharing with us new information about *C. occulta* findings, as well as the two anonymous reviewers for valuable comments that improved the final version of the paper.

REFERENCES

- AL-SHEHBAZ, I. A., 1988: The genera of Arabidae (Cruciferae; Brassicaceae) in the southeastern United States. *Journal of the Arnold Arboretum* **69**, 85–166.
- AL-SHEHBAZ, I. A., BEILSTEIN, M. A. & KELLOGG, E. A., 2006: Systematics and phylogeny of the Brassicaceae (Cruciferae): an overview. *Plant Systematics and Evolution* **259**, 89–120.
- AL-SHEHBAZ, I. A., MARHOLD, K. & LIHOVÁ, J., 2010: *Cardamine* Linnaeus. In: FLORA OF NORTH AMERICA EDITORIAL COMMITTEE (eds.), *Flora of North America: North of Mexico, Volume 7, Magnoliophyta: Salicaceae to Brassicaceae*. Oxford University Press, New York, Oxford, p. 464–484.
- BLEEKER, W., KLAUSMEYER, S., PEINTINGER, M. & DIENST, M., 2008: DNA sequences identify invasive alien *Cardamine* at Lake Constance. *Biological Conservation* **141**, 692–698.
- COOKE, E. L. & HEATHCOTE, S. J., 2017: *Cardamine occulta*, another small white-flowered weedy *Brassica*. *BSBI News* **135**, 73–74.
- CRESPO, M. B., AZORÍN, M. M. & CAMUÑAS, E., 2013: Novedades corológicas para la flora valenciana [New records for the flora of the Valencian Community (E of Spain)]. *Flora Montiberica* **55**, 118–127.
- DIRKSE, G. M., ZONNEVELD, B. J. & DUISTERMAAT, L. H., 2015: *Cardamine hamiltonii* G. Don – Aziatische veldkruis (Brassicaceae) in Nederland. *Gorteria* **37**, 64–70.
- DRAKE, J. A. (ed), 2009: *Handbook of Alien Species in Europe. Invading nature: Springer series in invasion ecology 3*. Springer, Knoxville, p. 160.
- GOVAERTS, R., 1999: *World Checklist of Seed Plants 3(1, 2a & 2b)*. MIM, Deurne, p. 1–1532.
- HEPENSTRICK, D. & HOFFER-MASSARD, F., 2014: Un xénophyte asiatique du groupe *Cardamine flexuosa*: identification, nomenclature et génétique. *Bulletin du Cercle vaudois de botanique* **43**, 69–76.
- HOFHUIS, H., MOULTON, D., LESSINNES, T., ROUTIER-KIERZKOWSKA, A. L., BOMPHELY, R. J., MOSCA, G., REINHARDT, H., SARCHET, P., GAN, X., TSLANTIS, M., VENTIKOS, Y., WALKER, S., GORIELY, A., SMITH, R. & HAY, A., 2016: A morphomechanical innovator drives explosive seed dispersal. *Cell* **166**(1), 222–233.
- HRUŠEVAR, D., MESAROŠ, J., VLADOVIĆ, D., VUCIĆ, A. & MITIĆ, B., 2018: *Cardamine occulta* Hornem. – A new alien plant taxon in Croatia. In: Jelaska, S. D. (ed.), *Book of Abstracts of the 3rd Croatian Symposium on Invasive Species with International Participation*, Croatian Ecological Society, Zagreb, p. 97–97.
- IPNI, 2021: International Plant Names Index. Published on the Internet <http://www.ipni.org>. The Royal Botanic Gardens, Kew, Harvard University Herbaria and Libraries and Australian National Botanic Gardens (retrieved: March 12th 2021).
- KLAUSMEYER, S., 2006: *Analyse von potenziellen Cardamine Hybriden in der Ufervegetation des Bodensees*. State Examination Thesis, University of Osnabrück, Department of Systematic Botany, Osnabrück.
- KUČERA, J., MARHOLD, K. & LIHOVÁ, J., 2010: *Cardamine maritima* group (Brassicaceae) in the ampho-Adriatic area: A hotspot of species diversity revealed by DNA sequences and morphological variation. *Taxon* **59**(1), 148–164.
- LIHOVÁ, J. & MARHOLD, K., 2006: Phylogenetic and diversity patterns in *Cardamine* (Brassicaceae) – a genus with conspicuous polyploid and reticulate evolution. In: SHARMA, A. K. & SHARMA, A. (eds.), *Plant genome: biodiversity and evolution, Volume 1C, Phanerogams (Angiosperms – Dicotyledons)*. Science Publishers, Enfield, p. 149–186.
- LIHOVÁ, J., MARHOLD, K., KUDOH, H. & KOCH, M. A., 2006: Worldwide phylogeny and biogeography of *Cardamine flexuosa* (Brassicaceae) and its relatives. *American Journal of Botany* **93**, 1206–1221.
- LOEB, R. E., 2009: Biogeography of Invasive Plant Species in Urban Park Forests. In: KOHLI, R. K., JOSE, S., SINGH, H. P. & BATISH, D. R. (eds.), *Invasive Plants and Forest Ecosystems*. CRC Press, Boca Raton, p. 110.
- MANDÁKOVÁ T., ZOZOMOVÁ – LIHOVÁ J., KUDOH, H., ZHAO, Y., LYSÁK, M. A. & MARHOLD, K., 2019: The story of promiscuous crucifers: origin and genome evolution of an invasive species, *Cardamine occulta* (Brassicaceae), and its relatives. *Annals of Botany* **124**(2), 209–220.
- MANSANET-SALVADOR, C.J., FERRER-GALLEGO, P.P., FERRANDO, I. & LAGUNA, E., 2015: Notas sobre el complejo taxonómico *Cardamine flexuosa* With. (Cruciferae) y su presencia en la Comunidad Valenciana. *Flora Montiberica* **59**, 72–82.
- MARHOLD, K., 1996: Typification of the Linnaean names of the genus *Cardamine* (Cruciferae). *Botanical Journal of the Linnean Society* **121**, 111–131.

- MARHOLD K, ŠLENKER M, KUDOH, H. & ZOZOMOVÁ – LIHOVÁ, J., 2016: *Cardamine occulta*, the correct species name for invasive Asian plants previously classified as *C. flexuosa*, and its occurrence in Europe. *PhytoKeys* **62**, 57–72.
- MATSUHASHI, S., KUDOH, H., MAKI, M., CARTOLANO, M., TSIANTIS, M., ITAGAKI, T. & SAKAI, S., 2016: Invasion history of *Cardamine hirsuta* in Japan inferred from genetic analyses of herbarium specimens and current populations. *Biological Invasions* **18**, 1939–1951.
- MILOVIĆ, M., 2015: *Cardamine* L. In: NIKOLIĆ, T., MILOVIĆ, M., BOGDANOVIĆ, S. & JASPRICA, N. (eds.), *Endemi u hrvatskoj flori* [Endemic taxa in Croatian flora, on Croatian]. Alfa, Zagreb, p. 135–147.
- NASIR, H., IQUBQL, Z., HIRDATE, S. & FUJII, Y., 2005: Allelopathic Potential of *Robinia pseudo-acacia* L. *Journal of Chemical Ecology* **31**(9), 2179–2192.
- NIKOLIĆ, T. (ed.), 2020: Flora Croatica Database. Department of Biology, Faculty of Science, University of Zagreb, <http://hirc.botanic.hr/fcd/> (retrieved: November 16th 2020).
- PLISZKO, A., 2020: First record of Asian *Cardamine occulta* Hornem. (Brassicaceae) in Poland. *BioInvasions Records* **9**(3), 655–659.
- POWO, 2021: Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Published on the Internet; <http://www.plantsoftheworldonline.org/> (retrieved: March 12th 2021).
- PRLIĆ, D., 2015: Small-flowered bittercress, *Cardamine parviflora* L. (Brassicaceae), a new species of the Croatian flora. *Acta Botanica Croatica* **74**(1), 151–157.
- RAAB-STRAUBE, E. & VON RAUS, TH., (eds.), 2014: Euro+Med-Checklist Notulae, 3 [Notulae ad floram euro-mediterraneam pertinentes 32]. *Willdenowia* **44**, 287–299.
- ROLLINS, R. C., 1993: *The Cruciferae of Continental North America*. Stanford University Press, Stanford.
- ŠLENKER, M., ZOZOMOVÁ – LIHOVÁ, J. & MARHOLD, K., 2019: *Cardamine occulta* – inconspicuous neophyte in Slovakia. *Bulletin Slovenskej botanickej spoločnosti* **41**(1), 13–23.
- ŠLENKER, M., KUDOH, H., MANDÁKOVÁ, T., ZOZOMOVÁ – LIHOVÁ, J. & MARHOLD, K., 2018: Introduction of *Cardamine occulta* into Europe and origin of this species. *Botanica Serbica* **42**(1), 41–41.
- ŠLENKER, M., ZOZOMOVÁ – LIHOVÁ, J., MANDÁKOVÁ, T., KUDOH, H., ZHAO, Y., SOEJIMA, A., YAHARA, T., SKOKANOVÁ, K., ŠPANIEL, S. & MARHOLD, K., 2018: Morphology and genome size of the widespread weed *Cardamine occulta*: how it differs from cleistogamic *C. kokaiensis* and other closely related taxa in Europe and Asia. *Botanical Journal of the Linnean Society* **20**, 1–27.
- VERLOOVE, F., 2020: *Cardamine occulta*. Manual of the Alien Plants of Belgium. <http://alienplantsbelgium.be/content/cardamine-occulta> (retrieved: October 12th 2020).
- VERLOOVE, F. & ARDENGHI, N. M. G., 2015: New distributional records of non-native vascular plants in northern Italy. *Natural History Sciences. Atti della Societa Italiana di Scienze Naturali e del Museo Civico di Storia Naturale di Milano* **2**, 5–14.
- VERLOOVE, F. & GULLÓN, E. S., 2012: New records of interesting vascular plants (mainly xenophytes) in the Iberian Peninsula. II. *Flora Mediterranea* **22**, 5–24.
- YATSU, Y., KACHI, N. & KUDOH, H., 2003: Ecological distribution and phenology of an invasive species, *Cardamine hirsuta* L., and its native counterpart, *Cardamine flexuosa* With., in central Japan. *Plant Species Biology* **18**, 35–42.