

The History of Introduction and Present Distribution of *Elaeagnus angustifolia* L. in the Black Sea Region of Ukraine

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By the end of the 20th Century active dispersal *Elaeagnus angustifolia* L. has been observed in the Northern Black Sea region of Ukraine (Odesa, Mykolayiv, Kherson, and Crimea Regions). The initial centers of its invasion were plantations of trees adjacent to roads where this species was widely cultivated; later *E. angustifolia* spread spontaneously due to its abundant fruit reproduction. By its degree of naturalization it is regarded as an invasive plant (agriophyte) penetrated natural and disturbed plant communities. In man-made habitats, such as roadsides, railway embankments, waste grounds, and pastures, it usually occurs as solitary trees or in small groups of trees. In semi-natural habitats it usually prefers riverbank habitats and sandy steppes, overgrazed pastures, open sandy areas, coastal sand dunes, floodplain meadows, often saline meadow, stony and steppe-covered slopes of ravines, and rocky screes, mostly on dry soils. In this paper we present a distribution map of *E. angustifolia* in the Black Sea region of Ukraine.

Key words: Elaeagnus angustifolia distribution, Black Sea region, Ukraine

Ключові слова: Elaeagnus angustifolia, поширення, Причорномор'я, Україна

Introduction

By the end of the 20th century, the invasions of nonnative (alien, introduced, adventive) organisms, including plants, were widely realized as one of the major global threats to biodiversity [BALDACCHINO, PIZZUTO, 1996; CHORNESKY, RANDALL, 2003; CRONN, WENDEL, 2003; DAVIS, 2003; ELLSTRAND, SCHIERENBECK, 2000; GARNATJE et al., 2002; GOODWIN et al., 1999; KOWARIK, 2002; MOONEY, CLELAND, 2001; PEMBERTON, 2000; ПРОТОПОПОВА та ін., 2002; PROTOPOPOVA et al., 2006; PYŠEK, 2001; PYŠEK et al., 1999, 2004; REICHARD, WHITE, 2001, 2003; SAKAI et al., 2001; SAX, GAINES, 2003]. Scientists from various countries accumulated much data proving the negative economic and ecological consequences of invasions of some of the most aggressive species, and also the cumulative influence of alien plants on the stability and viability of ecosystems that once consisted mostly of native species.

Alien plants are now components of almost all types of anthropogenic, semi-natural, and some natural plant communities and ecosystems (e.g., forest, steppe, aquatic vegetation) in Ukraine. At present, the process of naturalization of alien species in natural and semi-natural habitats progresses rapidly. Many invasive plants occur in these habitats, actively participate in successions in disturbed plant communities, and eventually form communities in which alien plants dominate [ПРОТОПОПОВА, 1991]. Invasive species have considerable effect on the composition of plant communities in the Steppe zone of Ukraine. The spread of some highly invasive species is a serious

threat to fragments of the unique plant cover (flora and vegetation), e.g. in the Dunayskiy and Chornomorskiy biosphere reserves [ДУБИНА, ПРОТОПОПОВА, 1985; ДУБИНА, ШЕЛЯГ-СОСОНКО, 1984, 1989; ПРОТОПОПОВА, МОСЯКІН, ШЕВЕРА, 2002].

One of the highly invasive plants as well in the Steppe zone of Ukraine [ПРОТОПОПОВА, SHEVERA, 2005, 2006], and in the Europe [CAGIOTTI, RANFA, MARINANGELI, MAOVAZ, 1999; BARTHA, CSISZÁR, 2006, etc.] and America [BROCK, 1998, 2003; HABER, 1999; KNOPF, OLSON, 1984; LESICA, MILES, 2001; OLSON, KNOPF, 1986; STANNARD, 2002, etc.] is *Elaeagnus angustifolia* L. This communication provides information about present distribution of the species in the Northern Black Sea area of Ukraine.

Study area

The study area (Odesa), Mykolayiv, Kherson regions, and AR Crimea) is subdivided into four regions based on geographical divisions of the wetlands or delta-littoral landscape (in Ukrainian botanical literature this type of wetland-dominated coastal landscapes is collectively called *plavni*) of the Black Sea area [ДУБИНА, ШЕЛЯГ-СОСОНКО, 1989]: Danube steppe zone, Dnister steppe zone, Dnister-Bug steppe zone, and steppe zone of Dnipro-terrace-delta plain.

The region of the Northern Black Sea is characterized by unique landscapes formed by both fluvial and marine coastal geomorphological factors. As a result, rich and diverse natural ecosystems were developed there, and their diversity is reflected in plant communities [ДУБИНА та ін., 2004]. The regional ecosystems include steppe, sandy, meadow, salt-marshes, fragments of forest and shrub communities, aquatic types of plant vegetation, human-made and human-altered habitats. The present landscape of the region is managed in a moderately intensive way – mostly for agricultural purposes, pasture and hay-making.

Material and methods

This research focused on the invasive plant, Russian olive (*E. angustifolia*). The investigations are based on the original materials obtained by route surveys in Odesa, Mykolayiv, and Kherson regions in 2004–2006.

Comparative morphological and geographical methods of floristics were used in the present study. The collections of the Herbarium of the M.G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine (KW), I.I. Mechnikov Odessa National University (MSDU), Nikita Botanical Garden–National Science Centre, Ukrainian Agricultural Academy of Sciences (YALT), and Kherson Natural History Museum (personal herbarium of J. Paczoski) was used in the study. The dot map of distribution of *E. angustifolia* was prepared based on these herbarium and field survey data. The projectivity plant cover covering given according to L. RAMENSKY [1938]. Terminology in the article follows D.M. RICHARSON et al. [2000], and P. PYŠEK et al. [2004] is used. The nomenclature of vascular plants follows the checklist by S.L. MOSYAKIN and M.M. FEDORONCHUK [1999].

Results

The general distribution of *E. angustifolia* covers Caucasus, West Siberia (southern regions), Central Asia, Atlantic and Central Europe, Mediterranean, Asia Minor, Iran, NW China (Dzhungaria–Kashgaria). Within its native range it mostly occurs along riverbanks, on stony slopes, in sandy areas, and in the mountains at 700–1300 m a.s.l., and also in plantations [МИНЧЕНКО, 1974; ЦВЕЛЕВ, 2002; 2004].

There are varying opinions about the exact area of origin of the species; for example, some botanists consider that species as an Ancient Mediterranean (M.G. Popov, A.I. Barbarych, R.V. Kamelin, etc.) or Mediterranean [КОЗЛОВСКАЯ, 1958] element, while others [ЦВЕЛЕВ, 2002] consider it as a species of anthropogenic origin; in particular, N.N. Tzvelev indicates that the species probably emerged as a result of ancient cultivation and selection of closely related wild species, for example, *E. oxycarpa* Schlecht.

Since the 19th century, *E. angustifolia* was known in the southern regions of Ukraine as an ornamental plant: in private gardens near Odesa since 1830 [ПАЛИМПЕСТОВ, 1855], and in the Nikita Botanical Garden in Crimea since 1879 [ЗГУРОВСКАЯ, 1984]. Over time, the plant was cultivated along railways and roads, and in plantations in Black Sea (Odesa, Mykolayiv, Kherson regions, and AR Crimea) and Azov area (AR Crimea, Kherson, Zaporizhzhya, and Donetsk regions).

The first cases of occurrence of escaped *E. angustifolia* in Crimea, near Foros and Sudak, were reported in 1925 by Prof. S. Stankov. In the second half of the 20th century this species was occasionally recorded in the southern region of Ukraine (Odesa, Mykolayiv, Kherson, and Crimea Regions). By the end of the 20th century *E. angustifolia* was observed to actively disperse in the Northern Black Sea region.

The initial centers of its invasion were roadside plantations where this species was widely cultivated; later *E. angustifolia* spread spontaneously due to its abundant fruit reproduction. Birds (species of *Turdus* and others) play a key role in seed dispersal of the species. The species of the genera of *Turdus* L., *Chloris* L., *Emberiza* L. spp., *Pica pica* L. (in urban areas), and *Phasianus colchicus* L. (in protected areas) are the main agents of seed dispersal of the species on the Don delta region [ЗАБАШТА, 2006], the area adjacent to the Ukrainian Black Sea area. However, anthropochorous dispersal and vegetative reproduction by rootstock also occur.

Now *E. angustifolia* occurs in the region sporadically, generally forming large stands consisting of mature and young trees and seedlings. Owing to its degree of naturalization it is regarded as an invasive plants (according to terminology of D.M. RICHARSON et al., 2000, and P. PYSĚK et al., 2004) or agriophyte (according to the classification of J. KORNAŚ, 1968). The modern distribution of the species in the Northern Black Sea, the Azov Sea area, and Crimea is presented in fig 1.

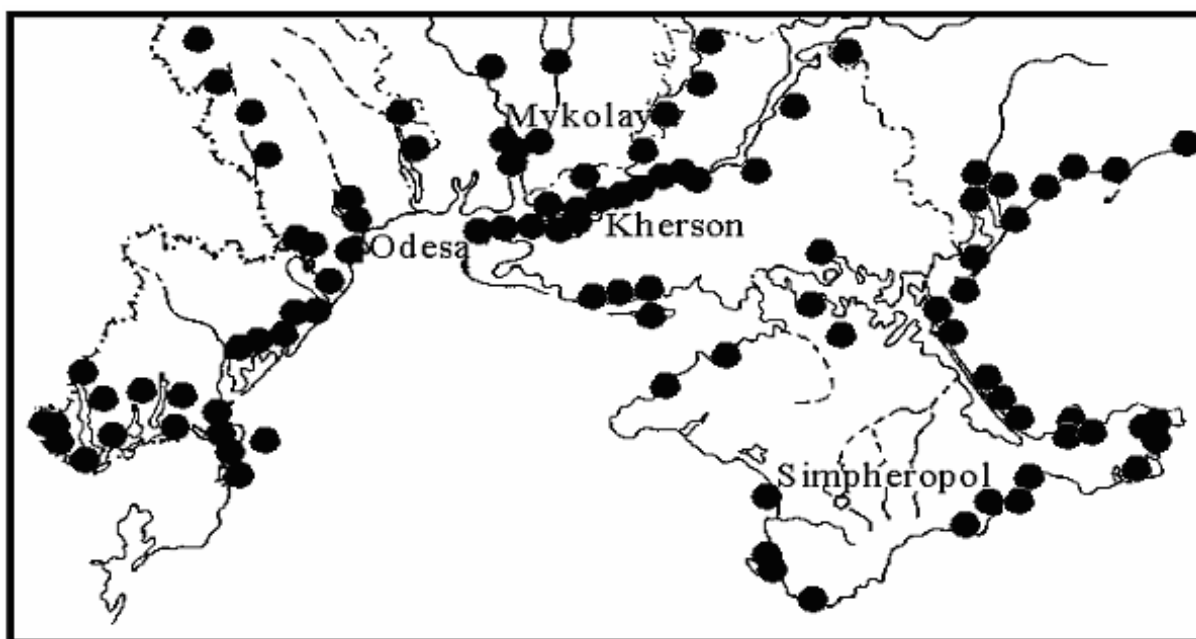


Fig. 1. Distribution of *Elaeagnus angustifolia* L. in the Northern Black Sea and the Azov area, and Crimea

Рис. 1. Поширення *Elaeagnus angustifolia* L. у Причорномор'ї, Приазов'ї та в Криму

In semi-natural habitats the species usually prefers shrubby riverside, sandy steppes, overgrazed pastures, open sandy areas, coastal sand dunes, and littoral zones. It penetrates stony slopes of ravines, rocky screes, floodplain meadows, and occurs on dry soils.

In the deltas of the Rivers Dunay (Danube), Dnister (Dnestr), Pivdennyi Bug (Southern

Bug), Ingulets, Dnipro (Dnieper), and on Cis-Dunay islands, *E. angustifolia* sporadically spreads among willow-poplar floodplain woods of the coastal strip, often together with another invasive species, *Amorpha fruticosa*. In these delta ecotopes the species occurs in the following associations: *Salicetum triandrae* Malcuit 1929, *Calamagrostio epigei-Hippophaetum rhamnoidis* Popescu, Sand, Nedelescu 1986 (in lowland habitats), and *Populetum nigro-albae* Slavnic 1952, *Salicetum albo-fragilis* (Issler 1926) Tx. 1955, *Saliceto-Populetum* (Tx.) Mejer-Drees 1936 (in elevated habitats). *Elaeagnus angustifolia* is a diagnostic species in the following two plant communities: association *Hippophae-Salicetum elaeagni* (Br.-Bl. 1933) Br.-Bl. et Volk 1940 [ДУБИНА та ін., 2004], occupying slope and depressions of seaside dunes, and association *Elaeagnetum angustifoliae* Chinkina 2002, occupying island banks, lakes, canals, ponds, etc.

According to our data in the wetland habitats (vill. Radhospne x Ulyanivka, Kherson reg.) *E. angustifolia* occurs in groups consisting of different age trees within the areas about 20 km; old trees are up to 5 or 6 m high, young ones – from 1,7 to 3 m high. Such species as *Phragmites australis* (Cav.) Trin. ex Steud., *Glyceria maxima* (C. Hartm.) Holmb., *Poa palustris* L., *Carex* sp. div., *Puccinellia gigantea* (Grossh.) Grossh.; *Artemisia santonica* L., *Achillea setacea* Waldst. et Kit., *Verbascum* sp. div., *Hordeum murinum* L. (near roadside), *Trifolium repens* L., *Polygonum paniculatum* Andrz., *Atriplex* sp. (along canals) are dominating in the herbaceous layer.

In saline meadow and floodplain habitats the species is a component of *Calamagrostio-Tamaricetum* (Rubtov 1940) Simon et Dihoru 1962, *Schoeno-Plantaginetum salsae* Soó 1957, *Juncetum gerardii* Wenzl. 1934 em. V. Sl. et Shel.-Sos. 1984 associations. However, *E. angustifolia* does not tolerate prolonged flooding, and perishes at higher humidity levels (Fig. 2, above).

In steppe habitats this species can be regarded both as a weed, occupying free sites with disrupted vegetation, for example, in pastures in *Secali sylvestris-Brometum tectorum* Hargitai 1940 and *Secali-Cynodonetum dactyli* Dubyna, Neuhausl. et Shel. 1995 associations, and also as a species actively spreading in sandy steppe, open sands and dunes in *Secalo-Stipetum borysthenicae* Korz. 1986 ex Dubyna, Neuhausl. et Shel. 1995, even among well-preserved natural vegetation, forming stands with the area up to 1 km and more. It has been noted, that in the sandy steppe habitats (Kherson vicinity); the colony of the *E. angustifolia* are presented by old trees from 3 to 7 m high, young trees – from 1,5 to 2 m high, and springs – from 20 cm to 1,5 m. The arboreal level's projective cover in these stands ranges from 10% up to 50% (rarely up to 70%), and in the herbaceous layer from 50–90 %. In such places the number of steppe and psammophilic species, for example *Secale sylvestre* Host, *Koeleria sabuletorum* (Domin) Klokov, *Achillea micrantha* Willd., *Artemisia marschalliana* Spreng., *Apera maritima* Klokov, *Calamagrostis epigeios* (L.) Roth, *Euphorbia seguieriana* Neck., and *Linum austriacum* L. decreases and these prevail only on glades. In more shaded places among trees *E. angustifolia*, these species are replaced by meadow-steppe species. The number of mesophilic species, for example *Elytrigia repens* (L.) Nevski, *E. elongata* (Host) Nevski, *Scirpoides holoschoenus* (L.) Soják, *Melandrium album* (Mill.) Garcke, *Eupatorium cannabinum* L., and *Potentilla reptans* L., increases and some forest species appear.

E. angustifolia sporadically spreads in the degradation steppe slope to estuary (vill. Nechayanne, Mykolayiv reg.). We noted four groups consisting of more than 20 different age trees on the territory of 300 km²: 18 middle tree to 6 m high, 3 young trees – to 2, and springs to 1 m high. *Festuca valesiaca* Gaudin, *Artemisia pontica* L. and *Grindelia squarrosa* (Pursh) Dunal are dominate in herbaceous layer; *Euphorbia seguieriana*, and *Xeranthemum annum* L. are sporadically, and *Cynodon dactylon* (L.) Pers., *Agropyron pectinatum* (M. Bieb.) P.Beauv., *Anisantha tectorum* (L.) Nevski, *Achillea setacea*, *Lotus corniculatus* L., *Centaurea diffusa* Lam., *Consolida paniculata* (Host) Schur, *Nigella arvensis* L., *Phlomis pungens* Willd, *Marrubium praecox* Janka, *Chondrilla juncea* L., *Salvia tesquicola* Klokov et Pobed., *Thymus x dimorphus* Klokov et Des.-Shost.), and *Asperula cynanchica* L., etc. are very rare.



Рис. 2. *Elaeagnus angustifolia* L.: верхнє – на приморських луках в Одеській обл. (фото В. Соломахи, 2006); нижнє – на петрофітних схилах в Миколаївській обл. (фото М. Шевери, 2005).

Fig 2. *Elaeagnus angustifolia* L.: under – in the cis-sea meadow habitats in Odesa region (photo by V. Solomaha, 2006); above – in the petrophytic slope habitats in Mykolayiv region (photo by M. Shevera, 2005).

According to our observation in cis-sea sandy habitats (vill. Rybakivka, Mykolayiv reg.), nearby motel complex, the colony of the species occupies ~ 2 km and presented by 7 old trees up to 7-8 m high, some young trees up to 3 m, and few cut fallen trees. The species *Phragmites australis* (Cav.) Trin. ex Steud., *Melilotus albus* Medik, and *M. officinalis* (L.) Pall. are co-dominating in herbaceous layer, while *Lactuca tatarica* (L.) C. A. Mey., *Xanthium albinum* Widd., *Tanacetum vulgare* L., *Chondrilla latifolia* M. Bieb. are presented by single plants; near the the sealine *Leymus sabulosus* occurs.

In overgrown vernal pool areas (known as 'pod' in Ukrainian) *E. angustifolia* becomes suppressed, and soon disappears. The species is very rarely recorded in fragments of natural stony steppe with domination of *Stipa capillata* L., *Festuca valesiaca*, *Agropyron pectinatum* (M. Bieb.) P.Beauv., *Salvia nutans* L., *Haplophyllum suaveolens* (DC.) G. Don f., *Phlomis tuberosa* L., *Ph. pungens*, and other steppe species.

In man-made habitats (roadsides, railway embankments, waste grounds, pastures) it usually occurs as solitary trees or small groups together with *Amorpha fruticosa* L., *Ailanthus altissima* (Mill.) Swingle, *Ulmus pumila* L., *Cotinus coggygria* Scop., and *Armeniaca vulgaris* Lam., etc. In degraded steppe and petrophyte ecotopes the species form large colonies (Fig. 2, under). We observed intensive dispersal of the species on clayey steppe slopes often used as pastures. Only some species (for example, *Festuca rupicola* Heuff. (~ *Festuca sulcata* (Hack.) Nyman), *Phlomis pungens*, *Asperula cynanchica*, *Agropyron pectinatum*, *Salvia tesquicola*, *Thymus x dimorphus*) of more than 50 species typical for such steppe communities were registered as persistent in the *E. angustifolia* colonies.

In summary, *E. angustifolia* shows high invasive ability to penetrate many different types of habitats (ecotopes) and plant communities (table 1), which occurs in different floristic complexes (natural: psammophyton, pratophyton, halophyton, steppophyton, drymophyton, petrophyton, litoralophyton, and anthropogenic: aggeratophyton, and runkatiodymophyton).

The species occurs mostly on sandy and riverside semi-natural ecotopes with unstable and sparse plant cover. The most diversity of plant communities with participation of *E. angustifolia* is observed in sandy (8 associations) and riverside (7 associations) biotopes with sparse vegetation. The main limiting factors for the species distribution in the studied region are excessively humid ecotopes.

At present the modern distribution of *E. angustifolia* in the Black Sea region of Ukraine is connected with anthropogenic and semi-natural communities, where rare endemics and relict steppe species and rare plant communities in general now are absent. The main damage from the impact of the species is hampering the restoration of typical steppe plant communities.

Conclusion

Today *E. angustifolia* occurs sporadically in the Northern Black Sea area, forming more or less large colonies. At present the main localities of the species concentration are semi-natural and anthropogenic habitats in deltas of the Dunay, Dnister, South Bug, Ingulets, and Dnipro rivers.

Thus, *E. angustifolia* penetrates semi-natural ecosystems with open spaces and sparse vegetation, which are especially typical for river bank, saline, sandy areas, different steppe variants, especially stone steppe and sandy steppe habitats. Such penetration of *E. angustifolia* in steppe communities hampers their restoration. There is a danger of outcompeting natural steppe communities by this species and replacing these communities by more mesophilic ones, which can result in the degradation of the indigenous ecosystems.

Table 1

Participation of *Elaeagnus angustifolia* L. in plant communities in the Black Sea area

Таблиця 1

Участь *Elaeagnus angustifolia* L в різних рослинних угрупованнях в Причорномор'ї

Plant communities	Sandy ecotopes			Meadow ecotopes		Riverside shrubby ecotopes	Petrophytic steppe ecotopes	Anthropogenic ecotopes
	S ₁	S ₂	S ₃	M ₄	M ₅			
<i>Juncetum gerardii</i>		S			S			
<i>Schoeno - plantaginetum salsae</i>					R			
<i>Secaletum sylvestre</i>	Sp		Sp					
<i>Secali sylvestris - Brometum tectorum</i>							Sp	U
<i>Secalo-Stipetum borysthénicae</i>	Sp							
<i>Centaureo odessanae-Festucetum beckeri</i>	Sp							
<i>Secali - Cynodonetum dactyli</i>								U
<i>Saliceto (rosmarinifoliae) – Holoschoenetum vulgaris</i>		S						
<i>Carici colchicae-Holoschoenetum vulgaris</i>		R		R				
<i>Centaureo odessanae-Caricetum colchicae</i>	R							
<i>Salicetum albo – fragilis</i>						U		
<i>Saliceto Populetum</i>	Sp					Sp		
<i>Populetum nigro-albae</i>	Sp					Sp		
<i>Salicetum triandrae</i>						U		
<i>Hippophae – Salicetum-elaeagni</i>		Sp				Sp		
<i>Calamagrostio epigei – Hippophaetum rhamnoidis</i>	Sp							
<i>Elaeagnetum angustifoliae</i>						U		
<i>Tamaricetum ramosissimae</i>	S			R		U		
<i>Calamagrostio-Tamaricetum</i>					R			

Symbols indicate: S₁– sandy risings, S₂ – sandy depressions, S₃ – sandy steppe, M₄ – floodplain meadows, M₅ – saline meadows; S – single, R – rare, Sp – sporadically, U – usually.

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