

**Quarries in Smerovišće (Zagreb County, Croatia) - where *Buddleja davidii* Franch. went wild**

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**Abstract**

The Asian species *Buddleja davidii* Franch. (Buddlejaceae) is a common ornamental plant which escaped from cultivation and is now considered invasive in many European countries. In Croatia it is also grown as ornamental but until now there has been little evidence of its naturalization, although it was marked as naturalized in the Flora Croatica Database. In this

article first detailed data on its local naturalization in Croatia are presented: it was discovered in quarries in Smerovišće forming quite big naturalized population, where it presumably originated from planted individual(s). In the future special attention should be paid to this species, and if necessary eradication or containment actions should be promptly carried out.

**Keywords:** alien species, *Buddleja davidii*, Buddlejaceae, naturalization, ornamental plant

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### Sažetak

Azijska vrsta *Buddleja davidii* Franch. (Buddlejaceae) česta je ukrasna biljka koja je pobjegla iz uzgoja te se danas u mnogim europskim zemljama smatra invazivnom. U Hrvatskoj se također uzgaja kao ukrasna biljka, ali do sada nije bilo preciznih podataka o njezinoj naturalizaciji, iako je označena kao naturalizirana u bazi podataka Flora Croatica. U ovom članku

predstavljani su prvi detaljniji podatci o njezinoj lokalnoj naturalizaciji u Hrvatskoj: otkrivena je u kamenolomima u Smerovišću gdje ima veliku naturaliziranu populaciju koja vjerojatno potječe od posađenih jedinki. U budućnosti je potrebno obratiti posebnu pažnju na ovu vrstu i, ako će biti potrebno, provesti akcije iskorjenjivanja ili sprječavanja širenja.

**Ključne riječi:** *Buddleja davidii*, Buddlejaceae, naturalizacija, strana vrsta, ukrasna biljka

### Introduction

The species *Buddleja davidii* Franch. (syn. *Buddleja variabilis* Hemsl., Buddlejaceae) is entomophilous, semi-deciduous shrub (phanerophyte) that flowers from late spring to mid-autumn and fructifies in autumn (Fig. 1). It produces numerous seeds which spread by wind and water, but it also reproduces vegetatively, by branches which root when buried with soil. It originates from central and southwestern China, where it grows in thickets on mountain slopes, side of draws in mountains, at elevations from 800 up to 3500 m a. s. l. (Li & Leeuwenberg 1996, Tallent-Halsell & Watt 2009, Petrova et al. 2013, Mavrič & Strgulc Krajšek 2017).



**Figure 1.** Species *Buddleja davidii* Franch. in flower in quarries in Smerovišće (Photo: I. Boršić, September 13, 2017).

As an ornamental plant it was introduced to Europe (France and the UK) several times in the second half of the 19<sup>th</sup> century (CABI 2017). Since then it has spread almost across the whole Europe, so it is in different phases of the naturalization/invasion process in different countries today. Within the frameworks of the Delivering Alien Invasive Species In Europe (DAISIE) project it was noted as established in Belgium, Corsica, France, Germany, Great Britain, Ireland, Italy, Liechtenstein, the

Netherlands, Poland, Spain and Switzerland, but its naturalization in Slovenia had been overlooked (Martinič 1999). It was considered not established in the Czech Republic, Hungary and Portugal, while its status was marked as unknown for Bulgaria and Croatia (DAISIE 2009). Since then it has become naturalized in the Czech Republic (Pyšek et al. 2012), and, furthermore, it is considered an invasive alien species in Hungary (Csiszár 2012), Slovenia (Jogan et al. 2012) and Bulgaria (Petrova et al. 2013). However, as early as 2006, it was included in the EPPO List of invasive alien plants (EPPO 2017).

In Croatia it has been grown as an ornamental plant for a long time, at least since mid-20<sup>th</sup> century. Anić (1954) mentioned *Buddleja variabilis* for Opeka Park near Varaždin, which, to my knowledge, is its first record for Croatia. Then, Karavla (1962) noted it for King Petar Svačić and Lenin (today King Petar Krešimir IV) Squares in Zagreb. Later it was also recorded as *Buddleia variabilis* Hemsl. in cultivation in the park of Borovo by Rauš (1969). Among several other reports on its ornamental usage in the last decades (cf. Nikolić 2017), Bertović et al. (1997) list cultivar *B. davidii* 'Royal Red' as present in parks in Rijeka and its surroundings and note that it is resistant to frost, but less vital. It was listed as "planta hortifuga" (i.e. cultivated plant species that has escaped from cultivation and grows spontaneously in different natural, semi-natural or manmade habitats) by Hulina (2010) for the continental part of Croatia. Its naturalized occurrence was reported for Istria (Rottensteiner 2014).

According to the standardized terminology of alien plants in Croatia (Mitić et al. 2008) *Buddleja davidii* is marked as allochthonous, outside cultivation and naturalized in the Flora Croatica Database (Nikolić 2017).

## Material and methods

Fieldwork in quarries in Smerovišće (Zagreb County) was carried out on September 13, 2017, with Luka Basrek, Boris Gerenčević and Martina Glasnović (Public Institution "Green Ring", Zagreb County), Mila Preradović (Ministry of Environment and Energy) and Goran Krivanek (Croatian Agency for the Environment and Nature). The coordinates and altitude of points were recorded on Garmin GPSMAP 60CSx GPS Receiver in the national HTRS96 coordinate system (Lapaine & Tutić 2007). Species *Buddleja davidii* Franch. was identified using Flora Europaea (Tutin 1971). Distribution maps were prepared using ESRI GIS ArcMap 10.1 software.

## Results and discussion

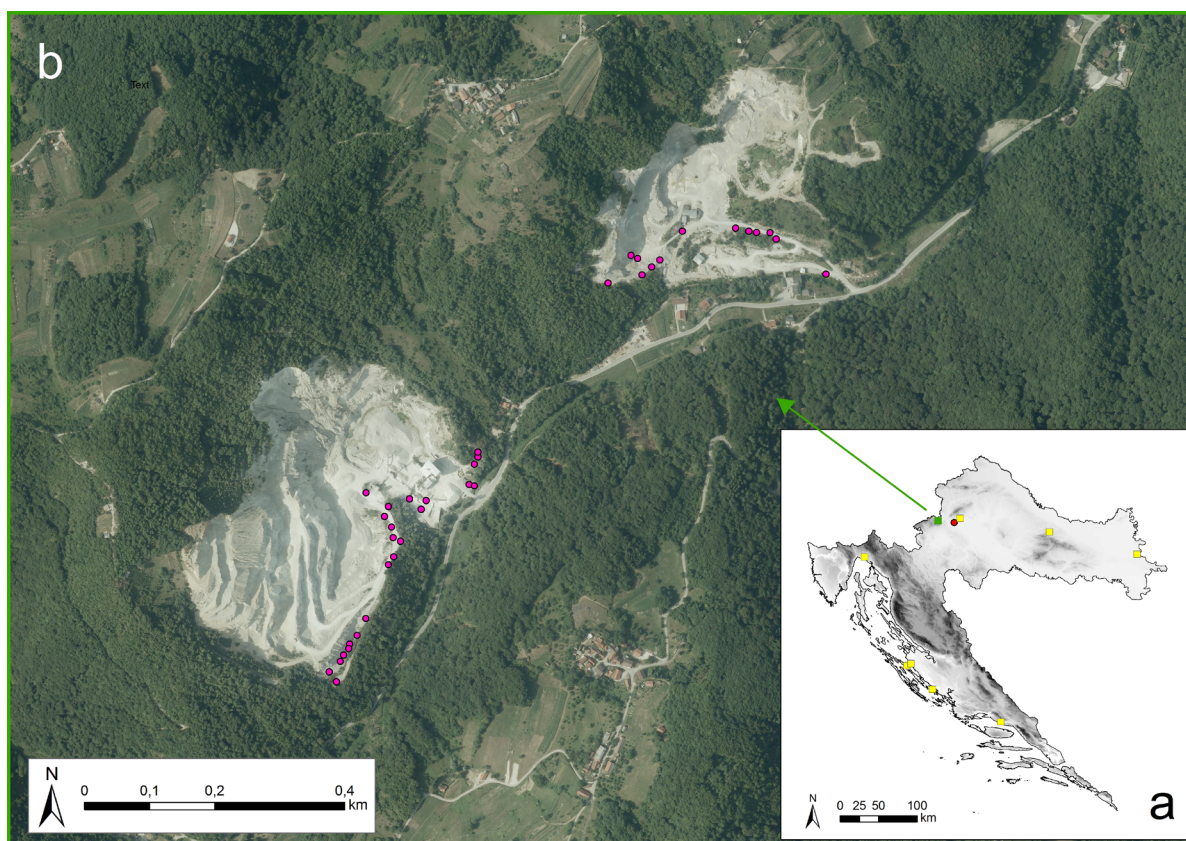
During fieldwork in two quarries in Smerovišće (Zagreb County) on September 13, 2017 the species *Buddleja davidii* Franch. was recorded on numerous points around both quarries (Fig. 2b). On each point at least one individual of *B. davidii* was observed. The coordinates and altitudes of those points are presented in Table 1.

Studied locality in Smerovišće has not been recorded before as shown on the distribution map of *B. davidii* from Flora Croatica Database (Fig. 2a; Nikolić 2017). The majority of the existing records in the database relates to the localities where it is cultivated as ornamental (cf. Nikolić 2017). However, due to its long-lasting usage as an ornamental plant, its wide availability in plant nurseries and garden centres as well as a lack of intensive investigations of garden flora in Croatia, the presented distribution map surely does not show the real extent of the presence of *B. davidii* in the horticulture in Croatia and it is undoubtedly more widespread in gardens than shown.

In addition to very few records in horticulture, there are almost no records of *B. davidii* outside cultivation in the database. One of such records might be a field observation of Hudina et al. (2011) from Konopljenka (Zagreb), although that is not clearly stated. In spite of that, *B. davidii* is marked as naturalized for Croatia (Nikolić 2017). In accordance with that status, Hulina (2010) lists *B. davidii* as a species that escaped from cultivation and grows spontaneously along roadsides in the continental part of Croatia, but notes that it is not aggressive. Furthermore, Rottensteiner (2014) states that it is naturalized in some places in inner Istria and along its western coast. Even so, in those references exact localities of naturalization are not specified and probably because of that they have not been included in the database. Everything considered it seems that *B. davidii* has already passed the

**Table 1.** Coordinates and altitudes of *Buddleja davidii* Franch. in Smerovišće.

X coordinate (m)	Y coordinate (m)	Altitude (m a. s. l.)
433940.57	5072904.00	224
433940.66	5072911.13	246
433935.29	5072892.85	245
433853.38	5072823.49	243
433835.57	5072839.61	247
433768.79	5072848.77	256
433803.06	5072827.75	262
433797.17	5072812.53	263
433807.89	5072795.93	267
433810.40	5072779.55	271
433821.88	5072774.31	271
433811.13	5072750.24	274
433803.00	5072738.22	277
433768.32	5072655.50	282
433754.93	5072629.59	279
433743.66	5072616.23	278
433742.03	5072609.34	277
433734.23	5072599.37	278
433729.37	5072589.46	279
433723.16	5072558.26	282
433712.08	5072573.72	282
433860.88	5072836.76	243
433927.44	5072861.34	240
433935.44	5072859.22	240
434475.29	5073184.69	230
434399.03	5073238.84	244
434389.86	5073248.34	244
434368.90	5073248.52	247
434357.10	5073250.57	249
434336.89	5073255.53	252
434254.77	5073250.64	256
434220.18	5073206.42	258
434207.73	5073195.60	260
434192.94	5073183.41	265
434140.55	5073170.93	285
434186.17	5073208.69	258
434176.16	5073213.63	261



**Figure 2.** a) Distribution map of *Buddleja davidii* Franch. in Croatia according to the Flora Croatica Database (Nikolić 2017); b) localities of *Buddleja davidii* Franch. in quarries in Smerovišće.

lag phase of the naturalization/invasion process although its naturalization in Croatia is not documented well enough.

According to Mitić et al. (2008) naturalized species are species „that sustain self-replacing populations for a period of time long enough to experience extreme climatic events in the area, and reproduce without direct intervention of people (or despite human intervention) by recruitment from seed or vegetative parts capable of independent growth (sustain self-replacing populations for at least 10 years without human impact or at least two spontaneous generations within at least 25 years)“.

By the entrance of the southwestern quarry a shrub of *B. davidii* in flower can be noticed on the Street View of Google Earth application, which was taken in September 2011 (Fig. 3). As flowering normally occurs in two-year old plants (Tallent-Halsell & Watt 2009), it can be concluded that *B. davidii* has been present in quarries of Smerovišće for at least eight years. During this period it must have experienced extreme climatic events in the area. Furthermore, taking into consideration the extent of its spread in the area,

it is safe to assume that it was not deliberately planted on all points where it was recorded, but that it reproduced without direct intervention of people and now sustains self-replacing population. All those facts support recognition of *B. davidii* as naturalized species in Croatia.



**Figure 3.** Street View of Google Earth application of the entrance of the southwestern quarry in Smerovišće with the bush of *Buddleja davidii* Franch. marked in red circle.

As *B. davidii* is a popular ornamental plant and horticulture is the main pathway of its introduction it is presumed that individuals recorded in quarries in Smerovišće originate from planted individual(s). The species has characteristics like fast growth, ability to tolerate wide range of physical conditions and vegetative reproduction, which are appraised in horticulture. These



**Figure 4.** Species *Buddleja davidii* Franch. growing in quarries in Smerovišće (Photos: I. Boršić, September 13, 2017).

characteristics in combination with other traits, such as production of numerous seeds (high propagule pressure) majority of which disperse >10 m from mother plant (Tallent-Halsell & Watt 2009) are most probably principal cause of its naturalization/invasion success.

*B. davidii* is considered to be a pioneer species which very quickly colonizes disturbed habitats (Petrova et al. 2013). Therefore, habitats in quarries in Smerovišće (Fig. 4) present ideal sites where seeds of *B. davidii* are easily spread by wind or by soil transfer by working vehicles. Seeds successfully germinate both on soil and on limestone sand, but the seedlings are very sensitive to draught (Mavrič & Strgulc Krajšek 2017). However, soil seedbank is short-term persistent, with seeds viable up to 3.5 years (Tallent-Halsell & Watt 2009). It is interesting to note that in Great Britain *B. davidii* first became naturalized on a significant scale in the 1930s in limestone quarries, on old walls and on areas of exposed chalk. Later it spread considerably primarily along rail tracks after World War II, while locomotives promoted the spread of its seeds. On abandoned railway lines it formed thickets (Tallent-Halsell & Watt 2009).

Besides quarries and railroads, other disturbed sites such as abandoned urban areas, agricultural fields, gardens, road edges, forest margins, burns and clear-cuts are also invaded by *B. davidii*. What is more, (more) natural

habitats like river banks and floodplains are also susceptible to its invasion (Tallent-Halsell & Watt 2009, Petrova et al. 2013, Mavrič & Strgulc Krajšek 2017). As those habitats are widely present in Croatia, *B. davidii* could spread significantly. Furthermore, climate suitability model for *B. davidii* showed potential for its further expansion in central and Eastern Europe under current and future climates, taking into consideration different climate change scenarios (Kriticos et al. 2011). Records of naturalized individuals of *B. davidii* in Smerovišće, along with naturalization data from Istria and continental Croatia, confirm the obtained results, positioning Croatia within its suitable climatic range.

### Conclusion

In this article a first detailed report on local naturalization of *B. davidii* in Croatia is presented, although its naturalization was observed in Istria and noted for the continental Croatia in general. As this is an invasive species in many European countries, this might be a beginning of its invasion process in Croatia as well. Therefore, its behaviour should be closely observed, by monitoring its spread in quarries in Smerovišće, as well as by noting all new occurrences outside cultivation. However, it might be impossible to detect all new naturalization sites early enough and respond rapidly because it is surely widely grown as ornamental throughout Croatia, and it is still widely available on the market. Anyhow, it is important to pay special attention to this species in order to eradicate it or contain it promptly on the first signs of its further aggressive spread because an advanced invasion process might be impossible to reverse, like in other European countries.

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