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Ecological study of invasive *Amorpha fruticosa* L. at research biological stations within Steppe zone, Ukraine

L.Karmyzova

Oles Honchar Dnipropetrovsk National University (Dnipropetrovsk, Ukraine)
linka_100@mail.ru

The article is devoted to ecological survey of invasive species *Amorpha fruticosa* L. in the conditions of the Prissamarsky Biosphere Station (downstream of Samara River, Dnieper basin) and the Dnieper-Orelesky Natural Reserve (the upper part of the Dnieper reservoir). Wide ecological range of *Amorpha* species was investigated. In the paper there are presented analyses of ecomorphes (climamorphes, trophomorphes, hygromorphes, geliomorphes and coenomorphes) and analysis of its spreading within native and urban habitats meeting the general European System of Habitats (EUNIS). Within the Prissamarsky Biosphere Station the obtained results for *A. fruticosa* ecological characteristics facilitate its analyses under urban conditions.

Key words: *Amorpha fruticosa*, research biological station, habitats, ecomorphes, ecological amplitude, floodplane, phytoinvasions.

Дослідження екології інвазійного виду *Amorpha fruticosa* L. на наукових стаціонарах Степу України

Л.О.Кармизова

Стаття присвячена дослідженню екології адвентивного інвазійного виду *Amorpha fruticosa* L. в умовах Присамарського біосферного стаціонару (нижня течія р. Самари дніпровської) і природного заповідника Дніпровсько-Орільського (верхня частина Запорізького (Дніпровського водосховища). Вивчена широка екологічна амплітуда поширення цього виду. Представлений аналіз екоморф: клімаморф, трофоморф, гігоморф, геліоморф і ценоморф, а також аналіз його поширення у природних та урбанізованих біотопах, який узгоджений із загальноприйнятою європейською системою біотопів EUNIS. Отримані дані екологічної характеристики *A. fruticosa* в умовах стаціонарів сприяють вивченню біотопічної приуроченості в умовах великого мегаполісу.

Ключові слова: аморфа чагарникова, науковий стаціонар, біотопи, екоморфи, екологічна амплітуда, заплава, фітоінвазії.

Исследования экологии инвазийного вида *Amorpha fruticosa* L. на научных стационарах Степи Украины

Л.А.Кармызова

Статья посвящена исследованию экологии адвентивного инвазийного вида *Amorpha fruticosa* L. в условиях Присамарского биосферного стационара (нижнее течение р. Самары днепроvской) и природного заповедника Днепроvско-Орельского (верхняя часть Запорожского (Днепроvского) водохранилища). Изучена широкая экологическая амплитуда распространения этого вида. Представлен анализ экоморф: климаморф, трофоморф, гигоморф, гелиоморф и ценоморф, а также анализ его распространения в природных и урбанизированных биотопах, который согласован с общепринятой европейской системой биотопов EUNIS. Полученные данные экологической характеристики *A. fruticosa* в условиях стационаров способствуют изучению биотопической приуроченности в условиях крупного мегаполиса.

Ключевые слова: аморфа кустарниковая, научный стационар, биотопы, экоморфы, экологическая амплитуда, пойма, фитоинвазии.

Introduction

Amorpha fruticosa L. is an adventive and widespread species of Fabaceae family (which includes 15 species of deciduous shrubs), growing in the temperate regions of North America. At present the native habitat of *A. fruticosa* within USA are North Carolina, Indiana, Iowa, Missouri, Nebraska, Kansas (Sokolov, Shipchinski, 1958). Introduced *A. fruticosa* is known since 1724, when it was brought to England as an ornamental plant. In early twentieth *Amorpha fruticosa* spread in continental Europe with a tendency to

savagery. In the Russian Empire *A. fruticosa* firstly appeared in 1796 in St.-Petersburg Botanical Garden (Sviaseva, 2005).

Currently *A. fruticosa* occurs in Canada, in the Ontario and Quebec Provincial Parks (Scoggan, 1978), in Mexico, Iraq, Pakistan, Japan, China and Korea (in the last two countries it is quite rare), and in the eastern Turkey. It is naturalized in many countries of Central and Southern Europe (Ball, 1968). The first information about naturalized *A. fruticosa* findings appeared since 1940–1950 for Danube and Tisza river valleys (Hungary). Pasture reducing and abandoned floodplain farmlands made a contribution to its naturalization. This process does not stop at the present time. The specimen of *A. fruticosa* usually spreads within meadows and river valleys (Szigetvari, Toth, 2008).

Since 1809 *A. fruticosa* spread in Ukraine, when its cultivation began in V.N.Karazin Botanical Garden, Kharkov region (Burda, Ignatyuk, 2012), and since 1811 it was cultivated in Botanical Garden of Kremenetsky (Lypa, 1952). In the twentieth century shrubs of *Amorpha fruticosa* were naturalized in Ukraine, especially in the late 40–50th of the twentieth century due to the total creation of shelterbelts and other plantations.

A. fruticosa was grown in Yekaterynoslav gardens at the end of the XVIII century according to I.Akinfiev (1889). By the late XX century it has been extended to different habitats in different types of landscapes of Steppe Dnieper region (Baranovsky, 1998; Baranovsky et al., 2008).

Objects and methods

The object of survey is adventive invasive species *A. fruticosa*. Shrubs of this species were identified within territories of the Prsamarsky Biosphere Station and the Dnieper-Orelsky Natural Reserve, Dnipropetrovsky region. *A. fruticosa* ecomorphical analysis had been conducted according to the A.L.Belgard's ecomorph system (1950, 1980). Biotopical analysis was accorded with the Common European System of Habitats EUNIS (European Nature Information System, 1996). It is all-purpose system within Europe to accord botanical descriptions and data collection to the criteria of habitat identifying. This classification includes wide range of habitat types, from native to artificial, terrestrial, freshwater and marine.

Of note the EUNIS classification is not quite adapted in Ukraine, but it is well-adapted to the European countries nearest to Ukraine: Czech Republic, Slovakia, Romania, Hungary, Germany, Poland; some individual items are developed concretely (Didukh, Aleshkina, 2012).

On the data basis the species range was considered in the Station conditions, which allows providing environmental characteristics of this type and adapting these ranges to urban conditions.

Results and discussion

According to scientific sources, *A. fruticosa* habitats are forest plantations, orchards and parks, coastal and floodplain sites, river banks, marginals, forests, meadows, and it is cultivated in nurseries (Akinfiev, 1889; Vascular plants..., 1987; Flora..., 1987; Gorelova, Alekhin, 1999). In the conditions of Yekaterynoslav gardens *A. fruticosa* was cultivated since the end of the XIX century (Akinfiev, 1889) and since the end of the XX century it was extended in different types of Steppe Dnieper region, firstly in the Dnieper River valley. Because a lot of environmental factors, intensive breeding, rapid growth due to dense root system (recovering actively after regular cutting) and wide ecological amplitude, *A. fruticosa* spread totally within native plant communities (Baranovsky, 1998).

Thus *A. fruticosa* is eurytopic species with wide range of distribution. In different landscapes of the Biological Station there were identified the habitats which *A. fruticosa* grows on. Vegetation regime and survey of ecotope adaptation allow making ecomorphical analysis.

Around the Prsamarsky Biosphere Station (downstream of Samara Dnieper River), watershed-gulley landscape and valley-terraced landscape with terrace system (floodplain terrace (short-term flooding conditions), arena and saline terraces) are situated (Belgard, 1950). In the conditions of watershed-gulley landscape shrubby *Amorpha* is not spread widely in shelterbelts (as underwood, more often on marginals), and almost has no tendencies to migration (Ivanko, 2013). In the valley-terraced landscape it occurs within the Samara River floodplain and feeders, on border of floodplain and sandy terrace and on sandy terrace.

In the Dnieper-Orelsky Natural Reserve Nature Reserve (the upper part of the Zaporizhzhya reservoir), valleys-terraced landscape has typically first terrace (floodplain, middle floodplane with flooding by reservoir water), second (sandy terrace) and third (saline) terraces (Belgard, 1950). In the conditions of Dnieper floodplain *A. fruticosa* frames water banks at all eco-topographical sites (especially on native levee), forms underwood of willow-stands and black poplar stands, and it formes thickets on sandy terrace

subsidences (Baranovsky, 1998; Baranovsky et al., 2011). From Yekaterynoslav *A. fruticosa* spread gradually into different habitats, firstly to the Dnieper River valley and then along feeder banks.

In accordance with Belgard ecomorphs system (1950, 1980) and typology-ecological surveys at the Biological Stations *A. fruticosa* has a range of illumination from heliophyte to helio-sciophyte habitats (from margin to underwood). In accordance with R.I Burda and A.A.Ignatyuk (2012) illumination low than 15% of total illumination is critical for *Amorpha* reproduction. Such illumination conditions inhibit *A. fruticosa* generation function (Burda, Ignatyuk, 2012). That is why in floodplain forest with low illumination *A. fruticosa* scrubs do not occur.

Moisture regime of *A. fruticosa* was varied from xerophylic to ultrahygrophilic.

A. fruticosa vegetates on sandy soils and can be found on the black soils and loamy soils.

In the Biological Station conditions habitat characteristics are studied sufficiently, and can be accorded with analogical habitats of the EUNIS classification. It also allows transferring the "classic" (in the biological station) habitats to another territory, including metropolis conditions.

According to EUNIS classification *A. fruticosa* is a part of many ecosystems (table 1) and it forms separate habitats (Didukh, Aleshkina, 2012).

Table 1.

Habitats by EUNIS

EUNIS code	EUNIS name	In the Stations conditions	In the urban conditions
(C)	Inland surface waters		
(C1)	Surface standing waters		
C1.63	Eutrophic temporary waters	+	+
(C2)	Surface running waters		
C2.34	Eutrophic vegetation of slow-flowing rivers	+	
(C3)	Littoral zone of inland surface waterbodies		
C3.2	Water-fringing reedbeds and tall helophytes other than canes		
C3.21	<i>Phragmites australis</i> beds	+	+
C3.23	<i>Typha</i> beds	+	+
C3.5	Periodically inundated shores with pioneer and ephemeral vegetation	+	
C3.61	Unvegetated river sand banks	+	+
(D)	Mires, bogs and fens		
D5	Sedge and reedbeds, normally without free-standing water		
D5.11	<i>Phragmites australis</i> beds normally without free-standing water	+	
D5.13	<i>Typha</i> beds normally without free-standing water	+	
D5.2121	Slender tufted sedge beds (<i>Carex acuta</i>)	+	
D5.213	Greater pond sedge beds (<i>Carex riparia</i>)	+	
(E)	Grasslands and lands dominated by forbs, mosses or lichens		
E5.21	Xero-thermophile fringes	+	
(F)	Heathland, scrub and tundra		
F9	Riverine and fen scrubs		
F9.128	Continental riverine willow scrub	+	
F9.35	Riparian stands of invasive shrubs	+	
FB	Shrub plantations		
FB.32	Ornamental shrub plantations		+
(G)	Woodland, forest and other wooded land		
G1	Broadleaved deciduous woodland	+	+
G1.1	Riparian and gallery woodland, with dominant <i>Alnus</i> , <i>Betula</i> , <i>Populus</i> or <i>Salix</i>	+	+
G1.111	Middle European <i>Salix alba</i> forests	+	+
G1.1112	Eastern European poplar-willow forests	+	+

G1.2	Mixed riparian floodplain and gallery woodland		
G1.225	Sarmatic riverine <i>Quercus</i> forests	+	
G1.A	Meso- and eutrophic <i>Quercus</i> , <i>Carpinus</i> , <i>Fraxinus</i> , <i>Acer</i> , <i>Tilia</i> , <i>Ulmus</i> and related woodland	+	
G1.C	Highly artificial broadleaved deciduous forestry plantations		
G1.C3	<i>Robinia</i> plantations	+	+
G3	Coniferous woodland		
G3.4	<i>Pinus sylvestris</i> woodland south of the taiga	+	
G3.4232	Sarmatic steppe <i>Pinus sylvestris</i> forests	+	
G3. F	Highly artificial coniferous plantations		
G3. F1	Native conifer plantations	+	+
G3. F12	Native pine plantations		+
G5	Forest belts, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice		+
G5.7	Coppice and early-stage plantations		
G5.71	Coppice	+	+
(I)	Regularly or recently cultivated agricultural, horticultural and domestic habitats		
I2	Cultivated areas of gardens and parks		+
(J)	Constructed, industrial and other artificial habitats		
J1	Buildings of cities, towns and villages		+
J1.5	Disused constructions of cities, towns and villages		+
J4	Transport networks and other constructed hard-surfaced areas		
J4.2	Road networks		+
J5	Highly artificial man-made waters and associated structures		+
J6	Tips, landfill sites and slurries produced as byproducts, usually unwanted, of human activity		+
G3	Coniferous woodland		
G3.4	<i>Pinus sylvestris</i> woodland south of the Taiga	+	
G3.4232	Sarmatic steppe <i>Pinus sylvestris</i> forests	+	
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J4.2	Road networks		+
J5	Highly artificial man-made waters and associated structures		+
J6	Tips, landfill sites and slurries produced as byproducts, usually unwanted, of human activity		+

The table shows that *A. fruticosa* spreads in many native habitats in the Biological Stations conditions. In the urban conditions it is represented less.

In accordance with the monograph by V.Tarasov (2005), ecological characteristic of *A. fruticosa* is shown by A.L.Belgard ecomorphs systems: as life form: phanerophyte (Ph), tropical type – oligo-

megatrophic (OgMgTr), in relation to moisture – mesoxerophyte (MsX), in relation to illumination – sciopheliophyte (ScHe), as coenomorphe – rudero-silvant (RuSil).

Because *A. fruticosa* is an eurytopic species, its ecomorph ecological characteristics were represented as following range: climaregime – Ph, tropical type from OgTr to MgTr, in relation to moisture – MsX-UHg, in relation to illumination – He-HeSc, as coenomorphe – CulRuSil.

Phytoviasion is a spread of invasive alien species. *A. fruticosa* is a typical representative of this settlement. Especially this species threatens the biodiversity of valley terraced habitats.

At present there are no universal ways to prevent the aggression of *A. fruticosa* invasion. Development of measures to prevent biological invasions and their consequences can also be elaborated by Research Station staff.

References

- Akinfiyev I.Y. Vegetation of Ekaterinoslav at the end of the first century of its existence. – Ekaterinoslav: typography named N.I.Pavlovsky, 1889. – P.238 (in Russian).
- Ball P.W. *Amorpha* L. // *Flora Europaea*. – 1968. – Vol.2. – P.127.
- Baranovsky B.A. *Amorpha* shrub distribution within the Dnieper river floodplain in the cascade conditions // *Issues on steppe forestry and forest reclamation of soils*. – Dnepropetrovsk: DNU, 1998. – Issue 2. – P. 147–151. (in Russian).
- Baranovsky B.A., Ivanko I.A., Aleksandrov A.A., Voloshina N.O. Anthropogenic transformation of the flora in large rivers valleys within the metropolis // *Live objects in conditions of anthropogenic pressure. Proceedings of the X International Research/Practice Ecological Conference*. – Belgorod, 2008. – P.17. (in Russian).
- Baranovsky B.A., Ivanko I.A., Karmyzova L.A., Yevtushenko T.M. Long-term dynamics of the Dnieper arena flora within Dnepropetrovsk // *Issues on steppe forestry and forest reclamation of soils*. – Dnepropetrovsk: DNU, 2011. – Iss.40. – P. 30–40. (in Russian).
- Belgard A.L. Forest vegetation of South-East part of the USSR. – Kyiv: KSU, 1950. – 258p. (in Russian).
- Belgard A.L. To the ecological analysis and structure of Steppe forest communities // *Issues on biological diagnostics of forest biogeocenoses in Prisamarya*. – Dnepropetrovsk: DNU, 1980. – P. 12–43. (in Russian).
- Burda R.I., Ignatyuk A.A. Reproductive effort importance in the man-made migration process of *Amorpha fruticosa* (Fabaceae) // *Ecosystems, their protection and optimization*. – 2012. – Vol.7. – P. 198–208. (in Russian).
- Didukh Y.P., Aleshkina U.N. The biotopes of the Kiev city. – K.: NaUKMA, Agrar. Media Group, 2012. – 163p. (in Ukrainian).
- Flora of the European part of the USSR / Edited by A.A.Fedorov. – Leningrad: Nauka, 1974–1987. – Vol.VI. – P.33. (in Russian).
- Gorelova, L.N., Alekhin A.A. Rare plants of Kharkov region. – Kharkiv: KNU, 1999. – 54p. (in Russian).
- Ivanko I.A. Characteristic of species composition in man-made forests of Dnieper Prisamarya // *Issues on steppe forestry and forest reclamation of soils*. – Dnepropetrovsk: DNU, 2013. – Vol.42. – P. 29–36. (in Ukrainian).
- Lyra A.L. Arboretum flora of Ukrainian SSR and its use // *Planting of settlements*. – K.: Architecture Academy of the USSR, 1952. – P. 9–52. (in Russian).
- Scoggan H.J. The flora of Canada. Part 3: Ottawa: National Museums of Canada. – 1978. – P. 973–974.
- Sokolov S.Y., Shipchinski N.V. False indigo – *Amorpha* L. // *Trees and shrubs of the USSR*. – M.; L.: Academy of Science of the USSR, 1958. – Vol.4. – P. 135–140. (in Russian).
- Sviازهva O.A. Trees, shrubs and vines of Botanical gardens (V.L.Komarov Botanical Institute). – SPb.: Rostock, 2005. – 384p. (in Russian).
- Szigetvari Cs., Toth T. False indigo (*A. fruticosa*) // *The most important invasive plants in Hungary* / Ed. by Z.Botta-Ducati, L.Balogh. – Vacratot: Institute of Ecol. and Bot., Hung. Acad. of Sci., 2008. – P. 55–61.
- Tarasov V.V. Flora of Dnipropetrovsk and Zaporizhzhya regions. Vascular plants. Biological and ecological characteristics of species. – D: Publishing house of DNU, 2005. – 276p. (in Ukrainian).
- Vascular plants of Ukraine. – K.: Naukova dumka, 1987. – 548p. (in Russian).

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