

## The spread of *Reynoutria* species (Polygonaceae) in Kampinos National Park and its vicinity (Central Poland)

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Knotweed taxa: *Reynoutria japonica*, *R. sachalinensis* and *R. ×bohemica* have been classified as the most dangerous invasive plants in Europe, North America, and other regions with cool climates. In Poland they are included on the list of 16 alien plant species which, when introduced into the natural environment, pose a threat to native biodiversity or natural habitats. Despite the serious threat they pose, *Reynoutria* species are still grown as ornamental plants, and are sometimes planted in hedges. Studies aimed at the identification of the range and the method of spread of knotweeds in settlement areas in Kampinos National Park and its vicinity were carried out from 2012. In mid-2018 there were 176 known sites where different species of *Reynoutria* were found. Most of these sites (118) were formed by *R. japonica*. *R. ×bohemica* was found on 54 sites, and *R. sachalinensis* only on four sites. Home gardens are a source of *Reynoutria* species spread in the region of Kampinoska Forest (national park with its buffer zone). Our results showed that the most of the *Reynoutria* species sites were located within the administrative borders of investigated localities, at different distances from home gardens, where these plants are grown. Although the distribution of knotweeds is largely limited to ruderal habitats, these invasive plants, especially *R. japonica* and *R. ×bohemica*, create a threat to semi-natural and natural biocoenoses at Kampinos National Park. *R. sachalinensis* was found only in villages on the periphery of KNP. Giant knotweed usually occupies large areas and form dense, homogeneous populations. It is necessary to constantly monitor the existing sites of knotweeds and prevent the formation of new stands in the area of Kampinos National Park and its close vicinity.

*Keywords:* invasive plants, rural areas, synanthropic habitats, protected area

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Таксони *Reynoutria japonica*, *R. sachalinensis* і *R. ×bohemica* були класифіковані як найбільш небезпечні інвазивні рослини в Європі, Північній Америці та інших регіонах з прохолодним кліматом. У Польщі вони включені в список 16 чужорідних видів рослин, які при інтродукції в природне середовище створюють загрозу для біорізноманіття або природного місця існування. Незважаючи на серйозну загрозу, яку вони представляють, види *Reynoutria* все ще вирощуються як декоративні рослини, а іноді і висаджуються як живі огорожі. Дослідження, спрямовані на виявлення ареалу і способів поширення цих рослин в населених пунктах національного парку Кампінос і його околиць, проводилися з 2012 року. До середини 2018 року було встановлено 176 локалітетів, де були виявлені різні види *Reynoutria*. Більшість з цих місцезростань (118) були сформовані *R. japonica*. *R. ×bohemica* був виявлений на 54 ділянках, а *R. sachalinensis* – тільки на чотирьох ділянках. Домашні сади є джерелом поширення видів *Reynoutria* в районі лісу Національного парку



Кампінос (національний парк з його буферною зоною). Наші результати показали, що більшість видів *Reynoutria* були розташовані в адміністративних межах досліджених місцевостей, на різних відстанях від присадибних ділянок, де вирощуються ці рослини. Хоча поширення цих рослин в основному обмежена рудеральними угрупованнями, ці інвазивні рослини, особливо *R. japonica* і *R. ×bohemica*, створюють загрозу для напівнатуральних і природних біоценозів в національному парку Кампінос. *R. sachalinensis* був виявлений тільки в селах на периферії Національного парку Кампінос. Рослина зазвичай займає великі площі і утворює щільні, однорідні популяції. Необхідно постійно стежити за його існуючими локалітетами і не допускати утворення нових насаджень в районі Національного парку Кампінос і його безпосередній близькості.

*Ключові слова:* інвазивні рослини, сільські райони, синантропні місця існування, території, що охороняються

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Таксоны *Reynoutria japonica*, *R. sachalinensis* и *R. ×bohemica* были классифицированы как наиболее опасные инвазивные растения в Европе, Северной Америке и других регионах с прохладным климатом. В Польше они включены в список 16 чужеродных видов растений, которые при интродукции в естественную среду создают угрозу для биоразнообразия или естественной среды обитания. Несмотря на серьезную угрозу, которую они представляют, виды *Reynoutria* все еще выращиваются в качестве декоративных растений, а иногда и высаживаются на живых изгородях. Исследования, направленные на выявление ареала и способов распространения этих растений в населенных пунктах национального парка Кампинос и его окрестностей, проводились с 2012 года. До середины 2018 года было установлено 176 локалитетов, где были обнаружены различные виды *Reynoutria*. Большинство из этих метопроизрастаний (118) были сформированы *R. japonica*. *R. ×bohemica* был обнаружен на 54 участках, а *R. sachalinensis* – только на четырех участках. Домашние сады являются источником распространения видов *Reynoutria* в районе Кампиносского леса (национальный парк с его буферной зоной). Наши результаты показали, что большинство видов *Reynoutria* были расположены в административных границах исследованных местностей, на разных расстояниях от приусадебных участков, где выращиваются эти растения. Хотя распространение узловатых в основном ограничено рудеральными местами обитания, эти инвазивные растения, особенно *R. japonica* и *R. ×bohemica*, создают угрозу для полунатуральных и естественных биоценозов в национальном парке Кампинос. *R. sachalinensis* был обнаружен только в селах на периферии Национального парка Кампинос. Растение обычно занимает большие площади и образует плотные, однородные популяции. Необходимо постоянно следить за его существующими локалитетами и не допускать образования новых насаждений в районе Национального парка Кампинос и его непосредственной близости.

*Ключевые слова:* инвазивные растения, сельские районы, синантропные места обитания, охраняемая территория

Kampinos National Park (KNP), established in 1959, the second largest national park in Poland (surface area – 385 km<sup>2</sup>, buffer zone – 378 km<sup>2</sup>), UNESCO MaB Reserve “Puszcza Kampinoska” (established in 2000) and Natura 2000 site “Puszcza Kampinoska” (established in 2004), have been for many years under strong anthropogenic pressure [ANDRZEJEWSKI, 2004]. This results from the Park's location in the temperate climate zone, the lack of geographical barriers, as well as urban pressure. KNP is situated in the Central Masovian Lowland, in the Warsaw Basin, near Warsaw, the largest metropolis in Poland. Strong urban pressure also results from the close neighbourhood of the town of Łomianki, as well as many villages that have functions, infrastructure and development typical of small towns. These

factors have a huge impact on the spread of invasive species [OTRĘBA, 2008; BOMANOWSKA et al., 2014], including taxa from the genus *Reynoutria* [KIRPLUK, 2014].

Knotweed species: *Reynoutria japonica* Houtt., *Reynoutria ×bohemica* Chrtek & Chrtková and *Reynoutria sachalinensis* (F.Schmidt) Nakai are kenophytes, i.e. alien species permanently established in synanthropic habitats, also penetrating into semi-natural and natural plant communities. They are regarded as one of the most invasive species in the world [TOKARSKA-GUZIŁ et al., 2017; SHEVERA, 2017]. IUCN listed *Reynoutria japonica* among the 100 most invasive species [GISD 2010], and according to the DAISIE database (2006) this is one of the 18 most invasive plants in Europe. These three species are troublesome from an environmental and conservation point of view, as they are one of the most prevalent and destructive alien plants in the European protected areas [MONACO, GENOVESI, 2014; BRAUN et al., 2016].

Since the end of the 19th century, knotweeds gradually invaded increasingly larger areas in Europe. During the last decade, massive and rapid spread of these aggressive new aliens in Eastern and Southeastern Europe has been observed. Currently, these species are established in most of countries of the Carpathian Basin and Balkan Peninsula, e.g. Croatia, Bosnia and Herzegovina, Bulgaria, Hungary, Kosovo, Montenegro, Romania, Serbia and Slovenia [BALOGH, 2008; SİRBU, OPREA, 2008; SİRBU et al., 2012; HLAVATI ŠIRKA et al., 2013; DUMITRAȘCU et al., 2014, JOVANOVIĆ et al., 2018]. At present knotweeds are rapidly expanding in Ukraine, mainly in Western part of country [PROTOPOPOVA et al. 2006]. According to PROTS [2013] and PROTOTOPOVA and SHEVERA [2014] *R. japonica* and *R. ×bohemica* are the most harmful alien species for the Transcarpathia region. *R. japonica* is recognized as transformer species in Ukrainian Polissya [PROTOPOPOVA et al., 2015]. *R. ×bohemica* is considered as a potentially invasive species. At present it has been found in several localities from western (Transcarpathia, Chernivtsi and Lviv regions) and central (Zhytomyr, Kyiv and Poltava regions) parts of Ukraine [SHEVERA, 2017]. Results of numerous studies and observations provide evidences that knotweeds could become widespread throughout Ukraine under the current trend of expansion. The tendency of expansion of these invasive species eastward, i.e. forest-steppe and steppe zones of Ukraine has been observed [BURDA et al., 2015; HOLOBORODKO et al., 2016; PASHKEVYCH, BURDA, 2017].

In Poland knotweed species *R. japonica*, *R. sachalinensis* and *R. ×bohemica* are also regarded as dangerous species and have the highest (IV) category of invasiveness [TOKARSKA-GUZIŁ et al., 2012]. They are included on the list of 16 plant species which, when introduced into the natural environment, may pose a threat to native species or natural habitats [Dz. U. 2011 no. 210, item 1260].

The aim of the study was to identify sites of *Reynoutria* species in the area of Kampinos National Park and in its immediate vicinity, their distribution, methods of spread of these taxa to the plant communities of KNP, and factors promoting their invasion.

### **Materials and methods**

A detailed floristic survey was carried out in 2012-2018 on the settlement areas in KNP and its direct vicinity, i.e. 33 villages within the limits of the national park and 102 villages in the buffer zone. Special emphasis was put on the identification of taxa that are often confused, i.e. *R. japonica* and *R. ×bohemica*. To finally verify the number of sites of *Reynoutria* species we also analysed historical data, gathered by the authors of this paper and other researchers [OTRĘBA, MICHALSKA-HEJDUK, 2014], including unpublished information. On the basis of these data a map of current locations of *Reynoutria* taxa was prepared in ArcGIS.

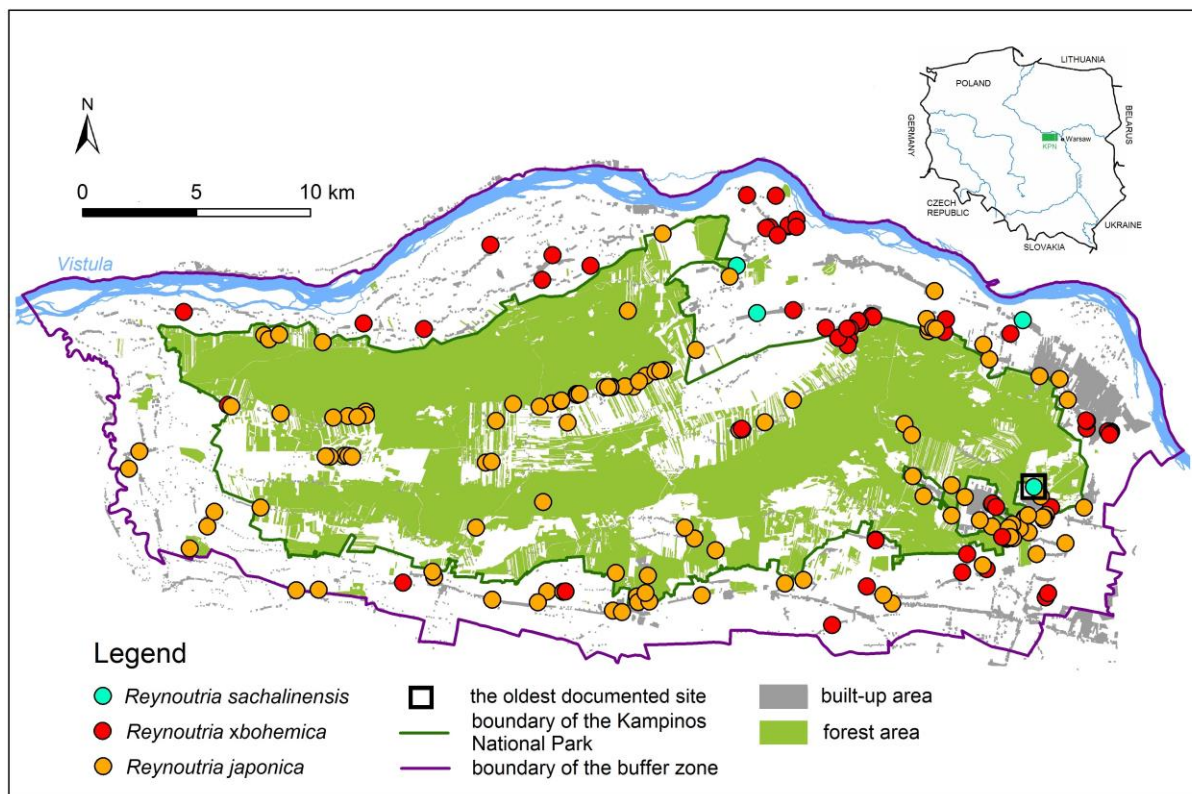


Fig. 1. Distribution of the *Reynoutria* species within the area of the Kampinos National Park (from 1985 to 2018).

Рис. 1. Поширення видів *Reynoutria* у Національному парку Кампніос (з 1985 по 2018 роки).

During the field survey we also monitored the existing, previously reported sites of knotweed species.

The nomenclature of taxa is consistent with “The International Plant Names Index” [THE PLANT LIST, 2013], and their synanthropic status with the classification proposed by Sudnik-Wójcikowska & Koźniewska [SUDNIK-WÓJCIKOWSKA, KOŹNIEWSKA, 1988].

### Results

In mid-2018 there were 176 known sites where different species of *Reynoutria* were found. Most of these sites were formed by *R. japonica* (118, of which 64 are within the national park and 54 in the buffer zone). *R. xbohemica* was found on 54 sites (six in the national park and 48 in the buffer zone), while *R. sachalinensis* - on four sites (all in the buffer zone) (Fig. 1).

Our observations revealed that most of the sites occupied by *Reynoutria* species were located within the administrative borders of smaller and larger villages, at different distances from home gardens, where these plants are grown. In 33 villages within the limits of Kampinos National Park we mostly identified *R. japonica*. This species was found in 11 villages, while *R. japonica* and *R. xbohemica* only in one village (Wiersze). In 102 villages located in the buffer zone we more often encountered *R. xbohemica*. This species was found in 37 villages, while *R. japonica* was found in 32, and both species were found in 12 villages. *R. xbohemica* was mainly found in villages near the northern and eastern borders of KNP. On the other hand, *R. japonica* prevailed in locations near the southern and western borders (Fig.1). Numerous sites of this species were identified mainly on the roadsides, particularly in areas where road repairs were carried out, new asphalt surface was laid and roadsides were paved. New sites of *R. xbohemica* emerging in subsequent years were found near the north-eastern border of KNP, particularly abundant in the villages of Adamówek and Łosia Wólka and a huge population near the shopping centre in Łomianki.

*R. sachalinensis* was detected in villages on the margins of KNP, in its eastern part, both northward (3 sites: Czeczotki, Sowia Wola, Wrzosówka), and southward (one site in Laski, on the forest edge).

Sites of knotweeds usually occupy large areas. They form dense, homogeneous populations. This concerns both the oldest sites of *R. japonica* reported from the area of KNP, and newly formed sites of *R. ×bohemica*. In places that are managed, e.g. mown or cleared, knotweed plants grow vigorously, and new sites in the vicinity are being formed.

One action aimed at removing knotweed plants from KNP was monitored between 2013 and 2018, on a field in Górki purchased by KNP for the project. In subsequent years *R. japonica* produced new shoots, but each year the regrowth was less vigorous. In 2018 only scarce, small plants of *R. japonica* were observed, regrowing near farm buildings.

### Discussion

The oldest available sources [KOBENDZA, 1930] do not provide information on the sites of *Reynoutria* species in Kampinoska Forest. The first spontaneously formed sites of *R. japonica* were reported in the 1970s in the buffer zone of Kampinos National Park [NOWAK, 1983], in the villages of Babice, Janów, Latchorzew, Leszno, Powązki and Zaborów. Sites from the area of KNP were reported much later, in the 1990s [KIRPLUK, 1996, 1998, 2003, 2009, 2012; FERCHMIN, unpubl.]. The first reports on the presence of *R. sachalinensis* date back to 1985 [Ferchmin, unpubl.]. Sites of *R. ×bohemica* were identified in the early 21st century (authors' own data and data from KNP, unpubl.).

By 2016 there were 129 sites of *Reynoutria* species reported, both from the area of the surveyed villages and outside them. The most frequently recorded species was *R. japonica* (123 sites, including 61 in KNP and 62 in its buffer zone). Each of the other two taxa have been found on three sites: *R. sachalinensis* (all in the buffer zone), and *R. ×bohemica* (one in the national park and 2 in its buffer zone). However, observations have shown that these data do not reflect the actual distribution of knotweeds in the Kampinoska Forest. This particularly refers to *R. ×bohemica*, which is difficult to distinguish from *R. japonica* [SHEVERA, 2017]. Verification of data revealed that most sites were formed by *R. japonica* (118 sites, of which 64 are within the national park and 54 in the buffer zone), but some of the previously reported sites were in fact occupied by *R. ×bohemica*. Overall, *R. ×bohemica* has been found on 54 sites (six in KNP and 48 in the buffer zone). Observations carried out in recent years also revealed that *R. ×bohemica* emerges in many new locations, quickly occupying considerably large areas. *R. sachalinensis* was found on four sites in the buffer zone of KNP (apart from those previously mentioned in our studies there was a site on the shore of Lake Dziekanowskie).

For *R. ×bohemica* we observed that plants escaped from home gardens, where they are cultivated, to ruderal habitats and colonized land near houses and fences, heaps of rubble, cemeteries, etc., where this taxon becomes established and changes its status from an escapee from cultivation (ergasiophyte) to an epiphyte. Next, this knotweed spreads spontaneously to semi-natural habitats (meadows) and natural habitats (forests), and becomes an agriophyte. The behaviour of *R. japonica* is similar – this species, present on numerous sites within KNP, spreads to forest communities located in villages near the national park. Knotweeds are characterised by vigorous growth and strong potential for regeneration [BEERLING et al., 1994; BÍMOVÁ et al., 2004; BROCK et al., 1995; BRADLEY et al., 2010; SOŁTYSIAK, BREJ, 2012; SUKOPP, STARFINGER, 1995; TOKARSKA-GUZIŁ et al., 2017]. They quickly colonize new habitats and in a short time can form large patches. By restricting access to light they prevent the growth and germination of native plant species. Allelopathic effects of knotweeds preventing the growth of other plants in their neighbourhood have also been reported [SHARMA et al., 2005; MORAVCOVÁ et al., 2011; VICHOTOVÁ, ŠERÁ, 2008].

The activities of KNP, aimed at eradicating the site of *R. japonica* from a field in Górkki purchased from a previous owner (as part of the LIFE + "ActiveKPN" project), proved to be effective, although they must be continued. The project ended in 2015, and work aimed at the eradication of knotweed were carried out at the cost of KNP and with the involvement of volunteers. Knotweed plants have been dug out 3-4 times a year. Expenses related to this work are each year earmarked in the budget of the Forest Fund of KNP (oral communication from the employees of KNP). Similar actions aimed at the elimination of sites of *R. japonica* have been carried out in two reserves of KNP – "Kaliszki" and "Zamczysko" (information from the management of KNP). These actions will be effective if work is done systematically, several times a year, until the invasive species is completely eliminated.

The experience of other researchers [TOKARSKA-GUZIŁ et al., 2012, 2017] shows that without substantial financial resources it is impossible to eradicate these very invasive *Reynoutria* plants. It is not enough to focus on the elimination of already existing numerous knotweed sites; it is necessary to prevent the formation of new ones. Large-scale campaigns are required to educate citizens, both local residents, who continue to grow knotweeds in their home gardens, and local authorities. The Regulation of the Minister of Environment [Dz. U. 2011 no. 210, item 1260] is not well known to the general public in Poland; this also applies to officials in villages, cities, municipalities and counties. Citizens are also not familiar with other reports commissioned by the General Directorate for Environmental Protection [TOKARSKA-GUZIŁ et al., 2012, 2017], which discuss in detail problems related to invasive species, including their eradication.

Many of the new sites of *Reynoutria* in the study area would not have been established if people had known methods of spreading knotweed and relevant services (and residents) had been informed about this. This applies both to the careless disposal of knotweed shoots removed from home gardens and cemeteries, and mowing roadsides as well as other places within the Park and its buffer zone. As a result of such activities, fragments of knotweed plants are introduced to various places, close or distant, or to local green waste dumps, and new populations of these plants are being established. In this way huge patches of *R. ×bohemica* have been formed in recent years near Adamówek, Łosia Wólka, and near the shopping centre in Łomianki. Each new site recorded during subsequent years of field research certainly has anthropogenic origin.

### Conclusions

Home gardens continue to be the major source of knotweed spread in the area of Kampinoska Forest (KNP and its buffer zone). The largest number of sites occupied by *Reynoutria* species was recorded near urban centres (Warsaw, Łomianki) in the north-eastern and eastern part of KNP, but also along the southern border of KNP, which is associated with the strong urbanization of this area: the concentration of villages, houses and home gardens is much greater here, and a well-developed network of roads and dense development promote the spread of knotweeds.

Although the distribution of knotweeds is largely limited to ruderal habitats, these invasive plants, especially *R. japonica* and *R. ×bohemica*, pose a threat to semi-natural and natural biocoenoses at KNP. On some of the sites, mainly those located inside the park, *R. japonica* occupies large areas and forms compact homogeneous populations.

Further efforts aimed at the eradication of sites of *Reynoutria* species from the area of Kampinos National Park and its close vicinity are necessary. It is advisable to constantly monitor the existing sites of knotweeds and prevent the formation of new ones. Therefore, large-scale campaigns aimed at educating citizens, both local residents and authorities, are required.



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### References

- ANDRZEJEWSKI R. (ed.) (2004). *Kampinoski Park Narodowy. Tom II. Przyroda Kampinoskiego Parku Narodowego*. Izabelin: Kampinoski Park Narodowy, 330 p. (in Polish)
- BALOGH L. (2008). Japanese, giant and Bohemian knotweed (*Fallopia japonica* (Houtt.) Ronse Decr., *F. sachalinensis* (Frdr. Schmidt) Ronse Decr. and *F. ×bohemica* (Chrtek et Chrtková) J. P. Bailey. In: Botta-Dukát Z., Balogh L. (eds). The most important invasive plants in Hungary. Vácrtót, Hungary: Institute of Ecology and Botany, Hungarian Academy of Sciences: ): 13–33.
- BOMANOWSKA A., FERCHMIN M, KIRPLUK I., OTRĘBA A. (2014). *Inwazyjne gatunki roślin we florze Puszczy Kampinoskiej*. In: Otręba A., Michalska-Hejduk D. (eds.). Inwazyjne gatunki roślin w Kampinoskim Parku Narodowym i w jego sąsiedztwie. Kampinoski Park Narodowy: 25–35. (in Polish)
- BEERLING D.J., BAILEY J.P., CONOLLY A.P. (1994). *Fallopia japonica* (Houtt.) Ronse Decraene (*Reynoutria japonica* Houtt.; *Polygonum cuspidatum* Sieb. Zucc.). *Journal of Ecology*, **82**: 959–979.
- BIMOVÁ K., MANDÁK B., KASPAROVA I. (2004). How does *Reynoutria* invasion fit the various theories of invisibility? *Journal of Vegetation Science*, **15**: 495–504.
- BRADLEY B.A., BLUMENTHAL D.M., WILCOVE D.S., ZISKA L.H. (2010). Predicting plant invasions in an era of global change. *Trends in Ecology and Evolution*, **25**: 310–318.
- BRAUN M., SCHINDLER S., ESSL F. (2016). Distribution and management of invasive alien plant species in protected areas in Central Europe. *J. Nat. Conserv.*, **33**: 48–57. doi: 10.1016/j.jnc.2016.07.002
- BROCK J.H., CHILD L.E., WAAL L.C., WADE M. (1995). *The invasive nature of Fallopia japonica is enhanced by vegetative regeneration from stem tissues*. In: Pyšek P., Prach K., Rejmánek M., Wade M. (eds.). Plant invasions: general aspects and special problems. Amsterdam: SPB Acad. Publ., 131–139.
- BURDA R.I., PASHKEVYCH N.A., BOIKO G.V., FITSAILO T.V. (2015). *Alien species of the protect florae of forest-steppe of Ukraine*. Kyiv: Naukova Dumka, 117 p.
- DAISIE European Invasive Alien Species Gateway (2006). *Fallopia japonica*. URL: [www.europealiens.org/speciesFactsheet.do?speciesId=8137](http://www.europealiens.org/speciesFactsheet.do?speciesId=8137) [22/11/2018].
- DUMITRAȘCU M., GRIGORESCU I., KUSCICSA G., DOROFTEI M., NĂSTASE M., DRAGOTĂ C-S. (2014). Invasive terrestrial plant species in the Romanian protected areas. A geographical approach. *Rev. Roum. Géogr./Rom. Journ. Geogr.*, **58** (2): 145–160.
- Dz.U. 2011 nr 210, poz. 1260. Rozporządzenie Ministra Środowiska z dnia 9 września 2011 r. w sprawie listy roślin i zwierząt gatunków obcych, które w przypadku uwolnienia do środowiska przyrodniczego mogą zagrozić gatunkom rodzimym lub siedliskom przyrodniczym. (in Polish)
- GLOBAL Invasive Species Database (2018) Species profile: *Polygonum cuspidatum*. URL: <http://www.iucngisd.org/gisd/speciesname/Polygonum+cuspidatum> [22/11/2018].
- HLAVATI ŠIRKA V., LAKUŠIĆ D., ŠINŽAR-SEKULIĆ J., TONI NIKOLIĆ T., JOVANOVIĆ S. (2013). *Reynoutria sachalinensis*: a new invasive species to the flora of Serbia and its distribution in SE Europe. *Botanica Serbica*, **37** (2): 105–112.
- HOLOBORODKO K.K., MARENKOV O.M., GORBAN V.A., VORONKOV Y.S. (2016). The problem of assessing the viability of invasive species in the conditions of the steppe zone of Ukraine. *Visn. Dnipropetr. Univ. Ser. Biol. Ekol.*, **24**(2): 466–472. doi:10.15421/011663
- JOVANOVIĆ S., HLAVATI-ŠIRKA V., LAKUŠIĆ D., JOGAN N., NIKOLIĆ T., ANASTASIU P., VLADIMIROV V., ŠINŽAR-SEKULIĆ J. (2018). *Reynoutria* niche modelling and protected area prioritization for restoration and protection from invasion: A Southeastern Europe case study. *Journal for Nature Conservation*, **41**: 1–15. doi: 10.1016/j.jnc.2017.10.011
- KIRPLUK I. (1996). Structure of ruderal floras in abandoned villages in the Kampinos Forest. In: Terpó A., Mochnacký S. (eds.). *II. Anthropization and environment of rural settlements. Flora and vegetation. Proceedings of International Conference. Tarczal-Tokaj, 1996*: 124–133.
- KIRPLUK I. (1998). Anthropophytes of ruderal sites in several villages in the Kampinos Forest. In: Mochnacký S., Terpó A. (eds.). *III. Anthropization and environment of rural settlements. Flora and vegetation. Proceedings of International Conference. Zemplinska Sirava, 1998*: 153–160.
- KIRPLUK I. (2003). *Antropofity siedlisk ruderalnych wsi puszczańskich Kampinoskiego Parku Narodowego*. In: Andrzejewski R. (ed). *Kampinoski Park Narodowy. Tom 1. Przyroda Kampinoskiego Parku Narodowego*. Kampinoski Park Narodowy, Izabelin: 275–283. (in Polish)
- KIRPLUK I. (2009). *Gatunki dziczejące z upraw w opuszczanych wsiach Kampinoskiego Parku Narodowego*. In: Andrzejewska A., Lubański A. (eds.). *Trwałość i efektywność ochrony przyrody w polskich parkach narodowych*. Kampinoski Park Narodowy, Izabelin: 237–245. (in Polish)

- KIRPLUK I. (2014). *Gatunki z rodzaju rdestowiec Reynoutria spp.* In: Otręba A., Michalska-Hejduk D. (eds.). Inwazyjne gatunki roślin w Kampinoskim Parku Narodowym i w jego sąsiedztwie. Kampinoski Park Narodowy, Izabelin: 60-65. (in Polish)
- KOBENDZA R. (1930). Stosunki fitosocjologiczne Puszczy Kampinoskiej. Materiały do flory polskiej. Warszawa: Planta Polonica 2, 201 p. (in Polish)
- MONACO A., GENOVESI P. (2014). *European Guidelines on Protected Areas and Invasive Alien Species*. Strasbourg: Council of Europe, Lazio Region, Rome: Regional Parks Agency, 58 p.
- MORAVCOVÁ L., PYŠEK P., JAROŠIK V., ZÁKRAVSKÝ P. (2011). Potential phytotoxic and shading effects of invasive *Fallopia* (Polygonaceae) taxa on the germination of native dominant species. *Neobiota*, **9**: 31-47.
- OTRĘBA A. (2008). Rozprzestrzenianie się obcych inwazyjnych gatunków roślin jako zagrożenie przyrody Kampinoskiego Parku Narodowego. *Dokumentacja Geograficzna*, **37**: 194-204. (in Polish)
- OTRĘBA A., MICHALSKA-HEJDUK D. (2014). *Metody zbioru i opisu danych*. In: Otręba A., Michalska-Hejduk D. (eds.). Inwazyjne gatunki roślin w Kampinoskim Parku Narodowym i w jego sąsiedztwie, Kampinoski Park Narodowy, Izabelin: 19-24. (in Polish)
- PASHKEVYCH N., BURDA R. (2017). Spread of alien plant species in the habitats of the Ukrainian Forest Steppe. *Ekologia (Bratislava)*, **36** (2): 121-129. doi :10.1515/eko-2017-0011
- PROTOPOPOVA V.V., SHEVERA M.V. (2014). Ergasiophytes of the Ukrainian flora. *Biodiv. Res. Conserv.*, **35**: 31-46. doi: 10.2478/biorc-2014-0018
- PROTOPOPOVA V.V., SHEVERA M.V., MOSYAKIN S.L. (2006). Deliberate and unintentional introduction of invasive weeds: A case study of the alien flora of Ukraine. *Euphytica*, **148**: 17-33. doi: 10.1007/s10681-006-5938-4
- PROTOPOPOVA V.V., SHEVERA M.V., ORLOV O.O., PANCHENKO S.M. (2015). The transformer species of the Ukrainian Polissya. *Biodiv. Res. Conserv.*, **39**: 7-18. doi: 10.1515/biorc-2015-0020
- PROTS B. (2013). Invasion success of alien plant species in the Carpathian region of Ukraine. *Biological systems (Біологічні системи)*, **5**(1): 116-121.
- SHARMA G.P., SINGH J.S., RAGHUBANSHI A.S. (2005). Plant invasion: emerging trends and future implications. *Current Science*, **88**: 726-734.
- SHEVERA M.V. (2017). *Reynoutria × bohemica* (Polygonaceae), a potentially invasive species of the Ukrainian flora. *Ukr. Bot. J.*, **74**(6): 548-555. (in Ukrainian) doi: 10.15407/ukrbotj74.06.548
- SÎRBU C., OPREA A. (2008). Two alien species in the spreading process in Romania: *Reynoutria x bohemica* Chrték & Chrtková and *Grindelia squarrosa* (Pursh) Dunal. *Cercetări Agronomice în Moldova*, **XLI**, 2(134): 41-50.
- SÎRBU C., OPREA A., SAMUIL C., TĂNASE C. (2012). Neophyte Invasion in Moldavia (Eastern Romania) in Different Habitat Types. *Folia Geobot.*, **47**: 215-229. doi: 10.1007/s12224-011-9112-y
- SOŁTYSIAK J., BREJ T. (2012). Characteristics that make the *Fallopia* genus (Polygonaceae) highly invasive. *Ecological Questions*, **16**: 23-27, doi: 10.2478/v10090-012-0002-6.
- SUDNIK-WÓJCIKOWSKA B., KOŹNIEWSKA B. (1988). *Słownik z zakresu synantropizacji szaty roślinnej*. Warszawa: WUW, 93 p. (in Polish)
- SUKOPP H., STARFINGER U. (1995). *Reynoutria sachalinensis*. In: Pyšek P., Prach K., Rejmánek M., Wade M. (eds.). Europe and in the Far East: a comparison of the species ecology in its native and adventive distribution range. In: Plant invasions: general aspects and special problems. Amsterdam: SPB Acad. Publ.: 151-159.
- THE Plant List (2013). Version 1.1. URL: <http://www.theplantlist.org/> [22/11/2018].
- TOKARSKA-GUZIŁ B., DAJDOK Z., ZAJĄC M., ZAJĄC A., URBISZ A., DANIELEWICZ W., HOŁDYŃSKI CZ. (2012). *Rośliny obcego pochodzenia w Polsce ze szczególnym uwzględnieniem gatunków inwazyjnych*. Warszawa: Generalna Dyrekcja Ochrony Środowiska, 197 p. (in Polish)
- TOKARSKA-GUZIŁ B., FOJCIK B., BZDEGA K., URBISZ A., NOWAK T., PASIERBIŃSKI A., DAJDOK Z. (2017). *Inwazyjne gatunki z rodzaju rdestowiec Reynoutria spp. w Polsce – biologia, ekologia i metody zwalczania*. Katowice: Wydawnictwo Uniwersytetu Śląskiego, 180 p. (in Polish)
- VICHOTOVÁ N., ŠERÁ B. (2008). Allopathic properties of knotweed rhizome extracts. *Plant Soil and Environment*, **54**: 301-303.

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