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# Contribution to the knowledge on the distribution of *Aristolochia clematitis* in riparian and roadside habitats of Serbia

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**Abstract**

*Aristolochia clematitis* L., belonging to the Aristolochiaceae family and commonly known as common birthwort or Dutchman's pipe, is a rhizomatous perennial herb best known for its unpleasant odor. It is widespread in Serbia, favoring warm, nutrient-rich soils in sunlit areas. It thrives in habitats such as floodplain forests, riverbanks, embankments and roadsides. This species is also significant from a plant, animal and human health perspective, as a phytopathogenic virus host, poisonous plant and producer of aristolochic acid I (AAI), a nephrotoxic and carcinogenic compound linked to Balkan endemic nephropathy. Field studies in Serbia were conducted along 236 riparian and 180 roadside field sites, where its presence and abundance were recorded along 100 m long vegetation transects. RDA analyses were performed using Canoco 5.0, with *A. clematitis* cover as a response variable and selected habitat features as explanatory variables. Generalized additive model (GAM) was done to fit a response curve of *A. clematitis* on the elevation gradient. *A. clematitis* was documented in 42 field sites, with the highest number of field sites being in the Danube catchment area (riparian) and along the E-75 highway (roadside). The cover of *A. clematitis* varied, equaling the cover of cca. 5% in 66.67% of riparian field sites, with some roadside sites reaching 30% cover. Analyses show that the presence and cover of *A. clematitis* was positively associated with lower altitudes and the presence of some anthropogenic features (e.g. debris) within the studied reach of the river. The study highlights the need for targeted control measures, considering the cover and abundance of *A. clematitis* in specific locations.

Key words: common birthwort, Danube catchment area, highway, Serbia

## INTRODUCTION

*Aristolochia clematitis* L. is a member of the Aristolochiaceae family, which is comprised of two genera in the flora of Serbia – *Aristolochia* L. and *Asarum* L. Genus *Aristolochia* in the flora of Serbia consists of two species: *A. clematitis* and *A. pallida*. *A. clematitis*, commonly known as (common) birthwort or Dutchman's pipe, is a rhizomatous perennial herbaceous plant which can grow up to 1 m, but is generally 25-50 cm tall. It is very characteristic for its rather unpleasant smell. It originated in the Mediterranean, Asia Minor and the Caucasus and was later introduced into Central Europe (Janković, 1970) and to certain North European countries (EPPO, 2025a). Floristically speaking, *A. clematitis* is considered to be a submediterranean floristic element (Janković, 1970).

In Serbia it is very widespread, primarily as a weed species, although it is often found in willow stands and mixed forests of oak and ash (Janković, 1970). Additionally, the overview of European vegetation done by Mucina et al. (2016) shows that *A. clematitis* is a diagnostic species in riparian gallery forests

of the *Alno glutinosae-Populetea albae* class and tall-herb semi-natural perennial vegetation found on disturbed forest edges and in forest clearings (*Epilobietea angustifolii* class) (Mucina et al. 2016).

*A. clematitis* is relevant from a plant health perspective as a proven host of the tomato spotted wilt virus (TSWV, *Orthotospovirus tomatomaculae*) (Parrella et al. 2003), considered to be one of the 'top ten' viruses in molecular phytopathology (EPPO, 2025b). It is also one of the most problematic poisonous plants in our agroecological conditions, which can affect the health of cattle and horses, where aristolochin from this plant can lead to difficulty beathing, convulsions and the appearance of blood in the urine of these animals (Konstantinović and Meseldžija, 2007).

*A. clematitis* has been known as the main cause behind a chronic kidney disease, the Balkan endemic nephropathy (Hranjec et al. 2005), due to its production of aristolochic acid I (AAI), a phytotoxin which is a strong nephrotoxic and highly carcinogenic compound. Such cases of exposure have been primarily linked to the consumption of *A. clematitis* plants, used as traditional remedies. However, studies (Pavlović et al., 2013; Li et al. 2018; Au et al. 2020) have shown that roots of vegetable (e.g. cucumber) and wheat and maize plants can absorb AAI. Moreover, others (Chan et al. 2016; Li et al. 2016; Drăghia et al., 2021) have proven that the sole presence of *A. clematitis* in the area leads to both soil, vegetable (lettuce, spring onion, tomato) and crop (corn, wheat) contamination by AAI, potentially making them a pathway of exposure to this carcinogen. Owing to its overall importance from a plant, animal and human health perspective, our aim is to provide new data on the distribution of *A. clematitis* in riparian and roadside habitats of Serbia.

## MATERIAL AND METHODS

### Field research

The presence of *A. clematitis* in riparian areas of Serbia was studied at 236 field sites, distributed along 38 rivers and 6 canal sections of the Danube-Tisa-Danube canal system (Anđelković, 2019; Anđelković et al. 2022). Following Aguiar et al. (2001, 2005) we set up 100 m long transects on the riverbank at each field site, positioned parallel to the river flow. At each transect we documented the presence and cover of the target species, along with the relevant environmental data, habitat and anthropogenic features. The cover and abundance were later transformed into a numerical scale, following the van der Maarel transformations (1979).

Additionally, the presence of *A. clematitis* in roadside areas of Serbia was studied at a total of 180 field sites, distributed along the highways and IB category of state roads. At each field site we set up 100 m long vegetation transects, located on the road verge and the downwards slope by the road and positioned parallel to the road, where we documented the presence and cover of the target species, in percentages (%). The cover of the target species was later transformed into cover values following the van der Maarel transformations (1979). Selection of the studied field sites in both habitat types was done to maximize the geographical coverage of the study area. Data on the presence of the target species was georeferenced using a hand-held Garmin GPS eTracker, and the distribution map (Figure 1) was created using the open source tool MapCustomizer.

### Data analysis

*A. clematitis* was observed in relation to the elevation gradient and selected habitat features. RDA analyses were performed with *A. clematitis* cover as a response variable and selected habitat features as explanatory variables. A response curve of *A. clematitis* on the elevation gradient, fitted using the generalized additive model (GAM), is shown. All of the analyses were performed in Canoco 5.0 (Ter Braak and Šmilauer, 2012).

## RESULTS AND DISCUSSION

*Aristolochia clematitis* was recorded along a total of 42 field sites - 30 riparian and 12 roadside (Tables 1 and 2; Figure 1). The highest number of field sites was recorded within the Danube catchment area (14), along the Danube (five) and Mlava (four) rivers (Table 1).

Table 1. Distribution records of *Aristolochia clematitis* in the riparian areas of Serbia

| Catchment | River | Field site | Latitude (N) | Longitude (E) | Altitude (m) | Cover value* |
|---|---|---|---|---|---|---|
| Danube | Begej | Žitište | 45.4886 | 20.547 | 81 | 5 |
| Danube | Danube | Belegiš | 45.02389 | 20.35358 | 76.5 | 4 |
| Danube | Danube | Grocka | 44.68005 | 20.7176 | 91 | 3 |
| Danube | Danube | Dubovac | 44.7886 | 21.21354 | 67 | 3 |
| Danube | Danube | Ram | 44.81607 | 21.333211 | 86 | 3 |
| Danube | Danube | Vinci | 44.69891 | 21.60446 | 75.5 | 3 |
| Danube | Zlatica | Sajan - Padej | 45.83715 | 20.20592 | 75 | 3 |
| Danube | Karaš | Straža | 44.96272 | 21.3161 | 83 | 3 |
| Danube | Mlava | Gornjačka klisura | 44.266116 | 21.544319 | 180 | 3 |
| Danube | Mlava | Leskovac | 44.355314 | 21.436306 | 128 | 3 |
| Danube | Mlava | Petrovac na Mlavi | 44.372792 | 21.421359 | 124 | 5 |
| Danube | Mlava | Malo Crniće | 44.54442 | 21.27925 | 99 | 3 |
| Danube | Nera | Kusić | 44.87103 | 21.47295 | 89.3 | 1 |
| Danube | Nera | Stara Palanka | 44.83296 | 21.35471 | 81 | 2 |
| Sava | Topčiderska reka | Pinosava | 44.68078 | 20.48215 | 131 | 3 |
| Kolubara | Kolubara | Ratkovac | 44.339028 | 20.090857 | 133 | 3 |
| Kolubara | Ub | Dokmir | 44.41493 | 19.97555 | 113 | 2 |
| Kolubara | Ub | Zvizdar | 44.4285 | 20.02535 | 108 | 3 |
| Kolubara | Ub | Gunjevac | 44.44835 | 20.04918 | 102 | 3 |
| Drina | Jadar | Lešnica | 44.684482 | 19.312385 | 106 | 2 |
| Velika Morava | Crnica | Glavica | 43.85893 | 21.44471 | 152 | 3 |
| Velika Morava | Crnica | Popovac | 43.90161 | 21.50605 | 193 | 4 |
| Velika Morava | Resava | Svilajnac | 44.23271 | 21.19385 | 107 | 3 |
| Zapadna Morava | Čemernica | Konjevići | 43.901386 | 20.404185 | 241 | 2 |
| Južna Morava | Jablanica | Živkovo | 43.0736 | 21.94023 | 225 | 4 |
| Južna Morava | Južna Morava | Stalać | 43.6769 | 21.41114 | 145 | 3 |
| Južna Morava | Toplica | Doljevac | 43.20406 | 21.83001 | 202 | 3 |
| Timok | Beli Timok | Ravna | 43.636635 | 22.267095 | 193 | 3 |
| DTD | Banatska Palanka - Novi Bečej | Grebenac | 44.90237 | 21.24677 | 84 | 3 |
| DTD | Novi Sad - Savino Selo | Novi Sad | 45.27422 | 19.84918 | 82 | 3 |

* Following the van der Maarel (1979) transformations

When discussing the necessity for the control of this plant species in certain field sites, in addition to its presence, it is also important to consider the cover of the target species. Consequently, it is important to highlight that *A. clematitis* was recorded with a cover and abundance value of 3 (following the van der Maarel (1979) transformations), which equals a cover of cca. 5% in the majority (66.67%) of field sites (Table 1). In contrast, roadside field sites exhibit a wider span of cover and abundance values, with two field sites along

the E-75 highway where it even reached cca. 30% of the transect (Velika Plana and Novo Selo). Majority of roadside field sites (five) were characterized by cover of 10-15% of the transect area (Table 2).

Table 2. Distribution records of *Aristolochia clematitis* in the roadside areas of Serbia

| Road category | District | Field site | Latitude (N) | Longitude (E) | Altitude (m) | Cover value* |
|---|---|---|---|---|---|---|
| E-75 highway | Podunavlje | Vrbovac | 44.5773 | 20.935797 | 103.6 | 5 |
| E-75 highway | Podunavlje | Krnjevo | 44.431065 | 21.053817 | 100.3 | 5 |
| E-75 highway | Podunavlje | Velika Plana | 44.349365 | 21.075523 | 102 | 7 |
| E-75 highway | Podunavlje | Novo Selo | 44.259418 | 21.110011 | 110.9 | 7 |
| E-75 highway | Podunavlje | Mihajlovac | 44.534513 | 21.001225 | 102 | 5 |
| E-75 highway | Pomoravlje | Bagrdan | 44.062403 | 21.205238 | 149.8 | 3 |
| E-75 highway | Pomoravlje | Jagodina | 43.992899 | 21.273081 | 120 | 3 |
| E-75 highway | Nišava | Čapljinac | 43.236656 | 21.820515 | 202.4 | 6 |
| State Road 10 | South Banat | Vršac - Vatin | 45.164827 | 21.291646 | 120 | 6 |
| State Road 18 | South Banat | Straža-Potporanj | 45.011266 | 21.278616 | 91 | 5 |
| State Road 10 | South Banat | Pančevo - Mali Rit | 44.85659 | 20.651621 | 74.8 | 5 |
| State Road 26 | Mačva | Duvanište | 44.734303 | 19.504937 | 90 | 3 |

* Following the van der Maarel (1979) transformations

Regarding the geographic distribution of our records, we can see that despite the wide geographic coverage of our field study, which encompassed all regions, roadside records are primarily grouped along the E-75 highway, mostly in the regions of Podunavlje and Pomoravlje (Table 2, Figure 1).

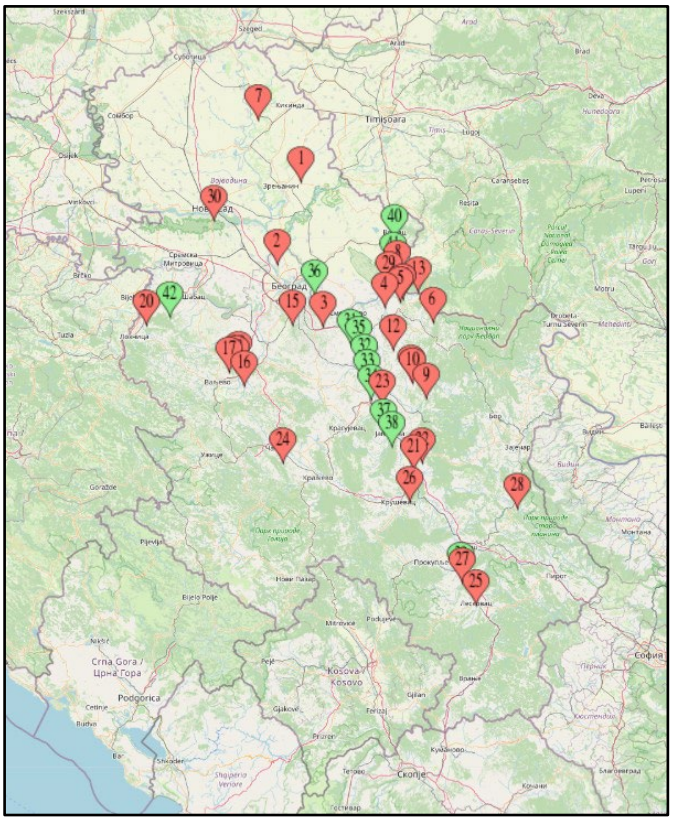


Figure 1. Records of *Aristolochia clematitis* presence in studied riparian (red) and roadside (green) field sites

Brzić et al. (2023) have shown that *A. clematitis* tolerates a broad range of climatic conditions, preferring moderately warm habitats. It also occurs in a variety of habitat types and vegetation classes. The authors highlight that it appears most frequently in riparian forests and along its edges. Despite this tendency, it can also be found in certain dry habitats (e.g. dry and semi-dry grasslands, Brzić et al. 2023), which aligns with out records of this species in roadside verges, especially along the highway (Table 2).

Brzić et al. (2023) have found that in central parts of its range *A. clematitis* has a wider ecological niche, being more prevalent in anthropogenic habitats, tolerating more frequent disturbance events. This tolerance of anthropogenic disturbances concurs with our findings, where the presence of this species was positively associated with the observation of debris in the field site (RDA, F=4.4, P=0.036).

Vegetated and unvegetated side bars represent geomorphological features which account for the total geodiversity of a river's reach, which in turn affects the overall ecological quality and potentially biodiversity (Stefanidis et al., 2023). Side bars represent depositional features, positioned along the river margins, with the vegetated ones having more than 50% of the surface area with plant cover (EA, 2022). Our analysis shows that both vegetated and unvegetated side bars (vegetated - RDA F=14.3, P=0.028; unvegetated - RDA F=7.2, P=0.034) were significant predictors of the *A. clematitis* presence in the field site (graphs not shown).

Figure 2 shows that *A. clematitis* is more prevalent in lowlands, while its presence and cover diminish at higher altitudes. This aligns with literature data showing that this weed species favors warm, sunlit places, with nutrient-rich soils (*in* Brzić et al., 2023).

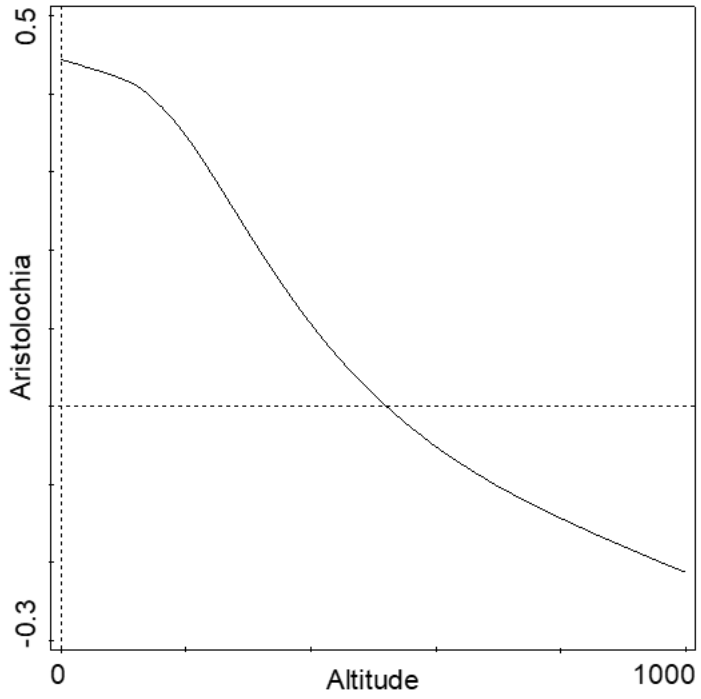


Figure 2. Cover of *Aristolochia clematitis* in relation to altitude

## CONCLUSION

We can conclude that the highest number of field sites where *A. clematitis* was observed are located withing the Danube catchment area (riparian) and along the highway (roadside). While the cover of *A. clematitis* varied across the studied sites, with some roadside sites reaching 30% cover of the transect. Analyses have shown that the presence and cover of *A. clematitis* is positively associated with lower altitudes and the presence of some anthropogenic features (e.g. debris) within the studied reach of the river. The study highlights the need for targeted control measures, considering the cover and abundance of *A. clematitis* in specific locations.

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