



Allium paradoxum from Asia to Europe: Ornamental, Invasive, Edible, and Medicinal

Jacek Drobnik¹

Accepted: 20 April 2023 / Published online: 23 May 2023
© The Author(s) 2023

Keywords *Allium paradoxum* · Invasive species · Edible and medicinal wild plants · Wild food · Garlic · Cuisine · Iran · The Caucasus · Europe · Social media

Introduction

An invasive alien plant is a species introduced into a local flora that becomes locally overpopulated and harms its new environment. Invasive plants can have a negative impact on habitats, causing ecological, environmental, or economic damage. They compete for space and nutrients, alter native population densities, and may outcompete native species that consequently are no longer able to fulfil their ecological roles (Ehrenfeld, 2010).

Many non-indigenous and now invasive plant species were introduced into Central or Western Europe for reasons ranging from their uses as food to their ornamental value, and many are now naturalized in local flora. For example, in present-day Poland, *Ailanthus altissima* (Mill.) Swingle, native to China as its common name China sumac suggests, was first used as a decorative tree in parks in 1808; *Helianthus tuberosus* L. (Jerusalem artichoke) was introduced as a vegetable yielding edible tuber in 1872; the nectariferous plants *Echinops sphaerocephalus* L. (globe thistle) and *Reynoutria japonica* Houtt. (Japanese knotweed) arrived in 1809 and 1882 respectively. Some plants introduced for their ornamental or nutritional characteristics are still used today, e.g., *Helianthus* spp. and *Rudbeckia* spp. (e.g., Black Eyed Susan, Gloriosa daisy) in parks, *Echinocystis lobata* (Michx.) Torr. & A.Gray (wild cucumber) and *Impatiens glandulifera* Royle (Himalayan balsam) in flower gardens, and *Cymbalaria muralis* G.Gaertn., B.Mey. & Scherb.

(Kenilworth ivy) as ground cover in flower beds and urban gardens (Tokarska-Guzik et al., 2012). Such introduced species can spread independently in suitable habitats and with adapted modes of dispersal or as a consequence of human activities, especially if they become fashionable or otherwise desirable, and thereby become invasive.

Allium paradoxum (M. Bieb.) G. Don (few-flowered garlic, few-flowered leek, paradoxical onion, or Asian wild onion) was first described by Marshall von Bieberstein (1819) and is native to northern Iran (Khodadadi et al., 2015), Georgia (Akhalkatsi et al., 2008), Azerbaijan (the Talysh Mountains) (Rukšāns, 2007), Armenia (Fayvush et al., 2017), and southernmost Russia: it grows in the wild in the Northern Caucasus, in the federal republics of Chechnya, Dagestan, and North Ossetia-Alania (Radzhi et al., 2008). It has also been reported as wild in north-eastern Iraq (Pieroni et al., 2017, 2019).

I present the history of *A. paradoxum* since its introduction as an ornamental in Central Europe and the chronology of its spread from house gardens to public and private parks and wild areas. Wild food foragers and gardening enthusiasts are now sharing their observations on *A. paradoxum* on the Internet. Here I address the trajectory of this species, which is conspicuous with its vivid green leaves in April, when most perennials are still dormant, from its introduction as a food and medicinal plant to its impact on the native flora, and its current distribution across Central Europe (Fig. 1).

Methods

To ascertain the range of *A. paradoxum* in the flora of Europe I consulted published botanical data (1819–2022), as well as online floristic databases maintained by research or nature

✉ Jacek Drobnik
jdrobnik@sum.edu.pl

¹ Department of Pharmaceutical Botany and Herbal Medicine, Faculty of Pharmaceutical Sciences in Sosnowiec, Medical University of Silesia in Katowice, Ul. Ostrogórska 30, 41-210 Sosnowiec, Poland

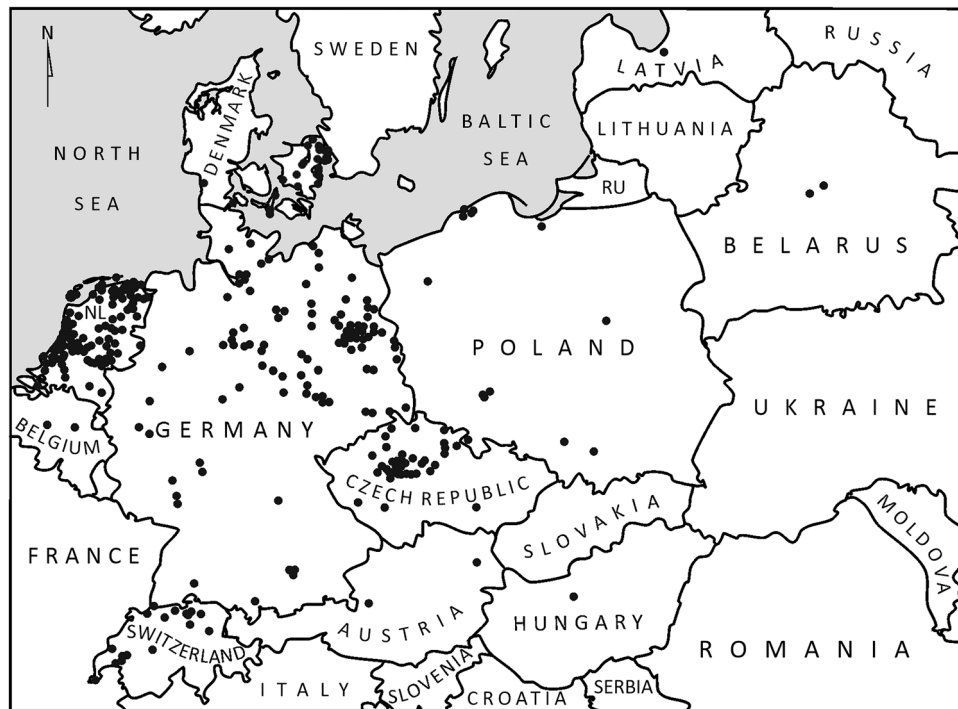


Fig. 1 General distribution of *Allium paradoxum* in central Europe. Compiled from: online databases (Bartha et al., 2021; Floron, 2020; Flora Web, 2022; OABIF, 2022; InfoFlora, 2021; Pladias, 2022; Manual..., 2022; Naturbasen, 2001), scientific articles (Bacieczko & Wołejko, 2011; Brennenstuhl, 1973; Everts-Bunders & Bojäre, 2020; Fabiszewski & Brej, 2007; Forstner & Hübl, 1971; Graulich, 2017; Hejný, 1971; Korda, 2013; Kubešová, 2000; Lustyk & Doležal, 2018;

Meerts, 2000; Rostański, 1961; Smoczyk, 2010; Sobisz & Antkowiak, 2009; Weeda, 1979; Wittmann, 1984), published floras (Dubovik et al., 2017), and amateur observations published on the Internet (Böttcher, 2021; Łuczaj, 2019; Palliwoda et al., 2017). Dates of observation as well as the character of the sites (gardens, garden escapees, populations in parks, established wild populations in forests) should be consulted in the listed sources. NL – The Netherlands; RU – Russia

conservation institutions.¹ Since Czechia (The Czech Republic), Belgium, and Poland do not have country-level databases, or they were out-of-date, I collected or supplemented relevant data from appropriate floristic publications. I plotted these data on a map to present the general distribution. The floristic data provided by online databases may have been collected according to non-uniform methods, depending on the country and period. Dates of floristic finds are noted in scientific articles, usually for the earliest occurrence of the species. In databases, dates are reduced to arbitrarily established periods. The character of the sites (cultivated vs. wild) of *A. paradoxum* has been cited here from publications, but it was not represented in cartograms at country level. Such information, if it exists, should be sought from the original datasets held by relevant institutions.

¹ They are available for Hungary (Bartha et al., 2021), The Netherlands (Floron, 2020), The British Isles (OABIF, 2022), Germany (Flora Web, 2022), Switzerland (InfoFlora, 2021), The Czech Republic (Pladias, 2022), Belgium (Manual of the Alien Plants of Belgium, 2022) and Denmark (Naturbasen, 2001).

To assess use of the plant as a current source of wild food, I browsed posts and information published in modern wild-food, gardening, and cuisine blogs, vlogs, and web stores, using popular search engines provided by Google, YouTube, and Facebook. I retrieved pharmacological and ethnopharmacological data on *A. paradoxum* using the following platforms: ScienceDirect, Jstor, PubMed, Springer, and Wiley.

Distribution, Ecology, and Taxonomy

Expansion into Europe

In 1823, *Allium paradoxum* was introduced as a garden plant in Scotland. In 1863, it was found in the wild in Binny Craig Forest near Edinburgh (Balfour, 1866; Seemann, 1866; Clement & Foster, 1994). It appeared in Gloucestershire County before 1948 (Barling, 1954, 1971).

In Central Europe, *Allium paradoxum* was cultivated in the Old Botanical Garden in Prague as early as in 1844 (Kubešová, 2000). Wild populations in several parks of Prague were spotted in 1867 (Čelakovský, 1870; Hejný, 1971)

and it became clear that the plant had been deliberately spread widely from the botanical garden into parks (Čelakovský, 1868). In Germany, *A. paradoxum* was recorded in 1875. It was found in stream forests and parklands in Lübeck, Neubrandenburg, and Havelufer between Tegel and Petzow (Rothmaler, 1966). Before 1909, it grew in the Botanical Garden Berlin-Schöneberg as “an annoying weed [seen] for a long time” (Graebner, 1909). Before 1971 it was established in Pfaueninsel Park in Berlin (Nath-Esser, 1993; Sukkop & Kovarik, 2007) located on Pfaueninsel Island on the Spree River, and finally in Salzwedel (Brennenstuhl, 1973).

In 1979, the first four localities in the Netherlands in which *A. paradoxum* were reported were: “in some woodlets on the inner side of the dunes near Heemstede En Bloemendaal (Noord-Holl region)” (Weeda, 1979). The floristic database for the Netherlands (Floron, 2020) holds 102 identifications of this species for the years 1990–2020. In Belgium, the first *A. paradoxum* was discovered in 1989 and a second had been identified by 2000 (Meerts, 2000). It was also found in Vienna in 1971 (Forstner & Hübl, 1971), and Salzburg in 1984 (Wittmann, 1984). Today, it grows in single localities in Denmark (Naturbasen, 2001) and is distributed in most lowland provinces of Germany (104 localities as of 2021) (Flora Web, 2022). It has several localities in eastern Ireland (OABIF, 2022), too. In Switzerland, the number of its localities has increased from five (before 1992) to 26 (InfoFlora, 2021).

In Poland, it was found for the first time in 1960 in historic parks in Wrocław (Rostański, 1961). Polish botanists published four further findings between 2007 and 2011 (Fabiszewski & Břej, 2007; Sobisz & Antkowiak, 2009; Smoczyk, 2010; Bacieczko & Wołejko, 2011), and I found the sixth in Katowice in 2018. Two localities of *A. paradoxum* in Belarus have been reported since 2010: in Minsk and in the vicinity of the village Domašany (Домашаны) in the Minsk region (Dubovik et al., 2017). In Hungary, *A. paradoxum* was found in 2010 in the south-western outskirts of Budapest (district Tétény) (Korda, 2013). In 2020, it was found near Riga (Latvia), on the Daugava River (Evarts-Bunders & Bojāre, 2020) (Fig. 1).

Current Status of *Allium paradoxum* in Western and Central Europe

A. paradoxum was classified as an invasive species in the British Isles in The Wildlife and Countryside Act (1981). After 2010, it was awarded the same category in Germany (Nehring et al., 2013) and Belgium (Graulich, 2017). In 2012, *A. paradoxum* was still rare enough to be classified as an ephemerophyte in Central Europe (Tokarska-Guzik et al., 2012), but its detailed status in various countries soon became diverged. Notably, in the Czech Republic it

is already naturalized (Pyšek et al., 2012) and considered “locally very invasive,” particularly in Prague (Lustyk & Doležal, 2018), but was apparently absent in Slovakia in 2012 (Medvecká et al., 2012).

Habitats

In Britain, *Allium paradoxum* occupies riverbanks, roadsides, field margins, rough and waste ground, and deciduous woodlands. It is very invasive in disturbed habitats and is increasingly abundant throughout its range, especially in southern Scotland (Flora Web, 2022). In Poland, *A. paradoxum* habitats include riparian forests on small streams (Smoczyk, 2010), large old parks (Rostański, 1961), fertile deciduous forests (Bacieczko & Wołejko, 2011), and old village cemeteries (Sobisz & Antkowiak, 2009). In the Czech Republic, it was reported in similar habitats, namely, abandoned city parks in Prague (Kopecký & Hejný, 1971) and Brno (Krahulec, 2002; Kubešová, 2000). There were more than 20 such localities across the country (Krahulec & Duhoslav, 2019). In Hungary, it colonized an abandoned park in Budapest Tétény where doubled in area from two m² to four m² within a year (Korda, 2013). In Latvia, it grew in disturbed forest and shrub-land habitats in Riga along the Daugava River (Evarts-Bunders & Bojāre, 2020). Carpet-like populations in parks or forests, as well as in gardens, can consist of 420 flowering specimens per one m² (Fabiszewski & Břej, 2007).

Urban parks currently appear to offer the most favorable habitats for the persistence and expansion of *A. paradoxum* populations. Wild food enthusiasts in Poland report localities of *A. paradoxum* in parks in Wrocław, Warsaw, Elbląg, and Kraków (Łuczaj, 2019). In Germany, it is common in parks and forests of Berlin: Pankow Blankenfelde, Krumme Lanke (Böttcher, 2021). Park visitors in Berlin were generally familiar with *A. paradoxum* as a wild food in 2014 (Palliwoda et al., 2017). For these countries, amateur reports on this plant are more informative than findings published in floristic articles.

Taxonomy and Dissemination Biology

Allium paradoxum dissemination and diaspore dispersal are twofold: the dominating diaspore type can be either inflorescence bulbils accompanied by very few flowers, or only flowers producing fruits with seeds. This difference became the basis for the division of this species into two infraspecific taxa:

Allium paradoxum var. *paradoxum* produces numerous inflorescence bulbils at the base of each umbel and only 2, 1, or 0 flowers per umbel (Stearn, 1987). On average, there are 14 such bulbils per one stem (Fabiszewski & Břej, 2007). This variety is common in Europe. Inflorescences

are variable: primary umbels can hold either several bulbils only, or the bulbils can be accompanied by 1–2 pedicellate flowers. A primary umbel can also produce 1 to 4 proliferations, each capped with a secondary or tertiary umbel consisting of flowers or bulbils (Brennenstuhl, 2015). Seeds are rare and may not be viable (ISNI, 2021). Barling (1971) in an extensive search within the Gloucestershire population found only five mature seeds in a sample of 250 plants.

The inflorescence bulbils of *var. paradoxum* fall after flowering (which ends in May). The plant can also spread vegetatively by sister bulbs which grow from the base of the main bulb in the soil.

A. paradoxum var. normale Stearn produces 3–5 flowers per inflorescence (Korda, 2013) and does not form inflorescence bulbils. This variety was described only in 1987 (Stearn, 1987), so older publications do not mention it. It was first reported from the species' native range (the Talysh Mountains in Armenia) in 1987 (Rukšāns, 2007). In Europe, it was reported by Dubovik et al. (2017), but their text was not clear enough to conclude that it had been found in Belarus. Korda (2013) found *var. normale* in Budapest. In 2012, Danihelka et al. (2012) listed it in the Czech Republic but only as a garden plant. A cultivar named *Allium paradoxum* 'Talish' which represents *var. normale* was offered as a garden plant in Europe in Latvia (Rukšāns, 2007).

Stearn (1987) published the following speculation on garlic species that can produce inflorescence bulbils: "... under man-made or man-influenced conditions, especially in gardens, the bulbilliferous [i.e., bulbil-bearing] form may survive better than the normal one and, through an inadvertent or deliberate introduction, may extend far beyond the natural range of the parent species. [...] Hence some species of *Allium* have first come to the notice of botanists in a bulbil-bearing form which has accordingly become the nomenclatural type of a specific name." He listed *A. paradoxum* among 10 species of *Allium* best (or first) known as bulbil-bearing forms.

Few-Flowered Garlic as an Edible Plant

Iran

A. paradoxum is widely known as a food plant in northern Iran, where it is native (Khodadadi et al., 2015). In the same region, it is grown in home gardens as a cultivated vegetable and spice, especially in Mazandaran province (Abbasi et al., 2008). Young leaves and infructescences are used raw as seasoning, boiled or fried, and pickled in vinegar (Pieroni et al., 2018). Other authors noted: "Leaves and bulbs are used as a fresh vegetable; widely collected and sold at markets in many towns in northern Iran. This species is endangered because of over-harvesting from the wild" (Nabavi et al., 2012a, b).

Iraq

In north-eastern Kurdish Iraq, leaves of *A. paradoxum* are consumed raw as *sawza*; as bread and yogurt seasoning, cooked with rice or bulgur, and preserved in brine (lacto-fermented) (Pieroni et al., 2019). In south-eastern Iraqi Kurdistan (Hawraman area) they are boiled in soup or wrapped in dough and fried (Pieroni et al., 2017).

Armenia and Azerbaijan

Young leaves, stems, and bulbs of *Allium paradoxum* in fresh or pickled form are used as a seasoning for various Armenian dishes (Fayvush et al., 2017). The leaves are used as a snack, as cheese seasoning, fried, cooked in soup, pickled and fermented in brine (Pieroni et al., 2018). In Azerbaijan, leaves and stems with bulbs are among the ingredients of national dishes: *dovga* (a soup of yogurt, various greens, rice, and eggs), *kutab* (various edible greens baked in a thinly rolled dough), and *kuku* (an omelet with various greens, sometimes with added meat or fish, and often mixed with yoghurt) (Fayvush et al., 2017). The leaves are also a snack (Pieroni & Söukand, 2019).

Europe

Enthusiasts of wild edible plants call themselves foragers and what they collect is "wild food" (Williams, 2015). I gathered opinions on the value of *A. paradoxum* published in contemporary Internet resources such as cuisine blogs, and wild food foraging blogs, and videos.

Parts Used and their Taste

Bulbils taste of garlic and chives (LadyKitchen, 2020). Flowers are sweet and tasty (AuJardin, 2021). Leaves are slightly sweet, and more delicate than the bulb; mature plants have a stronger taste (AuJardin, 2021). "Bulbils are not as strong in taste as garlic (*Allium sativum* L.)" (Wild Food UK, 2019). "The bulbils [...] bring some almost melon-like mellowness to their *allium* pungency" (Williams, 2015). They can be harvested when the plant has finished its vegetal cycle and dried (AuJardin, 2021). A German cuisine blogger Haupt (2017) wrote that *A. paradoxum*: "... tastes a little less intense than the real wild garlic [i.e., *A. ursinum* L.]. That's why it's a great alternative for those who don't like or can't stand the very intense taste of garlic."

Usage

A Scottish food blogger Bird (2016) posted recipes for pesto made from several species of wild edible garlic species available in Britain: three-cornered leek (*Allium triquetrum*

L.), ramsons (*A. ursinum* L.), rosy garlic (*A. roseum* L.), and *A. paradoxum*. She found the value of these species to be comparable. The herb became an ingredient in pesto, cleansing drinks, spreads, salads, salad dressings, steak tartare, and sandwiches (Vlkova, 2021). Another blogger proposed making garlic butter, garlic oil (by digesting the herb in olive oil), and garlic quark (soft white cheese). The herb can be also pickled or cooked as spinach (Wild Food UK, 2019). Inflorescence bulbils are dried and used as a condiment (AuJardin, 2021).

Allium paradoxum is considered a substitute for chives (*A. schoenoprasum* L., ramsons (*A. ursinum* L.), for garlic (*A. sativum* L.) (Vlkova, 2021), and a good substitute for leek (*A. ampeloprasum* L.) (AuJardin, 2021).

Remarks on Propagation and Cultivation by Amateurs

Two quotations from the Polish Internet published between 2014 and 2015 deserve our attention: 1) “While *Allium paradoxum* propagates easily, there are still no farmers who would undertake the cultivation of this crop for food” (Zarówna, 2014). 2) “Controlled (!) sites are increasing in number [...] as a result of the activities of [a non-profit] ecological group *Chwastożercy* (“Weedvores” analogous with “herbivores”). They disseminate this plant in Poland to attract more attention from consumers to it. *A. paradoxum* bulbils are offered to participants of some “Weedvores” group events. Botanists have already recognized it as invasive, although it is still relatively rare in Poland” (Rumińska, 2015). Between 2015 and 2019, enthusiasts promoted the consumption of *A. paradoxum* by organizing so-called wild food events (workshops and excursions) in parks of Wrocław (SW Poland). On their fan page, The meetings were announced on the internet: “Participants will receive a gift, i.e., seedlings from our garden – a bunch of paradoxical garlic to plant in one's own garden.” In their older posts they draw attention to saving the rare native food plant *Allium ursinum* L.: “[Foragers] are increasingly exploiting the populations of protected *A. ursinum* in a destructive manner” (Chwastożercy, 2017). A German forager Schatz (2009) wrote: “*Allium ursinum* is rare in our region, but [...] we are blessed with a similarly tasting plant [...] *Allium paradoxum* [...] Here, the herb is somewhat of a nuisance for native plants, as it spreads over large areas. So, you do not have to hesitate to harvest it (unlike *A. ursinum*, which is already on the list of endangered species in some regions of Germany).” And finally, one German and one Latvian gardening portal offered *A. paradoxum* for sale in 2021.

Modern Vernacular Names of *A. paradoxum*

An insight into the modern vernacular names of a popular plant can reveal attitudes towards it. German names for *A. paradoxum* include *Wunderlauch* (“wonderful garlic”), *Selt-samer Lauch* (“strange garlic”), and *Berliner Bärlauch*. While the first two are literal translations of its Latin binomial, the latter means “bears’ garlic of Berlin” and appeared on the Internet only 10 years ago. It reveals two pieces of ethnobotanical information: 1) *A. paradoxum* became an equivalent of a less common wild edible garlic, *Allium ursinum* L. (the Latin binomial of which means “bears’ garlic”), and 2) *A. paradoxum* is common in and known from parks and forests in and around Berlin. Such a distribution and abundance are confirmable in both the *Flora Web* (2022) database and on the German Internet. *A. ursinum* as a garden plant was described by Jäger (1866), but its cultivation is from seeds or sister bulbs, so the ease of growing *A. paradoxum* seems attractive to people who had difficulty growing *A. ursinum*.

Medicinal Properties

The medicinal properties of *A. paradoxum* as well as its ethnopharmacological uses were studied only in the twentieth century. In Iran, it was recorded as an antiacne and digestive folk remedy (Mozaffarian, 2012), and the following pharmacological effects have been confirmed experimentally: antihaemolytic (Ebrahimzadeh et al., 2010), antioxidant (Khodadadi et al., 2015; Mohammadi-Motamed & Naghibi, 2010), protective against induced nephrotoxicity in mice (Dehghan et al., 2016; Nabavi et al., 2012a, b), as well as antimalarial (Elmi et al., 2021). Phenolic compounds were identified in bulbs as substances inducing an anti-inflammatory effect (Ghavam-Haghi & Dinani, 2017). Regardless of this research, *A. paradoxum* is beginning to be recognised in Europe as a folk medicinal plant, first suggested published by an Iranian author Khoshtbakht (2006: 20), i.e., before any pharmacological research was published on the topic. He wrote: “Although no specific mention of medicinal uses has been seen for this species, members of this genus are, in general, healthy additions to the diet. They contain sulfur compounds (which give them their onion flavour) and when added to the diet on a regular basis they help reduce blood cholesterol levels, act as a tonic to the digestive system and tonify the circulatory system.” This transfer of knowledge from other known medicinal garlic species to *A. paradoxum*, based on similarity in taste and scent, can be done independently in any part of the world and repeats the reasoning

about *A. paradoxum* as a food plant. This quotation from Khoshbakht (2006) has been widely taken up on the Internet, e.g., by Plants for a Future (2010), Németh (2022), Natural Medicinal Herbs (2022), and makes *A. paradoxum* a candidate for a folk medicinal plant in Europe. The history of folk medicinal plants records a similar case of *Reynoutria japonica*, introduced in Europe in the second half of the nineteenth century, now very invasive, which became used in folk medicine in Germany as early as the 1920s (its stems are similar to rhubarb and therefore were used as a substitute for it) (Krober, 1929). However, the history of *A. paradoxum* in Europe is quite different from another *Allium* genus, *A. ramosum* L., which has been recently reported as newly identified in North-Eastern Poland and East European Russia but is still very rare. *A. ramosum* was introduced to Europe as a spice in the last decades of the twentieth century and is readily available to gardeners (Seregin & Korniak, 2013).

Conclusions

I summarize my research into the introduction and dissemination of *Allium paradoxum* in Europe in the following eight observations:

1. *Allium paradoxum* was introduced in Europe as an ornamental plant in 1823. It was first observed in 1867 in European parks, and by 1909 was identified as a garden weed. Wild populations in British forests were reported in 1863 and 1948, and in continental Europe since 1961. It was first identified as an invasive species in 1971, and recognised as such by law in 1981 (UK). It has been considered invasive in continental Europe since 2007.
2. Native to Iran it was first described as a spice plant in 2008 and classified there as a wild plant threatened by overharvesting in 2012. In Europe, it has been considered a food plant since 2009 (Schatz, 2009), although generally recognized as edible in approximately 2007.
3. Biochemical and pharmacological studies of *A. paradoxum* began in Iran in 2006. Independently, in the same year, Khoshbakht (2006) proposed it as a substitute for other medicinal plants from the genus *Allium*, a suggestion that spread across European websites after 2009.
4. *A. paradoxum* is highly invasive among the native flora of Europe. Its recent adoption as a food plant is chiefly due to: a) The genus *Allium* is an exotic attractive novelty in Central Europe, easily identifiable as garlic by its scent. Amateurs can readily find this plant on wild food portals on the internet; b) It grows as a monodominant in rapidly increasing populations and colonizes mostly man-made habitats visited by people. c) It can be grown in gardens and requires little attention to thrive; d) It resembles edible garlics already known as wild food plants. Wild food foragers in Europe are generally aware that *A. paradoxum* is an alien species in the European flora and therefore harvesting (and promoting its usage) is considered a form of care for the scarce resources of native edible garlic *A. ursinum*, which is legally protected across Europe.
5. Stearn's (1987) speculation on the ability of bulbil-bearing garlic to expand in man-made or man-influenced habitats proved to be correct for *Allium paradoxum*, which, in addition, has recently appealed to and is being deliberately spread by wild-food foragers and growers;
6. The range and frequency of *Allium paradoxum* in central Europe are underestimated. Activities of wild food enthusiasts increase the spread of its diaspores. Any intentional spread of this plant in natural and semi-natural ecosystems (e.g., parks) should be banned. Planting or transplanting it (into gardens and parks) can accelerate its invasiveness.
7. The status of *A. paradoxum* across Europe remains paradoxical. It outcompetes native plants (in Britain, Germany, and Czechia) and gardeners complain that it is a hard to manage weed (in Scotland). At the same time, it is promoted by amateurs as an attractive source of wild food, both harvested in the wild and cultivated (in Germany, Poland, the Czech Republic).
8. Modern European cuisine uses *A. paradoxum* in similar ways as in the Caucasus region where it is native), and in both regions it is both foraged from wild stands and grown in gardens. The medicinal value of *A. paradoxum* in self-healing, in Europe inspired by garlic or chives (amateur phytotherapy) seems to be a minor and recent justification for growing this plant.

Author contributions J.D. wrote the entire manuscript text and drew the Fig. 1.

Funding Financial support for this research was provided by Medical University of Silesia in Katowice (grant No. PCN-CBN-640-2-1-144A/22).

Data Availability A voucher specimen of *A. paradoxum* var. *paradoxum* collected on 22 Apr 2018 in Katowice (Poland, Silesian Upland, city Katowice, district Brynów, Ligęzy street) is housed in the SOSN herbarium (accession No. 1654). The first drawing of *Allium paradoxum* var. *normale* was published by Korda (2013).

Declarations

Competing Interests The authors declare no competing interests.

Informed Consent The nature of this research did not require informed consent.

Conflict of Interest The author declares no potential conflict of interest.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Abbasi, M., Fritsch, R. M., & Keusgen M. (2008). Wild *Allium* species used as food and folk medicine in Iran. In M. Keusgen, & R. M., Fritsch (Eds.), *First Kazbegi workshop on botany, taxonomy and phytochemistry of wild Allium L. species of the Caucasus and Central Asia* (pp. 25–28). Kazbegi, Georgia, Marburg & Gatersleben.
- Akhalkatsi, M., Fritsch, R. M., Maisaia, I., Nakhutsrishvili, G., & Pistrick, K. (2008). Habitats of *Allium* species in Georgia. In M., Fritsch & R. M. (Eds.), *First Kazbegi workshop on Botany, taxonomy and phytochemistry of wild Allium L. species of the Caucasus and Central Asia* (pp. 45–52), Kazbegi, Marburg & Gatersleben.
- AuJardin. (2021). Retrieved December 14, 2022, from <https://www.aujardin.info/plantes/allium-paradoxum.php>
- Baciczko, W., & Wolejko, L. (2011). Aktualny stan flory i znaczenie osobliwosci florystycznych dla różnorodności szaty roślinnej rezerwatu „Grądowe Zbocza” koło Recza. *Fol. Pomeranae Universit. Technol. Stetinensis, Agricultura, Alimentaria, Piscaria et Zoot-echnica*, 289(19), 7–26.
- Balfour, J. H. (1866). On the occurrence of *Allium paradoxum*, Don, in woods near Edinburgh. *Transactions of the Botanical Society of Edinburgh*, 8(1–4), 458–460. <https://doi.org/10.1080/03746606609468629>
- Barling, D. M. (1954). Distribution and chromosome number of *Allium paradoxum* in Gloucestershire. *Nature*, 173(1440), 877. <https://doi.org/10.1038/173877a0>
- Barling, D. M. (1971). Studies on Gloucestershire populations of *Allium paradoxum* (Bieb.) G. Don. *Watsonia*, 8, 379–384.
- Bartha, D., Bán, M., Schmidt, D., & Tiborcz, V. (2021). *Vascular plants of Hungary online database*. Department of Botany and Nature Conservation, Faculty of Forestry. Retrieved January 15, 2021, from <http://floraatlasz.uni-sopron.hu>. Sopron University
- Bird, F. (2016). Scotsman Food and Drink. Native and non-native wild garlic. Retrieved February 17, 2021, from <https://foodanddrink.scotsman.com/food/foraging-with-fiona-bird-native-and-non-native-wild-garlic>
- Böttcher, S. (2021). Wildes Berlin. from: <https://wildes-berlin.de/knoblauchduft-in-berliner-waldern>. Retrieved on 25 February 2021, published online 2021.
- Brennenstuhl, G. (1973). Ein neuer Fundort von *Allium paradoxum* (M. Bieb.) G. Don. *Gleditschia*, 1, 89–94.
- Brennenstuhl, G. (2015). Zur Variabilität der Infloreszenz von *Allium paradoxum* (M. Bieb.) Don. *Mitteil Floristischen Kartierung Sachsen-Anhalt*, 20, 19–24.
- Čelakovský, L. (1870). Květena okolí Pražského. *Živa. Sbor. Věd. Mus. Král. Českého*, 4, 1–164.
- Čelakovský, L. (1868). Prodróm květeny České. Komitét pro přírodnické výzkumání Čech, Praha, The Czech Republic, Volume 2, pp. 16–112.
- Chwastożercy. (2017). Retrieved September 20, 2022, from <https://www.facebook.com/chwastożercy>
- Clement, E. J., & Foster, M. C. (1994). *Alien plants of the British Isles*. BSBI.
- Danihelka, J., Chrtek, J., & Kaplan, Z. (2012). Checklist of vascular plants of the Czech Republic. *Preslia*, 84, 647–811.
- Dehghan, H., Sarrafi, I., & Salehi, P. (2016). Antioxidant and antidiabetic activities of 11 herbal plants from Hyrcania region, Iran. *Journal of Food and Drug Analysis*, 24, 179–188.
- Dubovik, D. V., Skuratovich, A. N., Parfenov, V. I., Savchuk, S. S., Lebed'ko, V. N., Tret'iakov, D. I., Dimitrieva, C. A., & Jakovleva, I. M. (2017). *Flora Belarusi. Sosudistie Rastienija* (Vol. 3, pp. 114–115). Belaruskaja Navuka.
- Ebrahimzadeh, M. A., Nabavi, S. F., Nabavi, S. M., & Eslami, B. (2010). Antihemolytic and antioxidant activities of *Allium paradoxum*. *Central European Journal of Biology*, 5, 338–345.
- Ehrenfeld, J. G. (2010). Ecosystem consequences of biological invasions. *Annual Review of Ecology, Evolution, and Systematics*, 41(1), 59–80. <https://doi.org/10.1146/annurev-ecolsys-102209-144650>
- Elmi, T., Hajjiliani, F., Asadi, M. R., Sadeghi, S., Namazi, M. J., Tabatabaie, F., & Zamani, Z. (2021). Antimalarial effects of the hydroalcoholic extract of *Allium paradoxum* in vitro and in vivo. *Journal of Parasitic Diseases*, 45, 1055–1064.
- Evarts-Bunders, P., & Bojāre, A. (2020). *Allium paradoxum* (M. Bieb.) G. Don – a new invasive plant species for the flora of Baltic States. *Acta Biologica Universitatis Daugavpiliensis*, 20(1), 55–60.
- Fabiszewski, J., & Brej, T. (2007). Powiększanie zasięgu czosnku dziwnego *Allium paradoxum* (M.Bieb.) G.Don w obszarze Wrocławia. *Annals Silesiae*, 35, 115–116.
- Fayvush, G., Aleksanyan, A., Mehdiyeva, N., Alizade, V., Batsatsashvili, K., Khutsishvili, M., Maisaia, I., Sikharulidze, S., Tchelidze, D., Kikvidze, Z., Paniagua Zambrana, N. Y., & Bussmann, R. W. (2017). *Allium paradoxum* (M. Bieb.) G. Don, *Allium ursinum* L., *Allium victorialis* L. In R. W. Bussmann (Ed.), *Ethnobotany of the Caucasus* (pp. 1–7). Springer International Publishing AG. https://doi.org/10.1007/978-3-319-50009-6_135-1
- Flora Web. (2022). Retrieved February 9, 2021, from <http://www.floraweb.de/webkarten/karte.html?taxnr=307>
- Floron. Verspreidingsatlas Vaatplanten. (2020). Retrieved March 3, 2020, from <https://www.verspreidingsatlas.nl/1546>
- Forstner, W., & Hübl, E. (1971). *Ruderal-, Segetal- und Adventivflora von Wien*. Notring Verlag.
- Ghavam-Haghi, F., & Dinani, M. S. (2017). Isolation and identification of Astragalin and 2-methoxy-tyrosol from the bulbs of *Allium paradoxum*. *Journal of Hermed Pharmacology*, 6(3), 114–118.
- Graebner, P. (1909). Die Pflanze. In E. Friedel & R. Mielke (Eds.), *Landeskunde der Provinz Brandenburg, I. Die Natur* (pp. 127–264). Reimer.
- Graulich, A. (2017). *Allium paradoxum* (Bieb.) G. Don var. *paradoxum*, une invasive en expansion à Waremme. *Dumortiera*, 112, 14–16.
- Haupt, S. (2017). *Ich darf vorstellen: Seltamer Lauch*. Retrieved February 15, 2021, from <https://www.ichmachesanders.com/2017/04/06/seltsamer-lauch>
- Hejny, S. (1971). Současný stav rozšíření *Allium paradoxum* (M.Bieb.) G. Don v Praze a okolí. *Zpr. Československé bot. spol.*, 6(2), 111–118.
- InfoFlora. (2021). Retrieved : <https://www.infoflora.ch>. Accessed on 22 Feb 2021.
- ISNI. (2021). Invasive Species Northern Ireland. Northern Ireland Environment Agency. Retrieved February 3, 2021, from <https://invasivespeciesireland.com/species-accounts/established/terrestrial/few-flowered-garlic>
- Jäger, H. (1866). *Allium ursinum*, der Bärlauch als Gartenpflanze. *Gartenflora*, 15, 325.
- Khodadadi, S., Nejadstatti, T., Naqinezhad, A., & Ebrahimzadeh, M. A. (2015). Diversity in antioxidant properties and mineral contents of *Allium paradoxum* in the Hyrcanian forests, Northern

- Iran. *Biodiversitas*, 16(2), 281–287. <https://doi.org/10.13057/biodiv/d160224>
- Khoshbakht, K. (2006). *Agrobiodiversity of Plant Genetic Resources in Savadkouh, Iran, with Emphasis on Plant Uses and Socioeconomic Aspects*. Kassel University Press GmbH.
- Kopecký, K., Hejný, S. (1971). *Ruderální společenstva bylin České republiky*. Zpr. Československé bot. spol. Academia.
- Korda, M. (2013). Újabb adat a magyar adventívflóra ismeretéhez: az *Allium paradoxum* (M. Bieb.) G. Don 1827 Magyarországon. *Kitaibelia*, 18(1–2), 31–34. Retrieved October 28, 2022, from <https://kitaibelia.unideb.hu/?download&aid=259>
- Krahulec, F. (2002). Alliaceae Agardh – česnekovitě. In K. Kubát (Ed.), *Klíč ke květeně České republiky* (pp. 752–757). Academia.
- Krahulec, F., & Duhoslav, M. (2019). *Alliaceae J. Agardh – česnekovitě*. In Z. Kaplan, J. Danihelka, J. Chrtek jr, J., J. Kirschner, K. Kubát, M. Štech, & J. Štěpánek, (Eds.), *Klíč ke květeně České republiky* (2nd ed., pp. 647–667). Academia.
- Krober, L. (1929). *Auslanddrogen und ihr Ersatz*. In *Botanik und Drogenkunde*, Thoms, H., Brandt, W., Eds, Band 5 (erste Hälfte), Urban & Schwarzenberg, p. 304.
- Kubešová, S. (2000). Česnek podivný (*Allium paradoxum*) také na Moravě. *Zpr. Československé Bot. Spol.*, 34, 177–178.
- LadyKitchen. (2020). Retrieved February 19, 2021, from <https://www.facebook.com/ladykitchenpl>
- Łuczaj, Ł. (2019). Czosnek przedziwny (*Allium paradoxum*), gość z Kaukazu w naszych parkach. Retrieved: https://youtu.be/3knxEvTV_5w. Accessed on 18 Feb 2021, published online 24 Apr. 2019.
- Lustyk, P., & Doležal, J. (2018). Additamenta ad floram Reipublicae Bohemicae – XVI. Additions to the flora of the Czech Republic – XVI. *Zprávy Čes. Bot. Společ.*, 53, 31–112.
- Manual of the Alien Plants of Belgium. (2022). Retrieved October 29, 2022, from <https://alienplantsbelgium.myspecies.info/species-list/allium-paradoxum>
- Marshall von Bieberstein, F. A. (1819). *Flora Taurico-Caucasica. Supplementum continens plantas phanerogamas per Tauriam atque Caucasum, post edita priora volumina detectas, et in pristina animadversiones*. Typis Academicis, Charkoviae, ; Volume 3(suppl.), pp. 267–268. <https://doi.org/10.5962/bhl.title.10825>
- Medvecká, J., Kliment, J., Májeková, J., Halada, L., Zaliberová, M., Gajdičová, E., Feráková, V., & Jarolímek, I. (2012). Inventory of the alien flora of Slovakia. *Preslia*, 84, 257–309.
- Meerts, P. (2000). *Allium paradoxum* (M. Bieb.) G. Don var. *paradoxum*, new xenophyte for Belgium, at Wezembeek-Oppem and Waremm. *Dumortiera*, 75, 24–26.
- Mohammadi-Motamed, S., & Naghibi, F. (2010). Antioxidant activity of some edible plants of the Turkmen Sahra region in northern Iran. *Food Chemistry*, 119, 1637–1642.
- Mozaffarian, V. (2012). *Identification of medicinal and aromatic plants of Iran*. Farhang Moaser.
- Nabavi, S. F., Nabavi, S. M., Hajizadeh Moghaddam, A., Naqinezhad, A., Bigdellou, R., & Ohammadzadeh, S. (2012a). Protective effects of *Allium paradoxum* against gentamicin-induced nephrotoxicity in mice. *Food & Function*, 3, 28–29.
- Nabavi, S. M., Hajizadeh Moghaddam, A., Fazli, M., Bigdellou, R., Mohammadzadeh, S., Nabavi, S. F., & Ebrahimzadeh, M. A. (2012b). Hepatoprotective activity of *Allium paradoxum*. *European Review for Medical and Pharmacological Sciences*, 16(Suppl 1), 43–46.
- Nath-Esser, M. (1993). Zur Verbreitung des Sonderbaren Lauchs (*Allium paradoxum*) auf der Pfaueninsel. *Mitteil. Pücker-Gesellschaft*, 9, 79–96.
- Natural Medicinal Herbs (2022). Retrieved September 01, 2022, from <http://www.naturalmedicinalherbs.net/herbs/a/allium-paradoxum=few-flowered-leek.php>
- Naturbasen. Danmarks nationale Artsportal. (2001). Retrieved October 29, 2022, from <https://www.naturbasen.dk/art/8891/spoejs-loeg>
- Nehring, S., Kowarik, I., Rabitsch, W., & Essl, F. (2013). Naturschutzfachliche Invasivitätsbewertungen für in Deutschland wild lebende gebietsfremde Gefäßpflanzen. BfN-Skripten, Bundesamt für Naturschutz, Bonn, Volume 352, pp. 46–47.
- Németh, K. (2022). Wundervoller Wunderlauch Retrieved August 31, 2022, from <https://katalin-nemeth.de/blog>
- OABIF. (2022). Online Atlas of the British and Irish Flora. Retrieved : <https://plantatlas.brc.ac.uk/plant/allium-paradoxum>. Accessed on 23 Sept. 2022.
- Palliwoda, J., Kowarik, I., & von der Lippe, M. (2017). Human-biodiversity interactions in urban parks: The species level matters. *Landscape and Urban Planning*, 157, 394–406. <https://doi.org/10.1016/j.landurbplan.2016.09.003>
- Pieroni, A., & Sökand, R. (2019). Ethnic and religious affiliations affect traditional wild plant foraging in Central Azerbaijan. *Genetic Resources and Crop Evolution*, 66(7), 1495–1513.
- Pieroni, A., Ahmed, H. M., & Zahir, H. (2017). The spring has arrived: Traditional wild vegetables gathered by Yarsanis (Ahl-e Haqq) and Sunni Muslims in Western Hawraman, SE Kurdistan (Iraq). *Acta Societatis Botanicorum Poloniae*, 86(1), 1–17. <https://doi.org/10.5586/asbp.3519>
- Pieroni, A., Sökand, R., Amin, H. I. M., Zahir, H., & Kukk, T. (2018). Celebrating multi-religious co-existence in Central Kurdistan: The bio-culturally diverse traditional gathering of wild vegetables among Yazidis, Assyrians, and Muslim Kurds. *Human Ecology*, 46(2), 217–227. <https://doi.org/10.1007/s10745-018-9978-x>
- Pieroni, A., Zahir, H., Amin, H. I. M., & Sökand, R. (2019). Where tulips and crocuses are popular food snacks: Kurdish traditional foraging reveals traces of mobile pastoralism in Southern Iraqi Kurdistan. *Journal of Ethnobiology and Ethnomedicine*, 15(1), 1–14. <https://doi.org/10.1186/s13002-019-0341-0>
- Pladias. (2022). Database of the Czech Flora and Vegetation. Retrieved October 29, 2022, from <https://pladias.cz/en/taxon/distribution/Allium%20paradoxum>
- Plants for a Future. (2010). Retrieved September 01, 2022, from <https://pfaf.org/user/Plant.aspx?LatinName=Allium+paradoxum>
- Pyšek, P., Danihelka, J., Sádlo, J., Chrtek jr, J., Chytrý, M., Jarošík, V., Kaplan, Z., Krahulec, F., Moravcová, L., Pergl, J., Štajerová, K., & Tichý, L. (2012). Catalogue of alien plants of the Czech Republic (second edition): checklist update, taxonomic diversity, and invasion patterns. *Preslia*, 84, 155–255.
- Radzhi, A. D., Gusejnov, S. A., & Murtazaliev, R. A. (2008). *Luk strannyi Allium paradoxum (Bieb.) G. Don fil.* In *Krasnaja kniga Rossijskoj Federacii (rastenija i griby)*. Ministerstvo Prirodnih Resursov i Ekologii Rossijskoj Federacii, Rossijskaja Akademiya Nauk; Rossijskoje Botaničeskoe Obshestvo. Moskovskij Gosudarstvennyj Universitet im. M. V Lomonosowa, Moskwa; p. 44.
- Rostański, K. (1961). Interesujące gatunki synantropijne z terenu miasta Wrocławia. Część II. *Fragmenta Floristica et Geobotanica*, 7(2), 291–298.
- Rothmaler, W. (1966). *Exkursionsflora von Deutschland. Gefäßpflanzen*. Aufl. 5. Volk und Wiesen Volkseigener Verlag. Berlin, p. 480.
- Rukšans, J. (2007). *Buried treasures: finding and growing the world's choicest bulbs*. Timber Press, Inc.
- Rumińska, A. (2015). Chwasty jadalne. Retrieved February 17, 202, from <http://dolnoslaskosc.pl/chwasty-jadalne,781.html>
- Schatz, P. (2009). *Im Berliner-Bärlauch-Wald*. Retrieved February 11, 2021, from <https://zuehmend-wild.de>
- Seemann, R. (1866). Botanical news. *The Journal of Botany, British and Foreign*, 4, 236–240.
- Seregin, A. P., & Korniak, T. (2013). *Allium ramosum* L. (Amaryllidaceae), a neglected alien in the European flora and its oldest record from Poland. *Phytotaxa*, 134(1), 61–64. <https://doi.org/10.11646/phytotaxa.134.1.6>
- Smoczyk, M. (2010). Rzadkie i zagrożone rośliny naczyniowe Pogórza Orlickiego (Sudety Środkowe) – cz. 1. *Przyroda Sudetów*, 13, 53–70.

- Sobisz, Z., & Antkowiak, W. (2009). Flora naczyniowa cmentarzy na obszarze Słowińskiego Parku Narodowego. *Ślupskie Prace Biologiczne*, 6, 127–144.
- Stearn, W. T. (1987). A paradoxical onion, *Allium paradoxum* var. *normale*. *Curtis Bot. Mag.*, 4(4), 194–201, reprinted as: Stearn, W. T. (1987). A paradoxical onion, *Allium paradoxum* var. *normale*. *Kew Mag.*, 4(4), 194–199. <https://doi.org/10.1111/j.1467-8748.1987.tb00473.x>
- Sukkop, H., & Kovarik, I. (2007). *Stinsenpflanzen in Mitteleuropa und deren agriophytische Vorkommen*. Ber. Inst. Landschafts-Pflanzenökol. Univ. Hohenheim, 17, 81–90.
- The Wildlife and Countryside Act*. (1981). Retrieved Matcg 3, 2020, from <http://www.legislation.gov.uk/ukpga/1981/69>
- Tokarska-Guzik, B., Dajdok, Z., Zajac, M., Zajac, A., Urbisz, A., Danielewicz, W., & Hołdyński, C. (2012). *Rośliny obcego pochodzenia w Polsce ze szczególnym uwzględnieniem gatunków inwazyjnych* (p. 110). Generalna Dyrekcja Ochrony Środowiska.
- Vlkova, J. (2021). Prima fresh. Retrieved February 19, 2021, from <https://fresh.iprima.cz/jak-na-to/cesnek-podivny-neni-podivny-ale-vynikajici>
- Weeda, E. J. (1979). *Allium paradoxum* (Bieb.) G. Don aan de binnen-duinrand in burgerend. *Gorteria*, 9(7–8), 278–281.
- Wild Food UK. (2019). *Few-Flowered Garlic*. Retrieved February 11, 2021, from <https://www.wildfooduk.com/edible-wild-plants/few-flowered-garlic>
- Williams, M. (2015). Galloway Wild Foods. Retrieved February 13, 2021, from <https://gallowaywildfoods.com/few-flowered-leek-identification-distribution-edibility>
- Wittmann, H. (1984). Beiträge zur Karyologie der Gattung *Allium* und zur Verbreitung der Arten im Bundesland Salzburg (Österreich). *Linzer Biologische Beiträge*, 16, 83–104.
- Zarówna, K. (2014). An interview with Anna Małys, an anthropologist of food and feast. Retrieved February 18, 2021, from <https://www.smakizpolski.com.pl/chwastozery-cz-ii>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.