

Ecological impact of phytoinvasions in Ukraine

V.V. Konishchuk¹, I.V. Solomakha¹, O.V. Mudrak^{*2}, H.V. Mudrak³, O.B. Khodyn⁴

¹Institute of Agroecology and Environmental Management NAAS of Ukraine, 12 Metrolohichna St., Kyiv, 03143, Ukraine,

²Vinnitsia Academy of Continuing Education, 13 Hrushevskiyi St., Vinnitsia, 21050, Ukraine,

³Vinnitsia National Agrarian University, 3 Soniachna st., Vinnitsia, 21008, Ukraine,

⁴Natural reserve "Medobory", 21 Mitskevycha St., Hrymailiv, Ternopil'ska oblast, 48210, Ukraine

*Corresponding author E-mail: ov_mudrak@ukr.net

Received: 02.06.2020. Accepted: 12.07.2020

By the decision of the United Nations Conference on non-native species (Trondheim, Norway, 1996), an obligation was made to conduct comprehensive studies of adventitious plants, animals and microorganisms, to develop regional strategies to control their introduction and distribution. The ecological problem of the expansion of advents has the second place in the conservation of biota after the destruction of ecotops of their existence. An interdepartmental working group on invasive alien species has been established at the Ministry of Ecology and Natural Resources of Ukraine. The list of invasive species of flora of Ukraine is discussed and includes from 40 to 100 species (*Acer negundo* L., *Ambrosia artemisiifolia* L., *Amorfa fruticosa* L., *Asclepias syriaca* L., *Azolla caroliniana* Willd., *Cenchrus longispinus* (Hack.) Fernald, *Conyza canadensis* (L.) Cronq., *Echinocystis lobata* (Michx.) Torr. et A. Gray, *Elaeagnus angustifolia* L., *Elodea canadensis* Michx., *Padus serotina* (Ehrh.) Ag., *Quercus rubra* L., *Fallopia sachalinensis* (F. Schmidt) Ronse Decr., *Robinia pseudoacacia* L., *Solidago canadensis* L., etc.). There are 215 species with highly invasive ability in total, of North American and Asian origin. Environmental hazards are quarantine, allergenic plants, transforming species that transform the local landscapes. A feature of invasive plants is their high adaptation, performance, intensive distribution, competition. Therefore, the environmental effects of phytoinvasions are very significant, especially for protected areas. Aboriginal vegetation cover varies, rare local species displaced. The most vulnerable are aquatic ecosystems, meadows, steppes, forests, coastal coasts. Less phytoinvasions in mountain regions (Carpathians, Crimea), sphagnum bogs (Polissia). Thus, given the high environmental risks of phytoinvasions, it is necessary to develop a strategy for invasive adventitious species of Ukraine. Priority measures relate to the prevention of spread, eradication, control and monitoring of phytoinvasions.

Key words: Alien plants; Invasions; Ecology Safety; Ukraine

Introduction

One of the priority tasks of biodiversity conservation is to conduct comprehensive studies of random plants, animals and microorganisms, control their introduction and distribution. The environmental problem of advent expansion currently ranks second in the world in biota conservation after the destruction of ecotopes of their existence (Mudrak, 2012-2013; Nagorniuk, Mudrak, 2017). The Global Strategy on Invasive Alien Species is based on contributions from the team leaders of the eleven main components addressed under Phase I of the Global Invasive Species Programme. This strategy summarizes key findings of the Phase I Synthesis Conference held September 2000 in Cape Town, Republic of South Africa and presents ten strategic responses that address mitigating the threats of invasive alien species. Directed toward the decision-makers whose policies and practices are affecting the movement of species around the world, this Strategy strives to provide a resource to increase awareness and provide policy advice. GISP has produced other volumes for more specialized audiences; these volumes provide detailed information and guidance to those interested (McNeely et al., 2001).

The ecological problem of the advents expansion is in the second place of the biota conservation after the destruction of ecotops of their existence. Article 8 (h) Parties to "prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species" (Convention on Biological Diversity). The characteristics alien plants in Ukraine: adaptation to the different conditions of the environment; active distribution (antropo-, zoochory); good vegetation growing, reproduction, independence from the mutualist; the stability of the seeds reserves; the role of the life strategy. The causes of the phytoinvasions are different: introduction, transport, accidental settlement, migration from botanical gardens, agriculture, forestry and water management and etc. The hypothesis phytoinvasions: Enemy Release, Escape from Enemies, Evolution of Increased Competitive Ability, Novel Weapon (Blossey and Nötzold, 1995). The barriers: geographical, ecological, reproductive, distribution, coenoses (Kennedy & al., 2002). Phytoinvasions are the special type of the biological contamination. More than 1000 of adventives species are listed in the Ukrainian flora now. Nowadays a lot of scientists are studying the phytoinvasions in Ukraine, namey V.V. Protopopova, R.I. Burda, S.L. Mosyakin, A.S. Mosyakin, M.V. Shevera, O.S. Abduloeva, O.O. Ivashchenko, B.H. Prots, L.B. Zub, L.V. Zavalova, N.A. Pashkevych, B.I. Vychor, M.S. Prokopuk, and V.V. Konishchuk.

There are different groups of invasive plants in Ukraine:

a) Species from the Europe, good naturalized, in stage of the expansions: *Acer negundo* L., *Acroptilon repens* (L.) DC. (quarantine), *Ailanthus altissima* (Mill.) Swingle, *Ambrosia artemisiifolia* L. (quarantine), *Amorpha fruticosa* L., *Azolla filliculoides* Lam., *Bidens frondosa* L., *Cenchrus longispinus* (Hack.) Fernald. (quarantine), *Echinocystis lobata* (Michx.) Torr. et A. Gray., *Grindelia squarrosa*

(Pursh.) Dunal., *Helianthus tuberosus* L., *Heracleum mantegazzianum* Sommier et Levier, *Iva xanthiifolia* Nut., *Padus serotina* (Ehrh.) Ag., *Fallopia sachalinensis* (F. Schmidt) Ronse Decr., *F. japonica* (Houtt.) Ronse Decr., *Solidago canadensis* L.

b) Species with the broader ecological amplitude: *Elodea canadensis* Michx., *Elodea nuttallii* (Planch.) St. John., *Impatiens glandulifera* Royle, *Fallopia x bohémica* (Chrtk et Chrtkova) J. P. Bailey, *Robinia pseudoacacia* L., *Solidago serotinoidea* A. L. et D. L.

c) Local, naturalized species: *Amaranthus albus* L., *A. retroflexus* L., *Anisantha tectorum* (L.) Nevski, *Artemisia annua* L., *Asclepias syriaca* L., *Azolla caroliniana* Willd., *Cannabis ruderalis* Janisch., *Cardaria draba* (L.) Desv., *Centaurea diffusa* Lam., *Coryza canadensis* (L.) Cronq., *Cuscuta campestris* Yunck. (quarantine), *Elaeagnus angustifolia* L., *Galinsoga ciliata* (Rafin) Blake, *Impatiens parviflora* DC., *Xanthium albinum* (Widder) H. Scholz.

The origin of the invasive plants species in Ukraine are North America (the south-east, north-east, orient), East Asia (Japan, Korea, China), tropical and subtropical America, Caucasia, and the Middle East.

An interdepartmental working group on invasive alien species has been established at the Ministry of Ecology and Natural Resources of Ukraine (Kyiv, January 16, 2019).

In 2019, the National Strategy on Invasive Alien Species of Flora and Fauna in Ukraine for the period up to 2030 was developed. But, unfortunately, the lists of invasive plants and animals have not yet been officially adjusted and finally not approved. Only quarantine species have a legal status (the List of Regulated Pests, approved by the order of the Ministry of Agrarian Policy and Food of Ukraine dated August 4, 2010 No. 467 "On Amendments to the List of regulated Pests". Measures in accordance with the Law of Ukraine "On Plants Quarantine" are being held).

Material and Methods

In the deductive approach to perception of the scientific problem of phytointvasion analysis and synthesis have been used. Typical environmental, botanical, geobotanical research methods have been applied. A bibliographic review of classical and recent international and Ukrainian sources have been conducted (Elton, 1958; Callaway, 2000; Mooney and Cleland, 2001; Rejmanek et al., 2005; Foxcroft et al., 2013; Protopopova et al., 2003; Burda et al., 2015; Konishchuk et al., 2016-2020). The provisions of international conventions and strategies (Convention on Biological Diversity; European Strategy on Invasive Alien Species; Heywood and Sharrock, 2013; Ivashchenko and Burda, 2014), the current legislation, and the Ukrainian regulatory framework have been taken into account.

Definitions, terms and concepts have been used in accordance with international practice (Richardson & al., 2000). The Latin names of plants are indicated according to generally accepted systematics (Mosyakin, Fedoronchuk, 1999) and a Web resource The International Plant Names Index (<http://www.ipni.org/>).

Results and Discussion

Decision No. 1143/2014 of the European Parliament of 22th October 2014 on the prevention and management of the introduction and spread of invasive alien species approved the requirements for risk assessment, procedures for the prevention of penetration of such species into the territory of the EU, the rapid identification and removal of new invasive alien species, the management of species that are already widespread in the EU, the responsibility of individual countries and civic engagement, etc. This document states that 12000 alien species are distributed in the European region, 10-15% of which exhibit invasive properties. The List of Invasive Alien Species for EU countries was agreed (Regulation (EU) 2016/1141).

The National Strategy on Invasive Alien Species of Flora and Fauna in Ukraine for the period up to 2030 was developed in Ukraine. Prevention of the invasive alien species spread and control of the introduction of such species into natural ecosystems, including marine ones, is one of the tasks of the Basic Principles (Strategy) of the State Environmental Policy of Ukraine for the period up to 2030, approved by the Law of Ukraine of February 28, 2019, No. 2697 / VIII. There are 830 (~1000) plant species in Ukraine that are considered alien (adventitious), 85 of which are highly invasive. Phytointvasions have a significant negative impact on the natural environment, as well as involve a loss in agriculture, forestry, waterworks systems, fisheries, tourism and recreation. The harm to people's health from individual invasive, quarantine plants, as well as allelopathic effects on local indigenous flora has been proved (Hiero, 2003). In addition to biotic contamination and landscapes transformation phytointvasions violates the ecosystems structure, changes natural successions, promote the spread of diseases. Therefore, the purpose of the National Strategy is to improve the state environmental policy in order to prevent penetration and control of the introduction of invasive alien species into natural ecosystems, eliminate and mitigate (minimize) the adverse effects of such species. The priority measures of the Strategy implementation are: scientific and experimental research; development of criteria for an invasive status designation for a species; creating a list of invasive species; database of invasive alien species by taxonomic groups; guidelines; information and educational campaigns; educational programs; information exchange; inclusion into state strategic documents; formation of the regulatory base; approving methods; updating the quarantine list; approving the criteria of invasive species and assessing their impact; approval of the list; development and approval of action plans; measures in the objects of the nature reserve fund; definition of responsible executors. Therefore, it is necessary to develop and approve the National Action Plan for the implementation of the National Strategy.

An annotated list of Ukrainian adventitious plant species with high invasive capacity was first developed in 2003 (Protopopova et al., 2003). The list included plant species with a high naturalization level, which showed biogeographic and cenotic activity. 27 species were assigned to archeophytes, and 58 – to neophytes. At the meeting of the Interdepartmental Working Group on Invasive Alien Species under the Ministry of Ecology and Natural Resources of Ukraine, the feasibility of 40-70 plant species listing as Invasive was discussed. The final version of the list was not agreed. However, the consensus of inappropriate inclusion of naturalized widespread archeophytes, some ruderal, segetal, residential, annual plant species was found.

100 invasive alien species of vascular plants, the most harmful for phytodiversity on the protected areas of national importance of Ukraine, are given as a brief compendium of three lists: Black (17), Grey (50) and Watch (33) (Zavialova, 2017). However, some suggested species are not appropriate to be included in the National List.

Local invasive species should be considered separately. The list of 31 invasive plants for the Transcarpathian region of Ukraine was approved by the Regional Council decision (Shevera & al., 2017). Quarantine, allergenic, aggressively distributed plant species call for special attention. Taking into account the literature data as well as our own expeditionary and experimental research, we provide a refined Ukrainian Invasive Alien Plants List (Table 1). The List includes 215 species of 66 families. From the main invasive

species of Ukraine, 10 families prevail: *Asteraceae*, *Poaceae*, *Rosaceae*, *Brassicaceae*, *Fabaceae*, *Scrophulariaceae*, *Apiaceae*, *Amaranthaceae*, *Hydrocharitaceae*, and *Tiliaceae* – 122 species (57%).

Other others include 93 (43%) species (Figure 1).

Table 1. Ukrainian Invasive Alien Plants List.

№	FAMILY	Species	total
1	<i>Acoraceae</i>	<i>Acorus calamus</i> L.	1
2	<i>Amaranthaceae</i>	<i>Amaranthus albus</i> L., <i>A. blitoides</i> S. Watson, <i>A. powellii</i> S. Watson, <i>A. retroflexus</i> L.	4
3	<i>Anacardiaceae</i>	<i>Cotinus coggygria</i> Scop.	1
4	<i>Apiaceae</i>	<i>Bupleurum fruticosum</i> L., <i>Conium maculatum</i> L., <i>Heracleum mantegazzianum</i> Sommier et Levier, <i>H. sosnowskyi</i> Manden.	4
5	<i>Araceae</i>	<i>Pistia stratiotes</i> L.	1
6	<i>Aristolochiales</i>	<i>Aristolochia clematis</i> L.	1
7	<i>Asclepiadaceae</i>	<i>Asclepias syriaca</i> L.	1
8	<i>Asteraceae</i>	<i>Acroptilon repens</i> (L.) DC., <i>Ambrosia artemisifolia</i> L., <i>Anthemis arvensis</i> L., <i>A. cotula</i> L., <i>Artemisia annua</i> L., <i>A. verlotiorum</i> Lamotte, <i>Bidens frondosa</i> L., <i>Carduus acanthoides</i> L., <i>C. nutans</i> L., <i>Centaurea diffusa</i> Lam., <i>C. solstitialis</i> L., <i>Cyclachaena xanthifolia</i> (Nutt.) Freser, <i>Conyza canadensis</i> (L.) Cronqist, <i>Centaurea diffusa</i> Lam., <i>Cichorium intybus</i> L., <i>Conyzanthus graminifolius</i> (Spreng.) Tamamsch., <i>Erechtites hieracifolia</i> (L.) Raf., <i>Erigeron annuus</i> (L.) Desf., <i>Galinsoga ciliata</i> (Rafin) Blake, <i>G. quadriradiata</i> Ruiz et Pav., <i>Gaillardia pulchella</i> Foug., <i>Glebionis coronaria</i> (L.) Cass. ex Spach., <i>Grindelia squarrosa</i> (Pursh) Dunal, <i>Helianthus annuus</i> L., <i>H. tuberosus</i> L., <i>H. subcanescens</i> (A. Gray) E. Watson, <i>Helianthus x laetiflorus</i> Pers., <i>Heliopsis helianthoides</i> (L.) Sweet, <i>Iva xanthifolia</i> Nut., <i>Lactuca serriola</i> L., <i>Onopordum acanthium</i> L., <i>Phalacrocoma annuum</i> (L.) Dumort., <i>P. septentrionale</i> (Fernald et Wiegand) Wagenitz, <i>P. strigosum</i> (Muehl. ex Willd.) Tzvelev, <i>Senecio cineraria</i> DC., <i>S. tataricus</i> Less., <i>S. viscosus</i> L., <i>S. vulgaris</i> L., <i>Silphium perfoliatum</i> L., <i>Sonchus arvensis</i> L., <i>S. oleraceus</i> L., <i>S. asper</i> (L.) Hill, <i>Symphotrichum x salignum</i> (Willd.) Nesom, <i>Symphotrichum ciliatum</i> (Ledeb.) Nesom, <i>S. novae-angliae</i> (L.) Nesom, <i>S. novi-belgii</i> (L.) Nesom, <i>Solidago gigantea</i> Aiton, <i>S. canadensis</i> L., <i>S. serotinoidea</i> A. L. et D. L., <i>Verbesina encelioides</i> (Cav.) Benth. et Hook. ex A. Gray, <i>Xanthium albinum</i> (Widder) Scholtz et Sukopp, <i>X. italicum</i> Miretti, <i>X. pensylvanicum</i> Wallr., <i>X. spinosum</i> L., <i>X. strumarium</i> L.	55
9	<i>Azollaceae</i>	<i>Azolla caroliniana</i> Willd., <i>A. filliculoides</i> Lam.	2
10	<i>Balsaminaceae</i>	<i>Impatiens glandulifera</i> Royle, <i>I. parviflora</i> DC.	2
11	<i>Boraginaceae</i>	<i>Anchusa officinalis</i> L.	1
12	<i>Brassicaceae</i>	<i>Brassica campestris</i> L., <i>B. napus</i> L., <i>Bunias orientalis</i> L., <i>Cardaria draba</i> (L.) Desv., <i>Capsella bursa-pastoris</i> (L.) Medik., <i>Lepidium densiflorum</i> Scharad., <i>L. draba</i> L., <i>L. ruderale</i> L., <i>Sinapis arvensis</i> L., <i>Sisymbrium loeselii</i> L., <i>S. volgense</i> M. Bieb. ex Fourn.	11
13	<i>Buddlejaceae</i>	<i>Buddleja davidii</i> Franch.	1
14	<i>Cactaceae</i>	<i>Opuntia engelmannii</i> Salm-Dyck subsp. <i>lindheimeri</i> (Engelm.) U. Guzman et Mandujano (<i>O. lindheimeri</i> Engelm.), <i>O. humifusa</i> Raf	2
15	<i>Caesalpiniaceae</i>	<i>Cercis siliquastrum</i> L., <i>Gleditsia triacanthos</i> L.	2
16	<i>Cannabaceae</i>	<i>Cannabis sativa</i> L., <i>C. ruderalis</i> Janisch.	2
17	<i>Caprifoliaceae</i>	<i>Lonicera etrusca</i> Santi, <i>Symphoricarpos albus</i> (L.) S. F. Blake, <i>Viburnum tinus</i> L.	3
18	<i>Caryophyllaceae</i>	<i>Saponaria officinalis</i> L.	1
19	<i>Celastraceae</i>	<i>Celastrus orbiculatus</i> Thunb., <i>C. scandens</i> L.	2
20	<i>Chenopodiaceae</i>	<i>Chenopodium album</i> L., <i>Kochia scoparia</i> (L.) Schrad., <i>Salsola tragus</i> L.	3
21	<i>Combretaceae</i>	<i>Rudbeckia hirta</i> L., <i>R. laciniata</i> L.	2
22	<i>Crassulaceae</i>	<i>Petrosedum rupestre</i> (L.) P.V. Heath	1
23	<i>Cucurbitaceae</i>	<i>Bryonia alba</i> L., <i>Echinocystis lobata</i> (Michx.) Torr. et A. Gray, <i>Thaladiantha dubia</i> Bunge	3
24	<i>Cuscutaceae</i>	<i>Cuscuta campestris</i> Yunck., <i>C. cesatiana</i> Bertol.,	2
25	<i>Elaeagnaceae</i>	<i>Elaeagnus angustifolia</i> L., <i>Hippophae rhamnoides</i> L.	2
26	<i>Euphorbiaceae</i>	<i>Acalypha australis</i> L., <i>Euphorbia davidii</i> Subils	2
27	<i>Fabaceae</i>	<i>Amorpha fruticosa</i> L., <i>Caragana arborescens</i> Lam., <i>Lupinus polyphyllus</i> Lindl., <i>Robinia pseudoacacia</i> L., <i>Trifolium hybridum</i> L., <i>Vicia angustifolia</i> , <i>V. villosa</i> Roth	7
28	<i>Fagaceae</i>	<i>Quercus ilex</i> L., <i>Q. rubra</i> L.	2
29	<i>Geraniaceae</i>	<i>Geranium sibiricum</i> L.	1

30	<i>Grossulariaceae</i>	<i>Ribes uva-crispa</i> L.	1
31	<i>Hydrocharitaceae</i>	<i>Elodea canadensis</i> Michx., <i>E. nuttallii</i> (Planch.) H. St. John., <i>Egeria densa</i> Planch., <i>Vallisneria spiralis</i> L.	4
32	<i>Iridaceae</i>	<i>Sisyrinchium angustifolium</i> Mill.	1
33	<i>Juglandaceae</i>	<i>Juglans cinerea</i> L., <i>J. mandshurica</i> Maxim., <i>J. regia</i> L.	3
34	<i>Juncaceae</i>	<i>Juncus tenuis</i> Willd.	1
35	<i>Lamiaceae</i>	<i>Ballota nigra</i> L., <i>Lamium album</i> L., <i>L. purpureum</i> L.	3
36	<i>Lemnaceae</i>	<i>Lemna turionifera</i> Landolt	1
37	<i>Leguminosae</i>	<i>Sarothamnus scoparius</i> (L.) Koch.	1
38	<i>Malvaceae</i>	<i>Alcea rosea</i> L.	1
39	<i>Moraceae</i>	<i>Ficus carica</i> L.	1
40	<i>Myrtaceae</i>	<i>Elsholtzia ciliata</i> (Thunb.) Hyl.	1
41	<i>Nyctaginaceae</i>	<i>Oxybaphus nyctagineus</i> (Michx.) Sweet	1
42	<i>Oleaceae</i>	<i>Fraxinus ornus</i> L., <i>F. pennsylvanica</i> Marshall, <i>Syringa vulgaris</i> L.	3
43	<i>Onagraceae</i>	<i>Oenothera biennis</i> L., <i>O. depressa</i> Greene	2
44	<i>Oxalidaceae</i>	<i>Xanthoxalis dillenii</i> (Jacq.) Holub, <i>X. corniculata</i> (L.) Small, <i>X. stricta</i> L.	3
45	<i>Pinaceae</i>	<i>Larix decidua</i> Mill., <i>L. sibirica</i> Ledeb., <i>Pinus strobus</i> L.	3
46	<i>Papaveraceae</i>	<i>Fumaria schleicheri</i> Soy.-Will., <i>F. officinalis</i> L., <i>Papaver rhoeas</i> L.	3
47	<i>Poaceae</i>	<i>Anisantha diandra</i> (Roth) Tutin, <i>A. sterilis</i> (L.) Nevski, <i>A. tectorum</i> (L.) Nevski, <i>Avena fatua</i> L., <i>Digitaria sanguinalis</i> (L.) Scop., <i>Bromus arvensis</i> L., <i>Cenchrus longispinus</i> (Hack.) Fernald, <i>Cynodon dactylon</i> L., <i>Echinochloa crus-gali</i> (L.) P. Beauv., <i>Eragrostis minor</i> L., <i>E. pilosa</i> (L.) P. Beauv., <i>Eragrostis suaveolens</i> A. Becker ex Claus, <i>Hordeum leporinum</i> L., <i>H. murinum</i> L., <i>Phragmites altissimus</i> Mabilie, <i>Setaria glauca</i> (L.) P. Beauv., <i>Setaria pumila</i> (Poir.) Roem. et Schult., <i>S. viridis</i> (L.) P. Beauv., <i>Zizania latifolia</i> (Griseb.) Turcz. ex Stapf., <i>Z. aquatica</i> L.	20
48	<i>Polygonaceae</i>	<i>Rumex obtusifolius</i> L.	1
49	<i>Portulacaceae</i>	<i>Portulaca oleraceae</i> L.	1
50	<i>Rhamnaceae</i>	<i>Rhamnus alaternus</i> L.	1
51	<i>Resedaceae</i>	<i>Reseda lutea</i> L.	1
52	<i>Rosaceae</i>	<i>Amelanchier canadensis</i> (L.) Medik., <i>A. spicata</i> (Lam.) K. Koch, <i>Crataegus sanguinea</i> Pall., <i>C. pinnatifida</i> Bunge, <i>C. coccinea</i> L., <i>C. crus-galli</i> L., <i>Malus domestica</i> Borkh., <i>Padus serotina</i> (Ehrh.) Agardh., <i>P. virginiana</i> L., <i>Physocarpus opulifolius</i> (L.) Maxim., <i>Rosa rugosa</i> L., <i>Sorbaria sorbifolia</i> (L.) A. Braun	12
53	<i>Rutaceae</i>	<i>Ptelea trifoliata</i> L.	1
54	<i>Salicaceae</i>	<i>Salix fragilis</i> L.	1
55	<i>Sapindaceae</i>	<i>Acer negundo</i> L.	1
56	<i>Scrophulariaceae</i>	<i>Antirrhinum majus</i> L., <i>Cymbalaria muralis</i> G. Gaertn., B. Mey. et Scherb., <i>Paulownia tomentosa</i> Steud., <i>Veronica persica</i> Poir. ex Lam., <i>V. filiformis</i> Smith	5
57	<i>Simaroubaceae</i>	<i>Ailanthus altissima</i> (Mill.) Swingle	1
58	<i>Solanaceae</i>	<i>Lycium barbarum</i> L.	1
59	<i>Typhaceae</i>	<i>Typha laxmannii</i> Lepech.	1
60	<i>Thymelaeaceae</i>	<i>Daphne laureola</i> L.	1
61	<i>Tiliaceae</i>	<i>Fallopia x bohémica</i> (Chrtk et Chrtkova) J. P. Bailey, <i>F. sachalinensis</i> (F. Schmidt) Ronse Decr., <i>F. japonica</i> (Houtt.) Ronse Decr., <i>F. convolvulus</i> (L.) A. Love	4
62	<i>Ulmaceae</i>	<i>Celtis occidentalis</i> L., <i>Ulmus pumila</i> L.	2
63	<i>Valerianaceae</i>	<i>Centranthus ruber</i> (L.) DC.	1
64	<i>Verbenaceae</i>	<i>Verbena officinalis</i> L.	1
65	<i>Vitaceae</i>	<i>Parthenocissus inserta</i> (A. Kern.) Fritsch, <i>P. quinquefolia</i> (L.) Planch., <i>Vitis vinifera</i> L.	3
66	<i>Zygophyllaceae</i>	<i>Peganum harmala</i> L.	1
			Σ 215

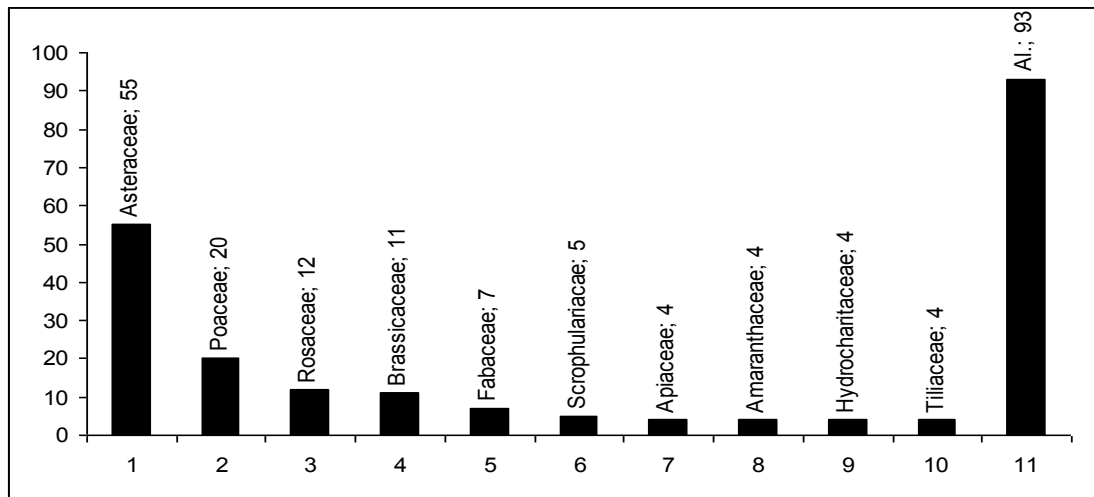


Figure 1. Dominant families of invasive plant species in Ukraine.

The first two families (*Asteraceae*, *Poaceae*) of phytointvasive species are dominant and inherent in physis-geographical zones of Ukraine.

Some species reveal sporadic, spontaneous invasions in agrolandscapes, near transport routes (*Portulaca oleracea* L., *Saponaria officinalis* L., *Cannabis sativa* L., *C. ruderalis* Janisch.). Introduced species in forestry (*Larix decidua* Mill., *Pinus strobus* L., *Ptelea trifoliata* L., *Ulmus pumila* L.) do not always reveal active invasiveness, but need to be monitored and further explored.

Some species (*Acorus calamus* L., *Bidens frondosa* L., *Juncus tenuis* Willd., *Salix fragilis* L., *Typha laxmannii* Lepech.), although considered invasive, are naturalized in Ukraine and do not carry significant threats.

Some species reveal local invasions (*Centaurea diffusa* Lam., *C. solstitialis* L., *Opuntia engelmannii* Salm-Dyck subsp. *lindheimeri* (Engelm.) U. Guzman et Mandujano (*O. lindheimeri* Engelm.), *O. humifusa* Raf, *Peganum harmala* L., *Fraxinus pennsylvanica* Marshall, *Paulownia tomentosa* Steud., *Symphytotrichum ciliatum* (Ledeb.) Nesom, *S. novae-angliae* (L.) Nesom, *S. novi-belgii* (L.) Nesom, *Syringa vulgaris* L., *Xanthium italicum* Miretti). Therefore, these species should be included in the upcoming regional invasive alien species lists.

It should be clarified that invasions of aboriginal forest species (*Acer platanoides* L., *Crataegus* sp. L., *Juniperus communis* L., *Pinus sylvestris* L.), as well as aquatic plant species (*Stratiotes aloides* L., *Trapa natans* L.) appear in Ukraine. As a result of combined changes, ecosystems transformations, their structure and autochthonous change take place. The phytointvasions mass distribution results in negative phenomena namely reservoirs eutrophication, meadows and steppes sylvatisation, boreal landscapes mesophytisation. Phytointvasions are on full display in agrolandscapes, near transport infrastructure and ecotons areas (valleys, shores, forest bands). Transformed ecotops (drained peat bogs, fallows, agrolandscapes, irrigation canals, pastures) are the most vulnerable to phytointvasions. Often phytosanitary, agrochemical, biotechnical measures are not effective in invasive alien plants control. Such works are generally limited in objects of the nature reserve fund, which often leads to valuable areas degradation.

Aquatic ecosystems are the most vulnerable. Invasive species from the hydro-helophyle ecosystems: *Acorus calamus*, *Amorpha fruticosa*, *Azolla liculoides*, *A. caroliniana*, *Bidens frondosa*, *Cenchrus pauciflorus*, *Echinocystis lobata*, *Eichornia crassipes*, *Elodea canadensis*, *E. nuttallii*, *Heracleum mantegazzianum*, *H. sosnowskyi*, *Juncellus serotinus*, *Juncus tenuis*, *Pistia stratiotes*, *Vallisneria spiralis*, *Zizania latifolia*, *Z. aquatica*. The species *Pistia stratiotes* L., formerly exotic for Ukraine, has now spread in the Dniester River lowlands, in the rivers Dnipro and Siverskyi Donets. Invasive species of *Amorpha fruticosa* L. and *Echinocystis lobata* (Michx.) Torr. et A. Gray essentially transform the coasts (Figure 2). In addition to the degradation of aquatic ecosystems econiches, phytointvasions cause decrease in populations or the disappearance of rare hydrophytes, which are included in the Red Data Book of Ukraine (2009), all together, for example *Aldrovanda vesiculosa* L., *Salvinia natans* (L.) All.

Changes in weather and climatic conditions, reducing livestock inventory, the cutting reducing contribute to the afforestation of meadows and steppe areas. At the same time shrubs and trees are actively spreading, replacing the rare meadow and steppe species (Figure 3).



Figure 2. *Echinocystis lobata*.
River Sluch, Rivnenska oblast
(2015, Konishchuk V.V.)



Figure 3. Spreading shrubs: *Crataegus* sp.
"Medobory" Natural Reserve, Ternopilska oblast
(2019, Konishchuk V.V.)

The mass distribution of *Elodea canadensis* Michx., *Stratiotes aloides* L. and other hydrophytes causes an eutrophication of reservoirs, their waterlogging and the rare plants extinction (Figures 4 and 5).



Figure 4. Eutrophication. River Udai, Chernihivska oblast (2017, Konishchuk V.V.)



Figure 5. Eutrophication. River Tsyra, Volynska oblast (2011, Konishchuk V.V.)

The rivers are very vulnerable to phytoinvasions, particularly those within the ecological corridors of the Emerald Ecological Network (Solomakha et al., 2020). Monitoring of phytoinvasions in agriculture should be carried out taking into account agroecological zoning (Konishchuk, 2018). The most dangerous are quarantine, allergenic phytoinvasive plants, transformer species, intensively distributed with allelopathic properties and high competitiveness. Some phytoinvasions change the structure of vegetations, invasive species are difficult to remove from phytocoenoses (Figure 6).



Figure 6. *Padus serotina* (Ehrh.) Ag., *Heracleum sosnowskyi* Manden., *Solidago canadensis* L., *Elaeagnus angustifolia* L. (photo by Konishchuk V.V.).

Conclusion

Invasive plants areas in Ukraine are actively expanding. Three natural zones (Forest, Forest-Steppe, Steppe), two mountain systems (Carpathians, Crimea) and two specific regions (Transcarpathia, Sub-Mediterranean zone of the south of Crimea) contribute to the distribution of a significant proportion of adventitious and invasive plant species. The part of naturalized archeophytes is now almost impossible to destroy, this is the case for species *Elodea canadensis* Michx., *Juncus tenuis* Willd., *Salix fragilis* L. and more. It is appropriate to regulate the expansion of trees in forest ecosystems (*Fraxinus pennsylvanica* Marshall, *Gleditsia triacanthos* L., *Padus serotina* (Ehrh.) Ag., *Quercus rubra* L., *Robinia pseudoacacia* L.), because in some regions it is real. For meadow and steppe ecosystems it is important to carry out biotechnical measures on the invasive shrubs and trees removal. For aquatic ecosystems it is necessary to clean up the streambeds, to remove biomass of the advents.

Mountain regions (Crimea, Carpathians), in particular the highlands, as well as the sphagnum bogs of Polissia are the most resistant to phytoinvasions. This is due to extreme natural conditions, tougher competition for environmental niches, isolation from the transport routes, infrastructure.

The primary tasks in the implementation of the National Strategy on Phytoinvasions are: the approval of the species list; inventory and monitoring of distribution centers; management plans for biotechnical, phytosanitary efforts (primarily in the objects of the nature reserve fund, near settlements); rehabilitation of disturbed phytocoenoses and transformed landscapes; preventive measures to keep new species from spreading; international, economic, regulatory and legal influencing mechanisms; extension of scientific research, educational and informational activities.

References

- Blossey, B., Nötzold, R. (1995). Evolution of increased competitive ability in invasive nonindigenous plants: a hypothesis. *J. Ecol.*, 83, 887-889.
- Burda, R.I., Pashkevich, N.A., Boyko, G.V., Fitsailo, T.V. (2015). Alien species of protected flora of the forest-steppe of Ukraine. *Kyiv. Naukova Dumka* (in Ukrainian).
- Callaway, R.M., Aschehoug, E.T. (2000). Invasive plants versus their new and old neighbors: a mechanism for exotic invasion. *Science*, 290, 521-523.
- Convention on Biological Diversity (1992). Available from: <http://www.biodiv.org/>
- Elton, C.S. (1958). *The ecology of invasions by animals and plants*. London. Methuen.
- European Strategy on Invasive Alien Species. Piero Genovesi and Clare Shine Convention on the Conservation of European Wildlife and Habitats (Bern Convention). Council of Europe Publishing F-67075 Strasbourg Codex. *Nature and environment*, 137, 68. Available from: <http://www.cbd.int/doc/external/cop-09/bern-01-en.pdf/>
- Foxcroft, L.C., Pyšek, P., Richardson, D.M., Genovesi, P. (2013). *Plant Invasions in Protected Areas Patterns, Problems and Challenges Invading Nature*. Springer Series in Invasion Ecology. 7. DOI 10.1007/978-94-007-7750-7.
- Heywood, V.H., Sharrock, S. (2013). *European Code of Conduct for Botanic Gardens on Invasive Alien Species*. Council of Europe, Strasbourg, Botanic Gardens Conservation International, Richmond. Council of Europe Publishing, F-67075 Strasbourg. Available from: www.coe.int/Biodiversity/.
- Hierro, J.L., Callaway, R.M. (2003). Allelopathy and exotic plant invasion. *Plant Soil*, 256, 29-39.
- Hulme, P.E. (2006). Beyond control: wider implications for the management of biological invasions. *Journal of Applied Ecology*, 43(5): 835-847. doi: <https://doi.org/10.1111/j.1365-2664.2006.01227.x>
- Invasive alien species indicators in Europe, review of streamlining European biodiversity (SEBI) (2012). Technical report No 15/A. [online] EEA/SEBI. Available from: <http://www.eea.europa.eu/>
- Ivashchenko, O.O., Burda, R.I. (2014). European policy on invasive alien plant species and the prospects of its implementation in Ukraine. *Scientific Papers of the Institute of Bioenergy Crops and Sugar Beet*, 20, 46.
- Kennedy, T., Naeem, S., Howe, K., Knops, J., Tilman, D. and Reich, P. (2002). Biodiversity as a barrier to ecological invasion. *Nature*, 417(6889), 636-638.
- Konishchuk, V.V., Khodyn, O.B., Solomakha, I.V., Koval, S.I., Melnyk, N.M. (2019). Ecological impact of phytointvasions in Ukraine. *Proceed. III INT. Conf. "Smart Bio", Kaunas, Lithuania*.
- Konishchuk, V., Yehorova, T. (2018). Agroecological zoning of Ukraine. *Agroecological journal*, 4, 6-22 (in Ukrainian).
- Konishchuk, V.V. (2016). Prospects researching conservation of biodiversity agrosphere in Ukraine. *Bulletin of Agricultural Science*, 3, 53-57 (in Ukrainian).
- Konishchuk, V.V., Shumyhai, I.V., Koval, S.I., Sapsai, T.P., Postoienko, D.M., Melnyk, N.M., Ed., V.V. Konishchuk (2017). *Methodical recommendations for evaluation of phyto-, and zoonavazity*. Kyiv. DIA (in Ukrainian).
- Mudrak, O.V. & Mudrak, G.V. (2013). *Features of biodiversity conservation in Podolia: Theory and practice*. Vinnytsya. TOV Nealan LTD (in Ukrainian).
- Mudrak, O.V. (2012). *Balanced development ecological network of Podillya: State, problems, prospects*. Vinnytsya. "SPD Glavatskaya R.V." (in Ukrainian).
- Mosyakin, S.L., Fedoronchuk, M.M. (1999). *Vascular plants of Ukraine. A nomenclatural checklist*. Kyiv. M.H. Kholodnyi Institute of Botany.
- McNeely, J.A., Mooney, H.A., Neville, L.E., Schei, P., Waage, J.K. (eds.) (2001). *A Global Strategy on Invasive Alien Species*. IUCN Gland, Switzerland, and Cambridge, UK.
- Mooney, H.A., Cleland, E.E. (2001). The evolutionary impact of invasive species. *PNAS*, 98(10), 5446-5451.
- Nagorniuk, O., Mudrak, O., Mudrak, G. & Sobczyk, W. (2017). Analysis of regulatory and legislative acts on the conservation of the planet's biodiversity, ratified by Ukraine. *Kwartalnik Naukowy*, 4(22), doi:10.15584/eti.2017.4.27 (in Polish)
- Protopopova, V.V., Shevera, M.V., Bagrikova, N.A., Ryff, L.E. (2012). Transformer species in the south coast of Crimea. *Ukrainian botanical journal*, 69(1), 54-68 (in Ukrainian).
- Protopopova, V.V., Mosyakin, S.L., Shevera, M.V. (2003). Influence of non-aboriginal plant species on the biota of Ukraine. In Dudkin O. (Ed.). *Assessment and directions of reduction of threats to biodiversity*. Kyiv. Khimdgest.
- Red Data Book of Ukraine. Vegetable Kingdom*. Ed. Ya. Didukh (2009). Kyiv. Globalkonsaltyng.
- Rejmanek, M., Richardson, D.M., Pyšek, P.E. (2005). Plant invasions and invasibility of plant communities. In van der Maarel, E. (Ed.). *Vegetation ecology*, Oxford: Blackwell, pp. 332-355.
- Richardson, D.M., Pyšek, P., Rejmánek, M., Barbour, M.G., Panetta, F.D., West, C.J. (2000). Naturalization and invasion of alien plants: concepts and definitions. *Diversity and Distributions*, 6(2), 93-107.
- Shevera, M.V., Protopopova, V.V., Tomenchuk, D.E., Andrik, E.J., Kish, R.Ya. (2017). The first official regional list of invasive species plans of Transcarpatia in Ukraine. *Visnyk NAS Ukraine*, 10, 53-61. doi: <https://doi.org/10.15407/visn2017.10.053/>
- Solomakha, I.V., Konishchuk, V.V., Mudrak, O.V., Mudrak, H.V. (2020). A Study of the Emerald Network objects in Ukrainian Forest-Steppe of Dnieper Ecological Corridor. *Ukrainian Journal of Ecology*, 10(2), 209-218. doi: 10.15421/2020_87
- Zavialova, L.V. (2017). The most harmful invasive plant species for native phytodiversity of protected areas of Ukraine. *Biological systems*, 9(1), 87-107.
- The International Plant Names Index. Available from: <http://www.ipni.org> <http://www.europe-aliens.org/speciesTheWorst.do/>

Citation:

Konishchuk, V.V., Solomakha, I.V., Mudrak, O.V., Mudrak, H.V., Khodyn, O.B. (2020). Ecological impact of phytointvasions in Ukraine. *Ukrainian Journal of Ecology*, 10(3), 69-75.



This work is licensed under a Creative Commons Attribution 4.0. License