

Invasion and distribution of *Cynanchum rossicum* (Asclepiadaceae) in the Toronto region, Canada, with remarks on its taxonomy

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Abstract: The present study gives an overview of the nomenclature for *Cynanchum rossicum* (KLEOPOW) BORHIDI that is being used in botanical literature. The distribution pattern of this invasive alien species in northeastern United States and southeastern Canada is described on the base of herbarium materials, field records and literature data. The area covered by the introduced range of *C. rossicum* is estimated to be 3 times the coverage of its original range which indicates a very high rate of spread across North America. Over the 100-year history (1902-2005) of invasion of *C. rossicum* in the Toronto region, Canada the total number of herbarium specimens is 65, with the number of infested vegetation communities being 1936, yielding a total of 2001 records. The dynamics of *C. rossicum* spontaneous invasion in the Toronto region were analyzed by multiple regression analysis. The obtained data indicate that number of species localities and mapping grids per year gradually increased during the four historical periods (1902-1999) and shows exponential growth in last fifth period (2000-2005). During the recent phase of invasion *C. rossicum* occurred in a wide range of habitats, and it invaded many natural and semi-natural sites.

Keywords: *Cynanchum rossicum*, taxonomy, plant invasion, distribution patterns, mapping, Toronto region, Canada.

Introduction

Cynanchum rossicum (KLEOPOW) BORHIDI (syn. *Vincetoxicum rossicum* (KLEOPOW) BARBARICH), dog-strangling vine, is a twining perennial herb in the *Asclepiadaceae* (milkweed) family. It was introduced over 100 years ago from Europe and naturalized in North America, particularly in the northeastern United States and southeastern Canada. The species is currently expanding its range at an alarming rate, threatening primarily natural and semi-natural forested habitats although no-till cropping systems are also at risk (DITOMMASO et al. 2005b). In the opinion of the researchers *C. rossicum* is the single most virulent invasive alien species in Ontario, and it made the top twenty "prioritized" list of invasive plants in all of Canada (CATLING & MITROW 2005).

Due to intensive research accomplished on populations of *C. rossicum* in North America during the last decade, botanists have collected rich biological and ecological information about this species (e.g., SHEELEY & RAYNAL 1996; CAPPUCCINO et al. 2002; DITOMMASO et al. 2005b). However, nomenclatural ambiguity regarding some genera in which *C. rossicum* has been placed, complicates interpretation of available data.

The main goal of our research is to explore the colonization potential of *C. rossicum* and predict the possible pathways of invasion.

This study was undertaken to analyze its distribution patterns at a regional level: knowledge that is essential for potential control of such severe invasive alien species.

Taxonomical notes

Due to a theorized phylogenetic relationship some botanists have placed this species in the *Apocynaceae* (dogbane) family (LIEDE & TÄUBER 2002; DICKINSON et al. 2004).

There are several nomenclatural synonyms for the genus *Cynanchum* (L.) PERS., 1805: *Vincetoxicum* WOLF, 1776; *Vincetoxicum* Walter 1788; *Vincetoxicum* MEDIK., 1790; *Alexitoxicum* ST. LAG., 1880; *Cynanchum* (L.) R. BR., 1810; *Antitoxicum* POBED., 1952. There has been considerable controversy over the taxonomic distinction of this genus.

DITOMMASO et al. (2005b) noted that the application of the generic name *Vincetoxicum* has had a confusing history, being at one time applied to various native North American plants. Some authors recognize the distinctiveness of *Cynanchum* (WOODSON 1941; KARTESZ 1999), while others (BULLOCK 1958; MARKGRAF 1972; LIEDE & TAUBER 2002) lump it with *Vincetoxicum*.

BULLOCK's (1967) study has claimed that the name *Vincetoxicum* should be used only the temperate Old World species. The present use of this name is widely followed in Europe, and prevailed in North America until recent decades.

Tab. 1. Published nomenclature of *Cynanchum rossicum*

Name	Synonym	Author
EUROPE		
<i>Cynanchum rossicum</i> KLEOP.	-	KLEOPOW 1929
<i>Vincetoxicum medium</i> SCHMALH. P. P. NON DECNE.	<i>V. schmalhauseni</i> (KUSN.) STANK.	STANKOV & TALIEV 1949
<i>Vincetoxicum rossicum</i> (KLEOP.) BARBAR.	<i>V. medium</i> SCHMALH. p. p. non DECNE.	BARBARYCH 1950; VISIULINA 1957, 1965
<i>Antitoxicum rossicum</i> (KLEOP.) POBED.	<i>V. rossicum</i> (KLEOP.) BARBAR., <i>V. medium</i> SCHMALH. p. p. non DECNE., <i>C. rossicum</i> KLEOP.	POBEDIMOVA 1952
<i>Cynanchum rossicum</i> (KLEOPOW) BORHIDI	<i>V. medium</i> SCHMALH. p. p. non DECNE., <i>A. rossicum</i> POBED.	BORHIDI & PRISZTER 1966; HOLUB 1970
<i>Vincetoxicum rossicum</i> (KLEOP.) BARBAR.	<i>C. rossicum</i> KLEOP., <i>A. rossicum</i> (KLEOP.) POBED.	POBEDIMOVA 1978
<i>Vincetoxicum rossicum</i> (KLEOP.) BARBAR.	<i>V. medium</i> SCHMALH. p. p. non DECNE., <i>A. rossicum</i> (KLEOP.) POBED.	GLAGOLEVA 1987
<i>Vincetoxicum rossicum</i> (KLEOPOW) BARBAR.	<i>A. rossicum</i> (KLEOP.) POBED.	MARKGRAF 1972
NORTH AMERICA		
<i>Vincetoxicum medium</i> (R. BR.) DECNE.	-	PRINGLE 1973
<i>Vincetoxicum hirundinaria</i> MEDIK.*	-	GLEASON & CRONQUIST 1991
<i>Vincetoxicum rossicum</i> (KLEOPOW) BARBAR.	-	SCOGGAN 1979; VOSS 1996;
<i>Vincetoxicum rossicum</i> (KLEO.) BARBAR.	<i>C. rossicum</i> KLEO., <i>C. rossicum</i> (KLEO.) BORHIDI, <i>A. rossicum</i> (KLEO.) POBED.	SHEELEY & RAYNAL 1996; NEWMASER et al. 1998;
<i>Vincetoxicum rossicum</i> (KLEOPOW) BARBAR.	<i>C. rossicum</i> (KLEOPOW) BARBAR.	CAPPUCCINO et al. 2002; DiTOMMASO et al. 2005a
<i>Cynanchum rossicum</i> (KLEOPOW) BORHIDI	<i>V. rossicum</i> (KLEOPOW) BARBAR., <i>V. medium</i> not (R. BR.) DECNE., <i>C. medium</i> not R. BR.	MORTON & VENN 1990; KARTESZ 1999; DARBYSHIRE et al. 2000; DiTOMMASO et al. 2005b

**V. rossicum* (KLEOPOW) BARBAR. is included by GLEASON & CRONQUIST (1991) in this species.

C. rossicum was described from “circa Charkovia” – Kharkov gubernija of the Russian Empire (nowadays Kharkiv oblast of Ukraine) at the beginning of the 20th century (KLEOPOW 1929). During recent study of Kleopow’s herbarium we discovered that an authentic specimen (holotypus) of *C. rossicum* is missing from the National Herbarium of Ukraine (KW) at the M.G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine. It seems that part of the herbarium of Kleopow was destroyed or lost during World War II.

An attempt at designating a new typical specimen (neotypus) of *C. rossicum* was undertaken using plants from the herbarium of Chernjaev in KW. The neotype (that is two plants mounted on one herbarium sheet) is originally from Ekaterinoslav gubernija of the Russian Empire (nowadays Dnipropetrovsk oblast

of Ukraine) where one plant, with flowers, was collected by VOJNOV in 1853 under the name *V. medium* DECRISNE, and next one, with fruits, by COLCHIGIN under name *V. nigrum* MOENCH. This neotype of *C. rossicum* was published only recently in typification of species of vascular plants described from Ukraine (FEDORONCHUK et al. 2006). However, a valid type specimen can only be made from a single plant.

While KLEOPOW gave much of information useful for locating and identifying the sheets he examined, they are now scattered in three different cities in two different countries. To do a proper job of lectotypification all six specimens should be sought for and examined prior to making a selection of one of them. From that we can conclude, that special taxonomic expertise and further *C. rossicum* identification are necessary.

KLEOPOW (1929) considered *C. rossicum* to be endemic species to southeastern Ukraine and southwestern Russia. He suggested that *C. rossicum* originated in Pliocene subxerophyllic oak woodlands in the Eastern part of Mediterranean (KLEOPOW 1990). The author, using the Braun-Blanquet system of flora geoelements, classified *C. rossicum* within the Crimea-Caucasian subelement of the Circum-Euxin geoelement of Submediterranean type of geoelement.

C. rossicum has also been treated in the floras and manuals from the territory of the former USSR also under the names *V. rossicum* (KLEOP.) BARBAR., *V. medium* SCHMALH. p. p. non DECNE., *V. schmahauseni* (KUSN.) STANK. and *Antitoxicum rossicum* (KLEOP.) POBED. (Table 1).

Specific epithets in North American literature have been used inconsistently (Table 1). Most authors have adopted European nomenclature, i.e. *V. rossicum* (KLEOPOW) BARBAR., while others have included this species into *V. hirundinaria* MEDIK. (GLEASON & CRONQUIST 1991).

Recently the name *C. rossicum* (KLEOPOW) BORHIDI is being used more often, however some authors use both names simultaneously (DITOMMASO et al. 2005a, 2005b). This study uses *C. rossicum* on the basis of priority as having been the first name assigned to the species and one still in frequent usage.

The common name of *C. rossicum* is also not consistent. It has been called: swallow-wort, swallowwort, dog-strangling vine, pale swallow-wort, and European swallow-wort. Many North American observers have erroneously identified it as black swallow-wort (*Cynanchum nigrum* (L.) PERS.), a Mediterranean species invasive in the eastern U.S.A. According to DITOMMASO et al. (2005b) the common name swallow-wort, and particularly pale swallow-wort is best restricted to *C. vincetoxicum* (L.) PERS. (*Vincetoxicum hirundinaria* MEDIK.) because of its pale cream-coloured flowers. For that reason we suggest that the most preferable common name for *C. rossicum* would be dog-strangling vine.

General distribution

C. rossicum was originally described from Kharkiv oblast' in Ukraine and is endemic to southeastern Ukraine and southwestern Russia. It occurs in the lower parts of the Volga, Don and Dnipro/Dnieper river basins, in regions north of

the Black Sea and the Caucasus (POBEDIMOVA 1952, 1978).

C. rossicum has local distribution in forest-steppe and steppe zones of southeastern Ukraine and southwestern Russia. This distribution is within an approximate area bounded by the following coordinates. *North*: Kharkiv (Ukraine) – 49°58'16.38" N, 36°14'23.70" E; *West*: Dnipropetrovs'k (Ukraine) – 48°24'05.78" N, 35°07'17.53" E; *South*: Rostov-na-Donu (Russia) – 47°09'53.88" N, 39°44'25.04" E; *East*: Volgograd (Russia) – 48°41'50.98" N, 44°30'44.33" E.

C. rossicum has rarely been recorded in other places of Europe. There are just a few reports of *C. rossicum* escaping cultivation in Germany (MARKGRAF 1971) and in Norway where it is potentially invasive (LAUVANGER & BORGEN 1998).

The history of introduction and spread of *C. rossicum* in North America is full of ambiguity because of the taxonomical controversy in regarding of species status as elucidated above. Detailed historical information on the distribution of *C. rossicum* in the USA was provided by SHEELEY & RAYNAL (1996). According to these authors, first collections of this plant were under the name *C. louiseae* from Monroe and Nassau counties (NY) in 1897 (SHEELEY & RAYNAL 1996). Modern distribution of *C. rossicum* plotted from the US herbarium specimens covers Connecticut, Indiana, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Pennsylvania (SHEELEY & RAYNAL 1996) and Missouri (KARTESZ 1999).

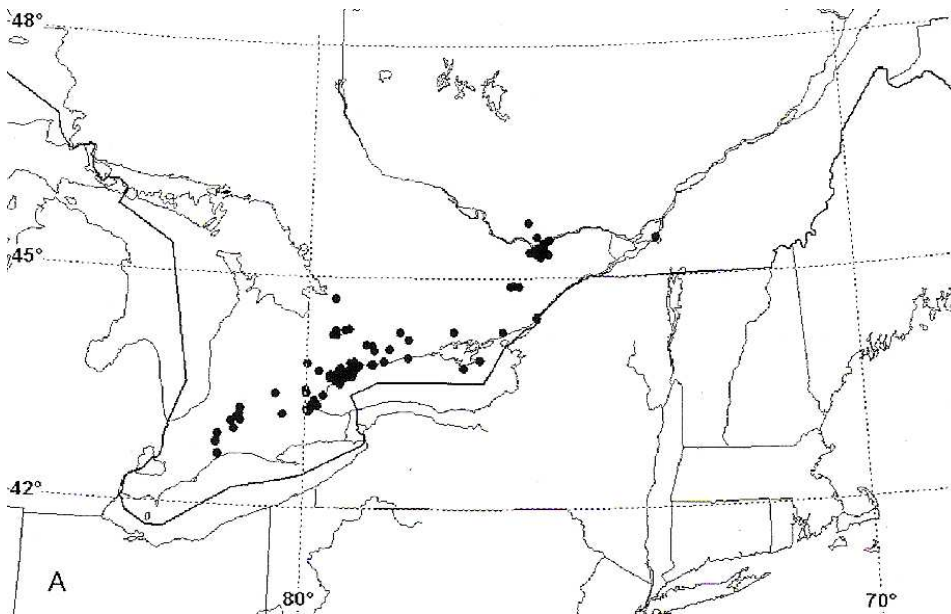


Fig. 1. Distribution of *Cynanchum rossicum* in Canada (after DiTOMMASO et al. 2005b)

The earliest specimen of *C. rossicum* from Canada was collected under the name *C. medium* in 1885 in Victoria (BC), but the species has not persisted there. The first collection in Ontario was made by MOORE in 1899 or 1889 near Toronto Junction, however this specimen could not be located (MOORE 1959). In the opinion of PRINGLE (1973), who studied this question in detail, an 1899 year of collection seems more certain. Later *C. rossicum* was found in many places mostly in southern Ontario, and recently at Montreal and in the Outaouais region of west Quebec (DITOMMASO et al. 2005b). The Canadian distribution of *C. rossicum*, based on herbarium data, is shown in Figure 1.

Materials and methods

To assess patterns of geographical distribution of *C. rossicum* in northeastern United States we used data published by SHEELEY & RAYNAL (1996) who evaluated 198 specimens from 14 herbaria; and in southeastern Canada based on PRINGLE (1973) and DITOMMASO et al. (2005b) that includes 207 specimens from 12 herbaria.

Historical distribution of *C. rossicum* in the Toronto region was evaluated on the basis of the following materials: 41 specimens examined by V. KRICSFALUSY in the Royal Ontario Museum (TRT) and University of Toronto (TRTE) herbaria (including 1 anonymous record from 1996); and 24 specimens examined by S. DARBYSHIRE (Agriculture and Agri-Food Canada) from the CAN, DAO, HAM, KANU, MO, MT, MTMG, and WAT herbaria. Later this total of 65 herbarium records (ranging from 1902-1996) was updated with an additional 1936 points (1997-2005) that were generated from the vegetation community (ELC polygon) records in the Toronto and Region Conservation Authority (TRCA) database.

Thus, two distinct types of record were included: a widely-distributed but relatively thin record of herbarium specimens from 1902-1996, and a much more intensive record of vegetation communities from 1997-2005. The latter, however, covers only about 60% of the natural cover in the TRCA jurisdiction and may miss isolated populations that fail to show as dominant in their respective polygons. Nonetheless, integrating the two types of record can help to provide a picture of the plant's distribution patterns.

The distribution of *C. rossicum* was recorded using the UTM mapping grids or squares (10 x 10 km) for TRCA. This approach is similar to that used for the Central European Mapping Project (NIKLFELD 1971). However, due to the large size of these squares (which would yield too coarse a distribution pattern for this study), we further divided them into 2 x 2 km grids, providing a finer level of detail. This method has been developed and successfully applied during the study of rare and threatened plant species of Carpathian flora (KRICSFALUSY & KOMENDAR 1990; KRICSFALUSY & MEZO-KRICSFALUSY 1994).

For determining prevalence of *C. rossicum* infestations in the Toronto region, queries were conducted using Geographical Information Systems (GIS) on data collected from 2000-2005 by TRCA biologists, with a few additional records dating back to 1996. This data covers about 60% of the natural cover within the TRCA jurisdiction. ("Natural cover" can be defined as land that is not under

urban, agricultural, or otherwise actively managed use and consists of forest, wetland, meadow, and successional habitats. The TRCA jurisdiction has approximately 25% natural cover, which includes 9% meadows. Therefore, the vegetation surveys cover about 15% of the total land base in the jurisdiction).

Vegetation communities were delineated as polygons in ArcView GIS software and categorized according to the Ecological Land Classification (ELC) for southern Ontario (LEE et al. 1998). The ELC data collection protocols were adapted for use by TRCA (TERRESTRIAL NATURAL HERITAGE 2005). Each vegetation community was divided into up to four different layers (canopy, middle or subcanopy, lower or understorey, and ground). The dominant species (up to four) present in each layer were recorded. Those polygons that included *C. rossicum* on the list for any of the vegetation layers were identified as infested land. The majority of sites/localities with *C. rossicum* present usually have abundant populations; thus, most of them would include *C. rossicum* as a dominant species within at least one polygon.

The ecological requirements of *C. rossicum* in the Toronto region were inferred from the vegetation community data of infested polygons as well as from North American literature sources; its native ecology was described from European sources.

Analysis of variance (ANOVA) and multiple regressions have been used for statistical purposes (STATISTICA package).

Results and discussion

Based on published data (see Introduction), we estimated the distribution of *C. rossicum* in North America within the geographical area characterized by following coordinates. *North*: Outaouais region (Quebec, Canada) – 45°30'43.30" N, 75°47'14.77" W; *West*: Berrien county (Michigan, USA) – 41°57'02.42" N, 86°24'31.54" W; *South*: Green county (Pennsylvania, USA) – 39°49'35.95" N, 80°13'26.16" W; *East*: Rockingham (New Hampshire, USA) – 42°57'37.40" N, 71°02'30.82" E. The recent record from Missouri is not included here (Kartesz 1999).

To estimate the rate of spread of *C. rossicum* we calculated and compared the area of its natural and introduced ranges. We found that the range *C. rossicum* in Europe (Ukraine and Russian Federation) roughly totals 11 661 154 km², and in North America (USA and Canada) – 39 949 513 km². Within the time span of not much more than a century, *C. rossicum* has already invaded an area 3 times the size of its original range; thus the rate of spread in North America is exceptionally rapid.

Distribution in the Toronto region

The earliest two extant documented specimens of *C. rossicum* from the Toronto region (at Toronto Junction) were collected under the name *V. medium* by J. WHITE in 1902 (following the missing specimen collected by Moore at the end of the 19th century). Numerous additional collections (25 records) of this

species were made within the Don River watershed in 1911-1980. During this phase the species occurred in a limited range of mainly anthropogenic habitats, notably along roadsides and around settlements. The ornamental use of the plant, perhaps in conjunction with the nursery trade is the main means that enabled the escape, adaptation and establishment of the species during the initial period of invasion.

According to historical records, particularly FAULL'S (1913) notes, *C. nigrum* (misidentified, but almost certainly *C. rossicum*) was not only present in the Toronto region, but was "found in abundance in Don Valley" (*sic*). Thus large populations of the plant, at least locally, have been present for about a century. The Charles Sauriol Reserve, centrally located on the East Don River just north of its confluence with the West Don, is now one of the densest centres of population of *C. rossicum* in the Toronto region. It seems likely that this may be one of the original locations. If so, this indicates the species' persistence in the landscape after introduction. It would not then be a temporary invader, overwhelming the ecosystem for a time but then quickly diminishing. Rather, *C. rossicum* would likely remain dominant on a permanent basis. During the recent phase of invasion *C. rossicum* occurred in a wide range of habitats, and it invaded many natural and semi-natural sites.

Over the 103-year history (1902-2005) of invasion of *C. rossicum* in the Toronto region the total number of herbarium specimens is 65, with the number of ELC polygons being 1936, yielding a total of 2001 records. The finalized data on distribution records of *C. rossicum* is shown on Figure 2. One should note that these records reflect the incomplete coverage of the TRCA jurisdiction. If there were 100% coverage, the number of infested polygons would be higher.

From the collected data we can assume that during four equal periods of 20th century (1900-1924, 1925-1949, 1950-1974 and 1975-1999) the number of *C. rossicum* records per period gradually increased. Over these four periods *C. rossicum* became thoroughly adapted and established in the Toronto region. This decisively supported an accelerating invasion.

By the period of 2000-2005, *C. rossicum* had sufficiently penetrated natural and semi-natural habitats to show a huge number of records in surveyed vegetation polygons (Table 2, Figure 3). The apparent exponential increase in this last period, however, must be qualified by the fact that the method of information collection was much denser.

Tab. 2. Collection records of *Cynanchum rossicum* in the Toronto region

Period (years)	Record type	Number of records	Percent of total
1900-1924	herbarium	5	0.25
1925-1949	herbarium	10	0.50
1950-1974	herbarium	26	1.30
1975-1999	herbarium	49	2.45
2000-2005	ELC form	1911	95.5
Total	2001	2001	100.00

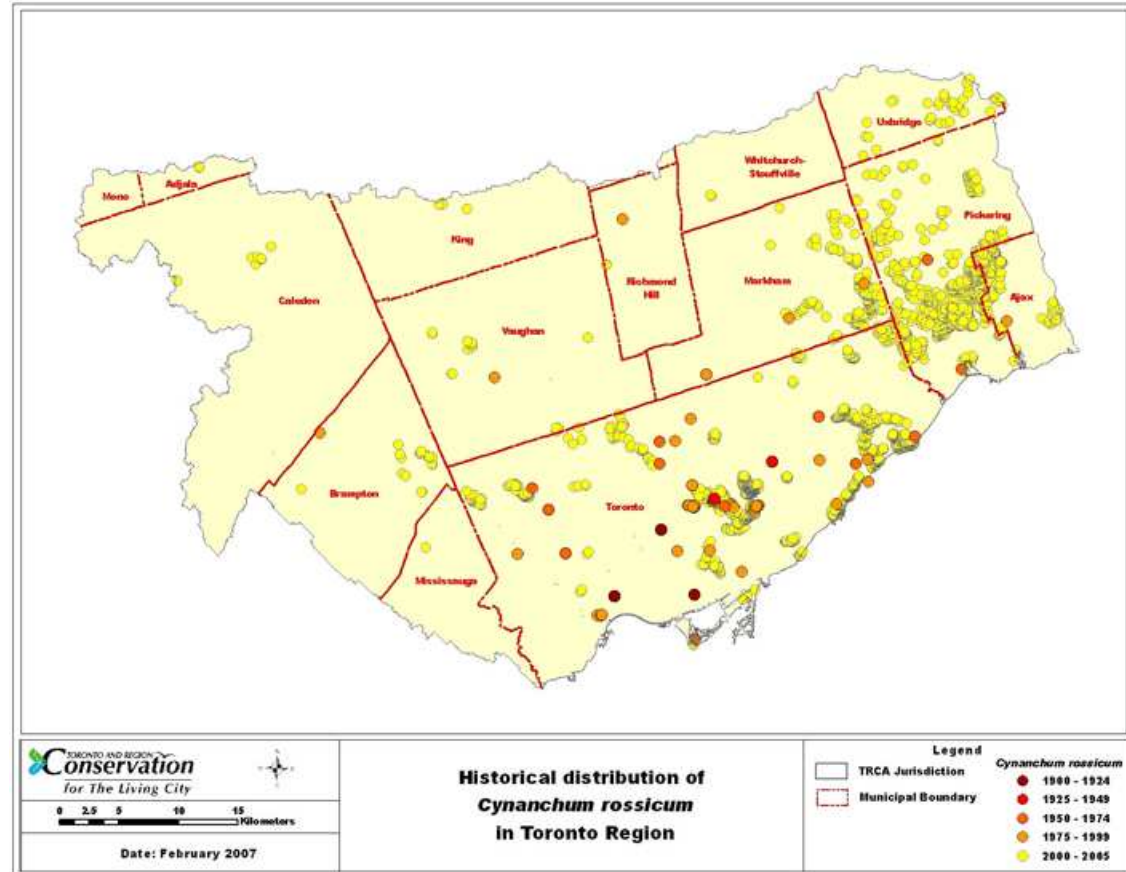


Fig. 2. Historical distribution of *Cynanchum rossicum* in the Toronto region plotted from herbarium specimens and ELC polygons

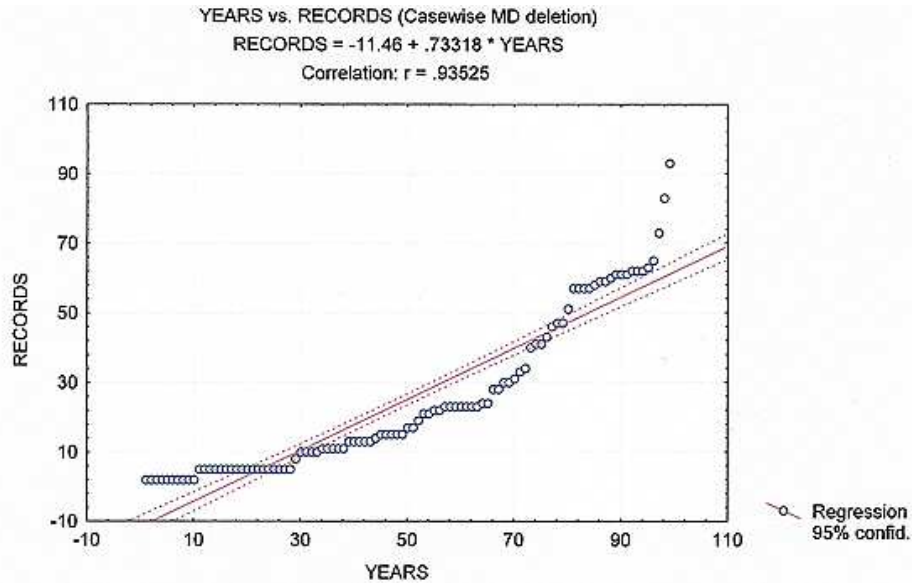


Fig. 3. Number of records (herbarium specimens and ELC polygons) of *Cynanchum rossicum* in the Toronto region (1902-2005)

Multiple regression analysis of the data for all five periods together (1900-2005) shows the following relationship between number of records (y) and year of collections (x): $y = -11.46 + 0.73318 * x$; correlation: $r = 0.93525$, $p < 0.05$.

The presented data indicate that the number of *C. rossicum* occurrences has been notably increasing in recent years. It seems highly probable that more populations will continue to be discovered in Toronto and Ontario overall, and that this species will be found in additional Canadian provinces.

The spatial expansion of *C. rossicum* within the watersheds of several rivers and streams in the Toronto region has been analyzed as well (Table 3).

Tab. 3. Collection records of *Cynanchum rossicum* within the watersheds in the Toronto region

Watershed	Herbarium specimen	ELC polygon	Total records	Percent of total
Carruthers	0	17	17	0.85
Don	25	540	565	28.24
Duffins	2	549	551	27.54
Etobicoke	0	2	2	0.1
Frenchman's Bay	1	96	97	4.85
Highland	5	175	180	9
Humber	8	101	109	5.45
Mimico	1	3	4	0.2
Petticoat	0	95	95	4.75
Rouge	1	132	133	6.65
Waterfront/Other	22	226	248	12.39
Total	65	1936	2001	100.00

The gathered data show very uneven spatial distribution of *C. rossicum* localities. For instance, the Don and Duffins watersheds concentrate over 50% of all localities for the entire Toronto region watershed. At the same time, 5 of 11 watersheds include slightly over 10 % of all localities.

The finalized distribution of *C. rossicum* in the mapping grids (2 x 2 km) of the Toronto region is shown in Figure 4.

Colonization success

Analysis of the local establishment and expansion of *C. rossicum* colonies, based on observations in the Toronto region, has been included to demonstrate the colonization potential of this alien. To estimate the rate of the spread of *C. rossicum*, we analyzed the dynamics of occupation as shown on the mapping grids.

Similar to the previous data on historical distribution (records vs years) the number of grids per year also gradually increased during the four periods and shows exponential growth in last fifth period (Table 4, Figure 5). However, it must be kept in mind that this exponential phase starts at the same time as the TRCA field inventories which provided an enormous wealth of new records.

Tabl. 4. Mapping grids (2x2 km) of the Toronto region with presence of *Cynanchum rossicum*

Period (years)	Record type	Number of new grids	Percent of total
1900-1924	herbarium	3	1.58
1925-1949	herbarium	2	1.05
1950-1974	herbarium	12	6.32
1975-1999	herbarium	21	11.05
2000-2005	ELC form	152	80.00
Total		190	100.00

The colonization dynamics of *C. rossicum* (estimated on cumulative number of mapping grids) may be divided into two separate phases (Figure 5) due to differences in the rate of spread. The “lag” phase of the invasion process lasted up to almost 100 years (1902-1999). The “exponential” phase shows a tremendous increase in the number of occupied mapping squares over last 5 years (2000-2005), but probably began earlier (and may have been detected if there had been systematic vegetation community surveys). Multiple regression analysis of it gives us the following equation: $y = - 17.62 + 0.6831 * x$. $R^2 (RI) = 0.38$; $F = 64.39$; $p < 0.05$.

We assume that under the present conditions the increase of the number of new records and occupied squares will continue in accordance with that “exponential” pattern. Then we can expect a “sigmoidal” phase with less intensive rate of spread of *C. rossicum* to emerge eventually.

The results show that the rate of establishment of *C. rossicum* in new localities has been notably increasing in recent years. According to conducted analysis, the species had spread by 2005 into 18.27% of all mapping grids in the Toronto region which attests to the high colonization success and potential of this alien.

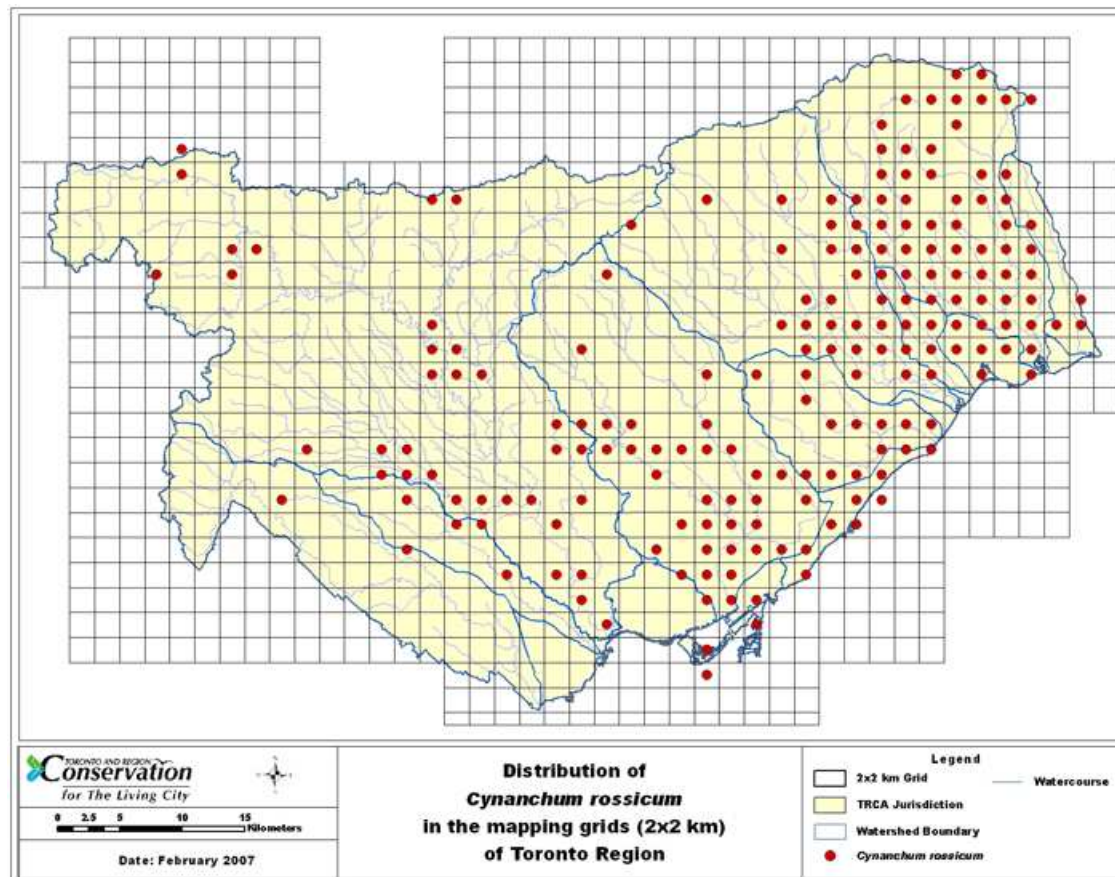


Fig. 4. Distribution of *Cynanchum rossicum* in the mapping grids (2 x 2 km) of the Toronto region

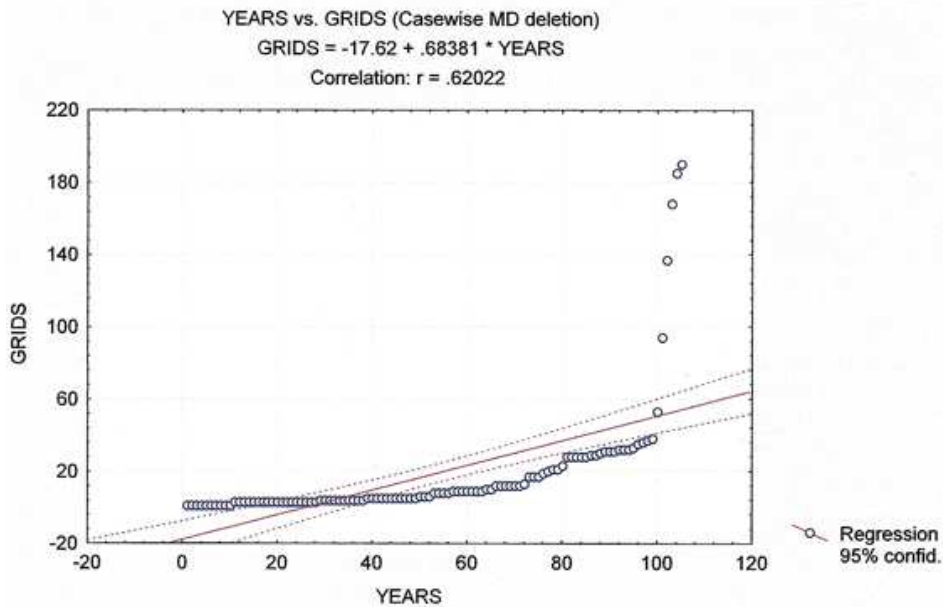


Fig. 5. Cumulative number of mapping grids of the Toronto region (2 x 2 km) with presence of *Cynanchum rossicum* (1902-2005) 0-100 – “lag” phase, 100-120 – “exponential phase.

The obtained data support the generally observed pattern of rapid and increasing invasion of *C. rossicum* and its impact on natural areas. We can expect continuous expansion of this species with further occupation of new mapping grids in the Toronto region.

It is not clearly understood what factors have resulted in this species' recent and rapid ability to become highly invasive. However, CAPPUCINO (2004) identified an “Allee effect” in *C. rossicum*, a kind of positive feedback whereby biomass and seed production of plants increased as populations increased. She attributed this to more effective suppression of background vegetation in large patches of *C. rossicum*. Thus, once an initially slow-growing population passes a certain threshold, explosive expansion is possible. In addition, initial studies of the species phytochemistry (MOGG et al. 2006) and ability to manipulate mycorrhizae (GREIPSSON & DITOMMASO 2006) also suggest a potent ability to out-compete and suppress pre-existing vegetation.

Nowadays the introduced area of *C. rossicum* in North America is approximately three times larger than its native range in Europe. On the regional scale this alien is present almost in one fifth of the total number of the Toronto region mapping grids. Both observations demonstrate the high capacity for invasion of *C. rossicum* at different scales. It seems highly probable that more

populations will continue to be discovered in the Toronto region, elsewhere in Ontario overall, and in other Canadian provinces as well as in the USA.

Construction practices and increased human use as a result of development probably will promote *C. rossicum* proliferation in higher quality areas where it is currently absent. This alien will likely out-compete native plants by taking over their habitat, reducing the quality of the site and making it less suitable for many native species.

There are many data gaps regarding *C. rossicum*. Studies should be undertaken to fill these gaps, including population dynamics, use by herbivorous insects with a view to biological control, and its impacts on native flora and fauna, particularly documenting the *in-situ* effects of invasion on site biodiversity over time.

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