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Original Empirical Research

Assessment of the Potential Risk of Poisonous Plants in Rostov-on-Don

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Abstract

Introduction. The flora of most urban areas has received scant attention regarding toxicity, resulting in the potential for humans and animals to encounter poisonous plants. Furthermore, there is an influx of new potentially hazardous species into populated areas. It is evident that there are two primary mechanisms through which their propagation occurs. The first of these is natural population increase. The second is the introduction of ornamental species in landscape projects. The presence of poisonous plants in urban areas is frequently identified solely on the basis of symptoms including poisoning, dermal and eye burns. Children are the most vulnerable in this regard. The situation in Russia has been examined using the example of several urban ecosystems; however, the distribution of toxic flora in Rostov-on-Don remains unstudied. The aim of this research is to evaluate the potential hazard posed by poisonous plants in Rostov-on-Don.

Materials and Methods. The research focused on species of poisonous vascular plants growing within the city limits of Rostov-on-Don. The data was collected during fieldwork in 2023–2024 using the route method. Information on the presence of poisonous plants on the territory of the city in 2007–2022 was also taken into account. The names of the plant species are given according to the Plant List database. The toxicity class was determined according to the A. Filmer scale.

Results. In the urban context of Rostov-on-Don, a total of 66 species of poisonous plants were identified (8% of the city's total floral biodiversity). They belonged to diverse hazard categories according to their potential impact on human and animal health. A thorough analysis of taxonomic structure of the toxic flora revealed the most prominent orders: *Ranunculales* (14 species) and *Solanales* (6 species). The potentially lethal plants within the city limits included *Hyoscyamus niger, Conium maculatum, Aristolochia clematitis, Convallaria majalis, Ricinus communis,* and others (21 species). The ecological and cenotic analysis demonstrated that almost one third of the detected toxic plant species (30%) were associated with ruderal habitats, i.e. roadsides and abandoned areas. The majority of species (41%) were found to be associated with artificial phytocenoses that were created for ornamentation. Of particular concern were plants bearing poisonous fruits of high ornamental value. This group comprised 14 species, including *Parthenocissus sp., Phytolacca americana,* and *Wisteria sinensis.* A biomorphological analysis of the toxic flora revealed the predominance of perennial and annual grasses (66%). Shrubbery, conversely, exhibited a lower level of diversity (16%), yet demonstrated a more extensive geographical distribution.

Discussion and Conclusions. This is the first study to assess the potential threat posed by poisonous plants in urban ecosystems within the southern Russian region. The identification of toxic plant species, their role in the urban landscape and ways of their further development will help to minimize poisoning by poisonous plants. Uncontrollably spreading ruderal toxic plants, among which particularly dangerous species have been found, require special attention. During landscaping and green construction, the toxicity of each specimen should be taken into account.

Keywords: toxic flora of Rostov-on-Don, toxic plants in cities, classes of plant toxicity, ruderal toxic plants, introduction of ornamental toxic plants

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Оригинальное эмпирическое исследование

Оценка потенциальной опасности ядовитых растений города Ростова-на-Дону

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Аннотация

Введение. Флора большинства городов слабо изучена с точки зрения токсичности, при том что люди и животные рискуют столкнуться с ядовитыми растениями. К тому же на территории населенных пунктов проникают новые потенциально опасные виды. Известны два основных пути их распространения. Первый — естественное увеличение популяции. Второй — внедрение декоративных видов в ландшафтных проектах. Ядовитые растения в городе часто выявляются только при отравлениях, ожогах кожи или глаз. Наиболее уязвимы в этом плане дети. Ситуация в России рассматривалась на примере нескольких городских экосистем, однако проблема распространения токсикофлоры в Ростове-на-Дону не изучалась. Поэтому цель представленной научной работы — оценка потенциальной опасности, которую представляют ядовитые растения в Ростове-на-Дону.

Материалы и методы. Исследовались ядовитые сосудистые растения, произрастающие в черте Ростова-на-Дону. Данные собирались в ходе полевых работ в 2023–2024 годах маршрутным методом. Также учитывались сведения о ядовитых растениях, обнаруженных в городе с 2007 по 2022 год. Названия видов растений приводятся в соответствии с базой данных Plant List[1]. Класс токсичности определялся по шкале А. Филмера.

Результаты исследования. В Ростове-на-Дону обнаружено 66 видов ядовитых растений (8 % от общего числа видов флоры города). Они относятся к различным классам опасности по степени воздействия на человека и животных. Анализ таксономической структуры токсикофлоры выявил наиболее крупные группы — лютикоцветные (14 видов) и пасленоцветные (6 видов). Потенциально смертельно опасны *Hyoscyamus niger*, *Conium maculatum*, *Aristolochia clematitis*, *Convallaria majalis*, *Ricinus communis* и другие (всего 21 вид). Эколого-ценотический анализ показал, что 30 % видов токсических растений связаны с рудеральными местообитаниями — обочинами дорог и заброшенными территориями. 41 % видов ассоциированы с искусственными фитоценозами декоративного назначения. Особенно опасны декоративно ценные растения с ядовитыми плодами: *Parthenocissus sp*., *Phytolacca americana*, *Wisteria sinensis* и др. (всего 14 видов). Биоморфологический анализ токсикофлоры выявил преобладание трав (66 %). Кустарники менее разнообразны (16 %), но широко распространены.

Обсуждение и заключение. Впервые оценена доля и потенциальная опасность ядовитых растений в экосистеме Ростова-на-Дону. Выявление токсических видов растений, их роли в ландшафте и путей распространения поможет минимизировать риски отравления ядовитыми растениями. Требуют особого внимания бесконтрольно распространяющиеся рудеральные токсические растения, среди которых обнаружены особо опасные виды. При ландшафтных работах и зеленом строительстве следует учитывать токсичность каждого экземпляра.

Ключевые слова: токсикофлора Ростова-на-Дону, токсические растения в городах, классы токсичности растений, рудеральные токсические растения, внедрение декоративных токсических растений.

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Introduction. Poisonous plants in urban environments pose a threat to humans and animals. Incidents of poisoning by weeds, wild plants, as well as those used in landscape design have been reported. In Germany, for example, between 2001 and 2010, approximately 13,000 incidents were recorded, with children accounting for 85% of victims [1]. According to the American Association of Poison Control Centers, from 2000 to 2008, plants were responsible for 3.4% of all poisonings in the United States, and children under the age of six accounted for almost 70% of cases [2]. The analysis of various Poison Control Centers in Australia, Germany [3], Morocco [4], New Zealand [5], Thailand [6], and the United Kingdom found that plant exposure was the cause of 1.8–8% of all referrals [7]. In most cases, significant intoxication was not recorded, but there were reports of severe and life-threatening poisoning. The risk of poisoning in urban areas remains high. A study of the urban flora in Hong Kong revealed 26 species of poisonous plants, which were

[1] *World Flora Online, WFO.* URL: https://wfoplantlist.org/ (accessed: 11.02.2025).

associated with 65 cases of poisoning ranging in severity from 2003 to 2017 [8]. The flora in Novi Sad (Serbia) included 22 species of poisonous plants, and the authors [9] noted their dangerous proximity to children's institutions.

Poisonous plants are those that, when touched or ingested, can cause harm or even death. They also include plants that may cause a toxic or fatal reaction [10].

Poisonous plants are related to allergenic plants, which have been previously studied in Rostov-on-Don [11]. While allergenic plants can cause allergies, poisonous ones can be much more dangerous.

According to statistics, more than 15,000 cases of poisoning from poisonous plants are reported annually in Russia. Typically, plant toxins affect the body through the digestive system, eyes, and skin. Of these cases, 80% involve children under the age of six [12].

The analysis of literary sources has revealed a lack of knowledge about the distribution and species composition of poisonous plants in cities of the Russian Federation. The most comprehensive information is available for Saratov. The authors [13] mention 46 species of poisonous plants from 29 families found within the city. Poisonous flora of Voronezh, Buinaksk, and Makhachkala has also been studied insufficiently and separately [14].

Poisonous plants in Rostov-on-Don have not been studied specifically. There is little information available about the Lower Don region [15].

The aim of the presented work was to assess the potential threat posed by poisonous plants growing in Rostov-on-Don.

Materials and Methods. The species of poisonous vascular plants in Rostov-on-Don were studied. The primary data was collected by the route method during field work in 2023–2024.

The toxicity class of plants was determined in accordance with the modified classification proposed by A. Filmer [16].

– A — strong toxic effect, may cause serious illness or death;

– B — minor toxic effect, vomiting or diarrhea occurs if the plant is swallowed;

– C — effect is caused by oxalate crystals (irritation of the mouth, tongue and throat, can lead to swelling of the throat, difficulty breathing, burning pain and upset stomach);

– D — juice or thorns can cause skin rash or irritation.

Rostov-on-Don has a temperate continental climate with mild winters and hot, dry summers. According to long-term weather observations, the average air temperature is +11.0°C. January is the coldest month with an average temperature of –2.0°C, and July is the warmest month with an average of +23.4°C. The annual average precipitation in Rostov-on-Don is 618 millimeters. The surrounding vegetation is mainly steppe [17].

Results. As a result of research in Rostov-on-Don, 66 species of poisonous vascular plants belonging to 23 orders of flowering plants have been identified. According to D.V. Vakhnenko [18], the entire flora of the Rostov urban agglomeration consisted of 848 species. Thus, the share of registered toxic flora species was about 8% of the total number of species of the Rostov flora.

The order Ranunculales was found to be the largest, with 14 toxic plant species (21%). The order Solanaceae included 6 species (9%). The Asparagales order was in third place (5 species, 8%). The remaining 20 orders were relatively small and included from 1 to 4 species.

According to Ya.M. Golovanov [19], 67 species of poisonous plants were found in the flora of the city of Meleuz (Bashkortostan), which was close to the Rostov number.

For comparison, the flora of poisonous plants in Saratov was 30% smaller than in Rostov. It had 46 species [13]. Obviously, the greater diversity was due to the Rostov climate, which was more favorable for plants such as *Hedera helix, Toxicodendron radicans, Wisteria sinensis,* etc. They were often used in landscape design.

The studied toxic flora included various families, some of which were not typical for this region (Phytolaccaceae, Anacardiaceae, Hydrangeaceae). Most of the poisonous plants belonged to the Ranunculaceae and Solanaceae families, which was expected, as representatives of these families were generally toxic to varying degrees. Most of the poisonous plants in Rostov-on-Don were represented by 1–2 species. The intraspecific diversity of the toxic flora was very heterogeneous, since cultural forms also belonged to poisonous ones. Ornamental crops such as *Hosta, Hydrangea,* and *Paeonia* had a significant number of varieties, but all of them contained certain toxic substances.

Table 1 provides a complete list of poisonous plants found in Rostov-on-Don.

Table 1

Poisonous plants growing in Rostov-on-Don

Name	Order	Biotope[1]	Localization [2]	LF[3]	Toxicity	
					Class	Substance
Hosta sp.	Asparagales	Fg	Everywhere	P	B, D	Saponin
Adonis aestivalis	Ranunculales	Rh	Everywhere	A	A	Cardiac glycosides
Alstroemeria aurea	Liliales	Fg	Everywhere	P	B, D	Glycoside
Ambrosia artemisiifolia	Asterales	Rh	Everywhere, seeds	A	B	Allergenic proteins
Amorpha fruticosa	Fabales	Ud	Seeds	S	B	Glycoside amorphin
Anemonoides sylvestris	Ranunculales	Fg	Aerial parts of plants	P	A	Anemonin
Aquilegia vulgaris	Ranunculales	Fg	Everywhere	P	A	Cyanide
Aristolochia clematitis	Piperales	Rh	Everywhere	P	A	Alkaloid aristolokhin
Bryonia alba	Cucurbitales	Rh, Ud	Everywhere, especially fruits	P	A, B	Bryonin glycoside
Buxus sempervirens	*Buxales*	Ud, Ra	Everywhere	S	B, D	Alkaloids
Cannabis sativa	Rosales	Rh	Everywhere	A	B	Cannabinoids
Catharanthus roseus	Gentianales	Fg	Everywhere	A	B	Alkaloids
Chelidonium majus	Ranunculales	Rh	Everywhere, especially roots	P	B, D	Alkaloids
Clematis sp.	Ranunculales	Ra	Everywhere	L	D	Alkaloid clematin, anemonol
Colchicum autumnale	Liliales	Fg	Bulbs	P	B, D	Colchicine alkaloids
Coleus scutellarioides	Lamiales	Fg	Everywhere	P	B, D	Diterpene coleonol
Conium maculatum	Apiales	Rh	Everywhere	B	A	Alkaloid coniine, conhydrin, pseudoconhydrin
Consolida regalis	Ranunculales	Rh	Everywhere, especially seeds	A	A	Triterpene alkaloids
Convallaria majalis	Asparagales	Fg, Ud	Everywhere	P	A	Saponin convallin and cardiac glycosides (convallamarin, convallatoxin, etc.)
Convolvulus arvensis	Solanales	Rh	Everywhere	A	B	Alkaloids: convolvin, convolamine
Delphinium ajacis	Ranunculales	Rh, Fg	Everywhere, especially seeds	A	A	Triterpene alkaloids
Cynoglossum officinale	Boraginales	Rh	Everywhere	P	A	Glycoside cynoglossin
Datura stramonium	Solanales	Fg	Everywhere	A	A	Alkaloid atropine, hyoscyamine, scopolamine
Delphinium elatum	Ranunculales	Fg	Aerial parts of plants	P	A	Triterpene alkaloids
Digitalis purpurea	Lamiales	Fg	Everywhere	P	A	Cardiac glycosides
Echium vulgare	Boraginales	Rh	Everywhere	P	B, D	Glycoside cynoglossin, consolidin
Ranunculus ficaria	Ranunculales	Fg, Rh	Everywhere	P	A	Protoanemonin, prussic acid
Glaucium corniculatum	Ranunculales	Rh	Everywhere	A	B	Alkaloid protopine
Hedera helix	Apiales	Ra	Everywhere	L	B, D	Saponin gederin
Heliotropium arborescens	Boraginales	Fg	Aerial parts of plants	P	A	Glycoside cynoglossin
Hemerocallis fulva	Asparagales	Fg	Everywhere	P	B	Glycoalkaloid
Hyacinthus orientalis	Asparagales	Fg	Bulbs	P	B, D	Oxalates
Hydrangea macrophylla	Cornales	Fg	Everywhere	P	B	Cyanogenic glycosides

Hyoscyamus niger	Solanales	Rh	Everywhere	P	A	Alkaloid atropine, hyoscyamine, scopolamine
Ipomoea purpurea	Solanales	Fg	Seeds	A	B	Ergine alkaloid
Juniperus virginiana	Pinales	Ud, Ra	Aerial parts of plants, seeds	S	B, D	Alcohol sabinol
Juniperus foetidissima	Pinales	Ud, Ra	Aerial parts of plants, seeds	S	B, D	Alcohol sabinol
Lactuca serriola	Asterales	Rh	Everywhere, in senile period	A	B	Lacturaria resin
Lactuca tatarica	Asterales	Rh	Everywhere	P	B	Coumarin
Ligustrum vulgare	Lamiales	Ud, Ra	Aerial parts of plants, fruits	S	B	Ligustrin glycoside
Lonicera caprifolium	Dipsacales	Ud, Ra	Fruits	S	B, D	Xylostein glycoside
Maclura pomifera	Rosales	Ra	Fruits	T	C, D	Glycosides
Narcissus poeticus	Asparagales	Fg	Everywhere	P	B	Alkaloid lycorin
Paeonia lactiflora	Saxifragales	Fg	Everywhere	P	B	Glycoside salicin, alkaloids
Papaver rhoeas	Ranunculales	Fg	Everywhere	A	A	Alkaloids
Papaver somniferum	Ranunculales	Rh	Everywhere	A	A	Alkaloids
Parthenocissus quinquefolia	Vitales	Ra	Fruits	L	B	Oxalic acid
Parthenocissus tricuspidata	Vitales	Ra, Ud	Fruits	L	B	Oxalic acid
Pelargonium zonale	Geraniales	Fg	Everywhere	P	B, D	Alcohol geraniol, linaliol
Phytolacca americana	Caryophyllales	Ra	Everywhere, especially fruits	S	B	Glycoprotein, saponin, phytolaccotoxin alkaloid
Ranunculus repens	Ranunculales	Fg	Everywhere	P	A	Protoanemonin, prussic acid
Ranunculus sceleratus	Ranunculales	Fg	Everywhere	P	A	Protoanemonin, prussic acid
Rhus typhina	Sapindales	Ra, Ud	Aerial parts of plants	T	D	Urushiol
Ricinus communis	Malpighiáles	Fg	Everywhere, especially fruits	A	A	Ricin, ricinine
Ruta graveolens	Sapindales	Fg	Aerial parts of plants	S	B, D	Alkaloids
Sambucus nigra	Dipsacales	Ra, Ud	Everywhere, especially unripe fruits	S	B	Glycoside d-amygdalin
Sedum sp	Saxifragales	Fg	Everywhere	P	B, D	Alkaloid sedamine
Jacobaea vulgaris	Asterales	Rh	Everywhere	Дв	B	Alkaloid yakonin
Solanum dulcamara	Solanales	Rh	Everywhere	P	B	Alkaloid solanine
Solanum nigrum	Solanales	Rh	Unripe fruits	P	B	Alkaloid solanine
Styphnolobium japonicum	Fabales	Ra, Ud	Fruits	B	B	Alkaloid cytisine
Symphoricarpos albus	Dipsacales	Ra, Ud	Fruits	S	B	Alkaloid chelidonin
Toxicodendron radicans	Sapindales	Ra	Aerial parts of plants	L	D	Urushiol
Vinca minor	Gentianales	Fg	Everywhere	P	B	Alkaloids
Wisteria sinensis	Fabales	Ra	Seeds, fruits	S	B, D	Glycoside vistarin
Aesculus hippocastanum	Sapindales	Ra, Ud	Fruits	T	B	Glycosides, saponins

[1] *Fg — communities of herbaceous ornamental plants; Rh — ruderal communities; Ud — urban dendrocenoses; Ra — communities of residential area.*

[2] *Part of the plant in which hazardous substances are concentrated.*

[3] *LF — life forms of plants. T — trees, S — shrubs, L — lianas, P — perennials, A — annuals.*

Rostov-on-Don ecological and cenotic analysis of the flora of poisonous plants shows the relationship of some species with certain types of habitats and cenoses (Fig. 1).

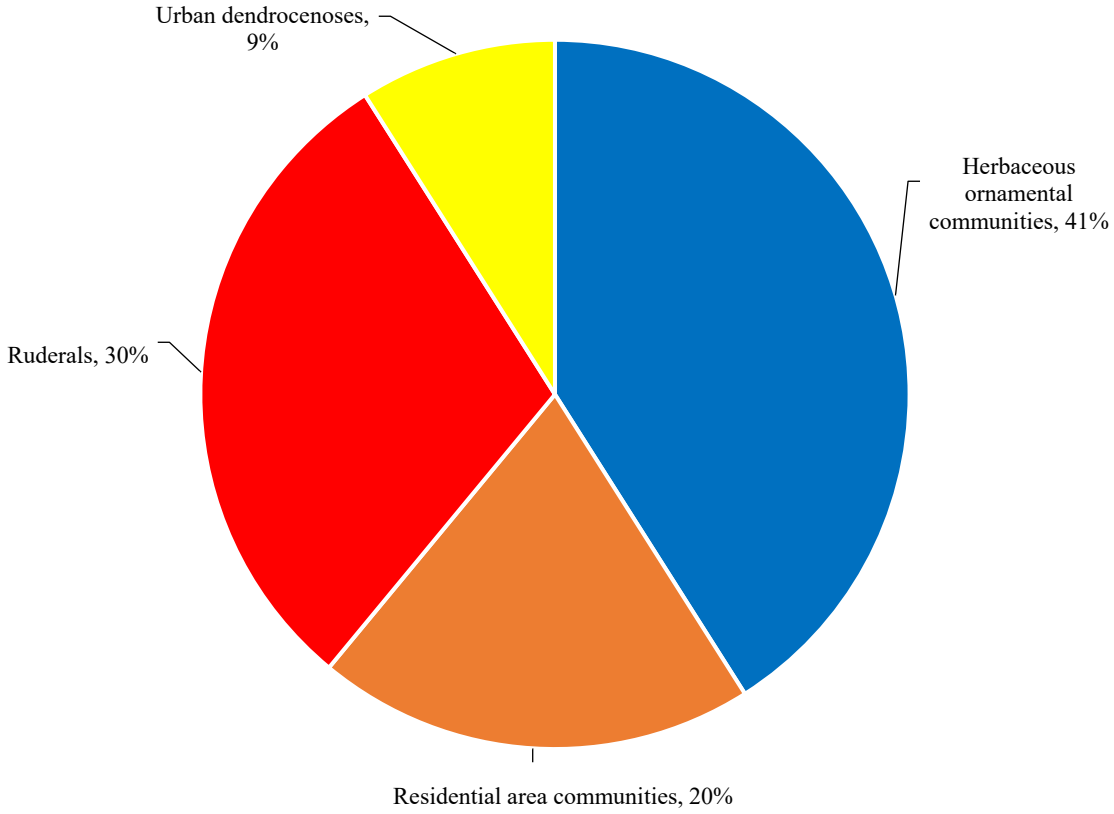

Fig. 1. Distribution of species of poisonous plants by Rostov-on-Don biotopes

Most poisonous plants were found in flower beds and parterres, that is, in communities of ornamental herbaceous plants (Flower garden) — 27 species (41% of the total number of species). Twenty species (30%) were associated with Ruderal cenoses. Thirteen species (20%) were found in the Residential areas. The least number of species was included in urban dendrocenoses — 6 species (9%).

The resulting distribution was quite natural, considering that artificial communities of flower beds and parterres included a diverse range of plants. However, planning elements of landscape design and green construction did not take into account the risks of poisoning by poisonous ornamental plants. For example, representatives of the buttercup family from the genera *Anemone* and *Aquilegia* contain alkaloids and glycosides that are dangerous to life and health, yet they are very popular among flower growers.

Many poisonous plants belonged to the group of ruderals. They grew in littered, unkempt territories, on roadsides, wastelands, etc. Ruderal poisonous plants were characterized by high rates of reproduction, quickly capturing new habitats, that is, they were powerful and uncontrolled sources of toxic substances. The group included such deadly species as poison hemlock (*Conium maculatum*), black henbane (*Hyasciamus niger*), European birthwort (*Aristolochia clemetitis*), and others.

Poisonous plants of residential areas were, as a rule, single specimens or group plantings in the private sector or elements of phytodesign on the territory of residential complexes. With an unqualified selection of the species, only decorative characteristics of the planting material were considered. However, such plants were quite dangerous, even in small numbers.

In recent decades, the American pokeweed (*Phytolacca americana*) has become widespread in southern Russia, including Rostov-on-Don. Pokeweed is native to North America, but the species is widespread on the Eurasian continent. The decorative qualities of pokeweed have caused it to be cultivated in different countries, and as a result, local ecosystems have suffered from another invasive species. Pokeweed has negatively affected the biocenoses of South Korea [20] and Italy [21]. It spreads due to its unpretentiousness, ability to grow rapidly and reproduce by producing large numbers of seeds. All parts of pokeweed, including attractive berries, contain saponins and alkaloids [22], which can cause serious poisoning when ingested by humans and animals.

Biomorphological analysis of the toxic flora of Rostov-on-Don revealed the predominance of perennial grasses. These included 30 plant species (45% of the total number of studied species). 14 species (21%) of poisonous plants were annual. Shrubs and trees came in third place with 15 species (23%). Lianas and biennials were also found among

the poisonous plants, the proportion of which did not exceed the total number of species. The resulting distribution was expected and reflected the proportion of life forms in the flora of the Rostov-on-Don agglomeration, where perennial grasses also predominated, and shrubs and trees were represented in smaller numbers [18]. It is worth noting that the largest number of poisonous plants belonged specifically to families with a predominance of herbaceous forms (Ranunculaceae, Solanaceae). A similar distribution of biomorphs was observed in the toxic flora of Saratov, where perennial grasses and shrubs also played a significant role [13].

Toxicity classes reflect the degree of danger of a particular species to humans and animals (Fig. 2).

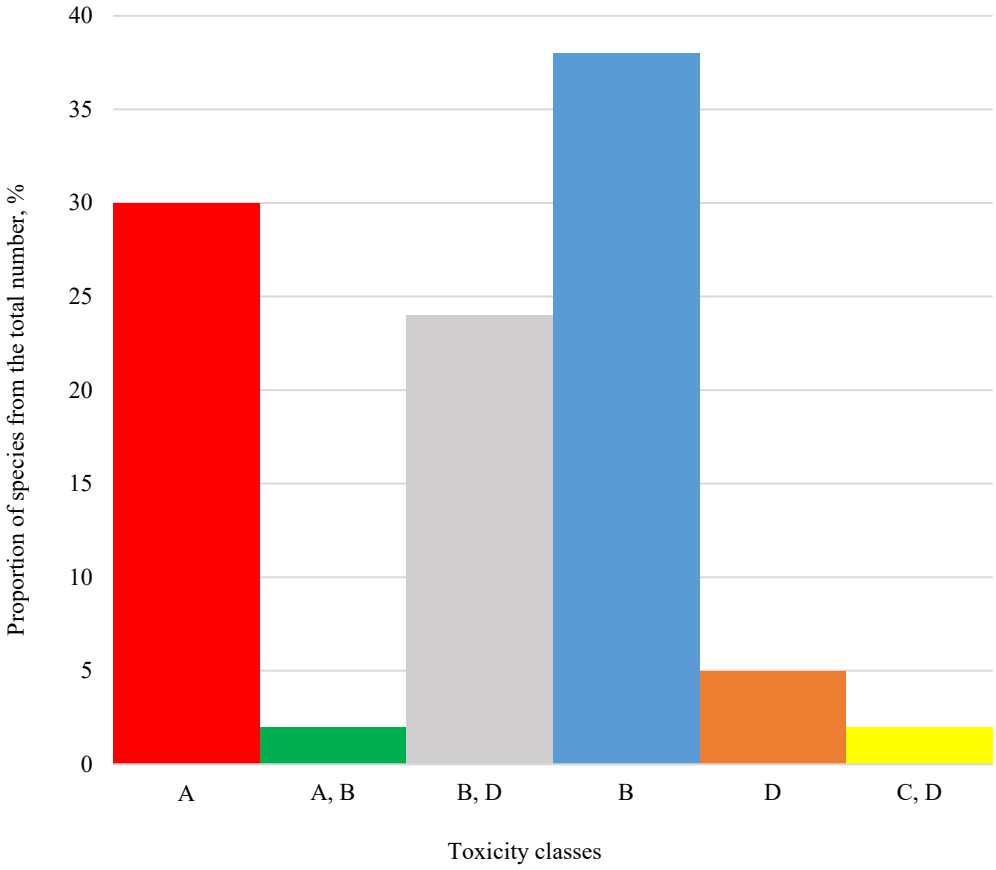

Fig. 2. Distribution of species of poisonous plants in Rostov-on-Don by toxicity classes

Some types combined the properties of two classes. As an example, *Hedera helix* and Hedera colchica ivies were climbing, evergreen vines that were increasingly used in private gardening (Fig. 3). The juice of these plants could cause burns and skin irritation (Class D), and when ingested, ivy caused gastrointestinal disorders (Class B).

Fig. 3. Colchian ivy (Hedera colchica) in the residential area of Rostov-on-Don

Most of the identified poisonous plant species did not have a significant toxic effect, although their use could lead to gastrointestinal discomfort. There were 42 such species, accounting for 64% of all identified species. Of these, 16 caused irritation or skin damage, and were therefore classified as Class D. Plants with the most severe toxic effect

from Class A included 21 species (32%). Only one species from Class C was identified (*Maclura pomifera*). The use of these plants threatened calcium oxalate poisoning with edema of the upper gastrointestinal tract and respiratory organs. *Maclura pomifera* was rare, but was found in private landscaping. It was chosen because of the interesting shape of its fruits.

Let us focus on ragweed (*Ambrosia artemisiifolia*) separately. Its allergenic activity in Rostov-on-Don was previously discussed [11]. Some authors pointed to toxic substances in all parts of ragweed, which could lead to negative consequences for the body [23].

Some species, often found in ruderal habitats, had an unconfirmed hazard status, i.e. there was no consensus on their toxicity. These were, for example, Schleicher fumitory (*Fumaria schleicheri*), chickweed (*Stellaria media*), and roadside pepperweed (*Lepidium ruderale*) [19].

The toxicity of plants in all identified cases was due to the presence of alkaloids — 28 species (42% of the total number of species), glycosides — 17 species (26%), saponins — 5 species (7%) and other toxic compounds.

Accessible and attractive plants with noticeable, bright fruits are dangerous (especially for children). In Rostov-on-Don, 14 such species were found (21% of the total number of species). They belonged to the toxicity class B, as a rule, they did not give an acute toxic effect, but they could cause moderate poisoning. Examples included *Parthenocissus sp.* [24] and *Symphoricarpos albus* [25].

Discussion and Conclusion. It is necessary to educate the population of Rostov-on-Don about the possible dangers of plants used for landscaping.

The scientific research described in this article revealed the presence of poisonous plants throughout the city. A significant proportion of these plants were found to be associated with ruderal habitats, where they grow freely and are easily accessible to humans and animals. Additionally, the diversity of toxic flora in urban environments is increasing due to the introduction of ornamental grasses and shrubs that contain dangerous compounds. These findings should be taken into consideration in landscape design projects to ensure the safety of both humans and wildlife.

The study of poisonous flora for the cities of southern Russia has been conducted for the first time. It is planned to study the quantitative characteristics of urban plant communities with toxic species. The data collected will be used to develop recommendations for landscaping and landscape design.

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