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ASSESSMENT OF DECORATIVE QUALITIES OF *LYSICHITON CAMTSCHATCENSIS* (L.) SCHOTT. IN THE CONDITIONS OF THE RIGHT-BANK FOREST-STEPPE OF UKRAINE

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Abstract

People's natural attraction to beauty prompts them to decorate water bodies. As a decorative element of the water surface, aquatic flowering plants and the groups formed by them are of the greatest importance. The aim of our research was to find out the decorative properties of the introduced species Lysichiton camtschatcensis (L.) Schott. in the culture conditions of the "Sofiyivka" National Dendrological Park of the NAS of Ukraine. The decorative characters of plants was evaluated during 2013-2022, according to a scale that includes 20 main features that characterize the general appearance. The highest decorativeness of L. camtschatcensis was recorded according to the characteristics of the duration of flowering (15 points), the strength of the peduncle (10 points), the number of simultaneously open flowers in the inflorescence (12 points), the density (10 points) and the size (5 points) of the inflorescence, the diameter of the flower (5 points), shedding of flower petals (10 points), coloring (15 points) and falling of fruits (10 points). The total score of 141 points (amplitude 40-200) confirms the high decorativeness of L. camtschatcensis in culture conditions.

Key words: *introduction, score of decorativeness, signs of decorativeness, total assessment of decorative characters, water plant.*

INTRODUCTION

As a decorative element of the water surface, aquatic flowering plants and the groupings formed by them have significant importance. Professional selection of plants increases their longevity and the operational period of water bodies. The choice of appropriate plant material depends on the degree of decorativeness, which will enhance the charm and overall impression of the composition (Danilik, 2004).

Among vascular plants cultivated for ornamental purposes, representatives of the *Araceae* Juss family are quite popular. These are typically perennial herbaceous plants with rhizomes or bulbs. Their inflorescence consists of a spadix, almost always surrounded by a modified leaf called a spathe. In monoecious aroids, characterized by the presence of male and female flowers on the same inflorescence, the spadix is usually organized with female flowers located at the bottom and male flowers at the top of the inflorescence (Long et al., 2017).

The family *Araceae* belongs to the order *Alismatales* and includes about 144 genera and 3600 species (Boyce & Croat, 2018; Jiménez et al., 2019).

They are predominantly distributed in tropical and subtropical regions, especially in the tropics of the New World. Some species are widely used as indoor decorative and garden plants. However, the species diversity of decorative representatives still sparks discussions. For example, in China, the diversity of the *Araceae* family comprises 181 species belonging to 26 genera. Among them, only 20 species have aesthetic value. Therefore, introduced species are increasingly used in landscaping. For the past 30 years, approximately 120 species from 14 genera of exotic plants from the *Araceae* family have been cultivated in China (Long et al., 2017).

Studies on the decorative properties and prospects of using hydrophilic plants in water body landscaping in Ukraine have been conducted by R.M. Danilik (2004), V.P. Kucheryavyi and R.M. Danilik (1997), V.M. Holub and N.P. Holub (Holub & Holub, 2002; Holub, 2001), D.V. Dubyna (1982), T.P. Mazur (2000), M.Ya. Didukh and I.V. Chikov (2011),

O.K. Red'ko and A.I. Kushnir (2013), G.A. Chorna (2006).

In particular, R.M. Danilik (Danilik, 2004) studied the hydrophilic vegetation cover in the ecological optimization of water ecosystems within the comprehensive green zone of Lviv city. The features of arrangement and landscaping of artificial and natural water bodies were analyzed by V.P. Kucheryavyi and R.M. Danilik (Kucheryavyi & Danilik, 1997). V.M. Holub and N.P. Holub (Holub & Holub, 2002; Holub, 2001) investigated the hydrophilic flora of the Prydniprovska Upland, decorative hydrophytes of the Right-Bank Forest-Steppe of Ukraine, and the prospects of their use in water body landscaping. In particular, they were involved in the introduction of rare species such as *Trapa natans* L. and *Salvinia natans* (L.) All. into the water bodies of the National Dendrological Park "Sofiyivka" of the National Academy of Sciences of Ukraine.

D.V. Dubyna (Dubyna, 1982) analyzed the species composition of hydrophilic flora, as well as distribution, stocks, biology, rational use, conservation issues, and species enrichment of the *Nymphaeaceae* family. T.P. Mazur (Mazur, 2000) and M.Ya. Didukh and I.V. Chikov (Didukh & Chikov, 2011) studied the taxonomic composition of native and introduced species and varieties in collections of aquatic and riparian plants. In particular, they researched life forms, allelopathic and bactericidal activity of plants, and studied the characteristics of seed and vegetative propagation, primarily representatives of the *Nymphaeaceae* family.

Red'ko O.K. and Kushnir A.I. (Red'ko & Kushnir, 2013), along with Ishchuk L.P. (Ishchuk, 2010a; 2010b), analyzed various groups of decorative plants, most suitable for landscaping water features depending on the zoning of the reservoir, its economic purpose and the structure of the surrounding landscape.

G.A. Chorna (Chorna, 2006) studied the flora of water bodies and marshes in the Forest-Steppe of Ukraine, the ruderalization of coastal habitats, as well as the floristic and cenotic features of mesotrophic marshes.

Among aroids, a group of decorative aquatic and semi-aquatic plants has attracted significant interest - *Calla palustris* L., *Lysichiton camtschatcensis* (L.) Schott., *Orontium aquaticum* L., *Pistia stratiotes* L., *Zantedeschia aethiopica* (L.) Spreng., which have long been cultivated as part of the collection of hydrophilic plants in the National Dendrological Park "Sofiyivka" of the National Academy of Sciences of Ukraine (Chikov, 2016).

One of the less common hydrophilic plants used in landscaping in Ukraine is the Far Eastern introduction *L. camtschatcensis*. In Japan, early in spring, right after the snow melts, this species creates an effect of white spots on marshes and in swampy alder forests due to the formation of a large white spathe (Fujita, 1997; Ohara, 1997). *Lysichiton camtschatcensis* - is a large, sprawling, perennial herbaceous plant reaching up to 75 cm in height, with a thick, white, short, erect rhizome. The basal tufted leaves, numbering from 3 to 8, are gathered in a rosette, with a spongy petiole that is almost flat-convex in cross-section. The leaf blade is large, simple, entire-margined, ranging from elliptic to narrowly elongated, semi-blunt, narrowing near the base, with a thick midrib and lateral veins curved inwards at the tip, not reaching the edge. After flowering, the petiole with the leaf elongates to 40-80, sometimes 100 cm in length, and 15-30 cm in width. The flower stalk is 10-30 cm long and up to 2 cm thick, densely covered with a narrow tubular lower part of a white cover - a modified leaf, 8-15 cm high, transitioning to an elliptical or egg-shaped upper part, which, when fully unfolded, measures 10-19 cm in length and 6-17 cm in width, with a sharply pointed tip. The spadix is cylindrical, densely many-flowered (over 100 flowers), 4-8 cm long and 1-3 cm thick during flowering, and elongated to short-cylindrical, up to 12 cm in length and 5 cm in width during fruit formation. The flowers are bisexual, with 4 small tepals, rounded at the tip; 4 yellow stamens, with a conical-ovate style; berries are 2-seeded; endosperm is absent. Decorative period: April - July (Vegetation of Japan, 1988; *Lysichiton camtschatcensis*. Encyclopedia, Science News & Research Reviews., URL: https://academic-accelerator.com/encyclopedia/lysichiton-camtschatcensis).

According to taxonomic data from WFO (WFO, 2024. *URL: https://www.worldfloraonline.org/taxon/wfo-0000231604* 2024), *L. camtschatcensis* has several synonymous names, including *Aretiodracon camtschatcensis* (L.) A. Gray, *A. camtschaticus* (Spreng.) A.

Grey, *A. japonicum* A. Grey, *Dracontium camtschatcense* L., *D. camtschaticum* Spreng., *L. album* Makino, *L. camtschatcense* (L.) Schott, *L. camtschaticus* Schott, *L. japonicas* (A.Gray) Schott ex Miq., *Pothos camtschaticus* Spreng., *Symplocarpus camtschatcensis* (L.) Bong, and *S. kamtschaticus* Bong. These names, to some extent, reflect impressions from the external appearance and indicate the origin of this species.

The aesthetic features of *L. camtschatcensis* are also reflected in its folk names. For example, the general name "asian skunk cabbage" derives from the term "skunk cabbage," which is used for the entire genus *Lysichiton*, including *L. americanus* Hultén & H. St. John, known for its unpleasant odor. In Japanese, *L. camtschatcensis* is known as "mizubasho" (水芭蕉) due to its resemblance to Japanese bananas. This name evokes more poetic associations rather than an unpleasant odor. Names like "far eastern swamp lantern" or "Japanese swamp lantern" highlight the significant visibility of the white spathes even in darkness (source: https://academic-accelerator.com/encyclopedia/lysichiton-camtschatcensis). The hybrid *L. camtschatcensis* × *L. americanus* = *L.* × *hortensis is* also used for greening coastal wetlands. It is distinguished by larger size compared to the parent forms (*L. camtschatcensis*. Encyclopedia, Science News & Research Reviews., URL: https://academic accelerator.com /encyclopedia/lysichiton-camtschatcensis).

In natural conditions, *L. camtschatcensis* grows in forests in well-moistened areas, near streams, along forest clearings, and in marshy meadows. It looks particularly beautiful near streams, where its delicate white spathes are reflected in the water. In ditches on compacted poor soils, on overgrown areas, *L. camtschatcensis* forms smaller inflorescences and leaves.

L. camtschatcensis is common in mountainous regions along the coast of the Sea of Japan from the northeast to the southern part of Honshu Island, at around 35° north latitude. It also grows in the Khabarovsk Krai (Shantar Islands, mouth of the Amur and Ussuri rivers, northwest coast of the Tatar Strait), in the Magadan Oblast, on the Kuril Islands, the southern part of the Kamchatka Peninsula, and Sakhalin Island (Horikawa, 1992; Fujita, 1997; Vegetation of Japan, 1988).

In Japan, the distribution range of *L. camtschatcensis* closely overlaps with the range of *Alnus japonica* (Thunb.) Steud. The vegetation is represented by a marshy community of *A. japonica* and *Salix udensis* Trautv. & C.A. Mey, reaching heights of up to 10-11 meters with an admixture of *Fraxinus mandshurica* Rupr. var. *japonica*. The understory and shrub layers are sparse. *L. camtschatcensis* dominates in hygrophilous meadows. Herbaceous ground cover is composed of *Calamagrostis langsdorffii* (Link) Trin., *Carex pseudocuraica* L., *Carex rhynchophysa* C.A. Mey, *Cicuta virosa* L. and *Phragmites australis* (Cav.) Trin. ex Steud. (Fujita, 1997).

In the southern part of the Sakhalin and Hokkaido islands, as well as in the southern Kuril Islands, *L. camtschatcensis* is found in species communities with *Caltha fistulosa* Schipcz. and *Carex rhynchophysa* C.A. Mey. The canopy of *Alnus hirsuta* (Spach) Rupr. is usually higher than that of *Salix udensis*. In the herbaceous layer, a high projective cover is noted, consisting of a combination of species such as *Carex dispalata* Boott., *Filipendula camtschatica* (Pall.) Maxim., *Parasenecio hastatus* (L.) H. Koyama subsp. orientalis, and *Petasites japonicus* (Siebold & Zucc.) Maxim. The number of vascular plant species per 100 m^2 ranges from 23 to 30 individuals, while ground mosses reach up to 3 individuals. The tree canopy consists of 1-2 tiers, with the upper tier reaching heights of 9-10 meters and the lower tier reaching 6-7 meters. The crown density is about 55%. The shrub layer is almost absent (projective cover - 1%). Conversely, the herbaceous layer is well-developed, with a projective cover of about 100%, including ground mosses, which make up less than 1% (Vegetation of Japan, 1988).

MATERIALS AND METHODS

In connection with a person's subjective perception of the habits of plants, the problem of an objective comparative assessment of their decorative qualities arises.

The aim of our research was to determine the decorative properties of *L. camtschatcensis* as a promising species for landscaping water bodies in Ukraine.

The research was conducted from 2013 to 2022 in the water bodies of the "Sofiyivka" National Dendrological Park of the National Academy of Sciences of Ukraine. The habitat of *L. camtschatcensis* in the water bodies of the "Sofiyivka" National Dendrological Park of the National Academy of Sciences of Ukraine is shown in Figure 1. *L. camtschatcensis* was introduced in May 2013 from the upper reaches of the water body of the Botanical Garden of Ivan Franko Lviv National University (Catalog…, 2015), where this species grows in an area of about 100 m^2.

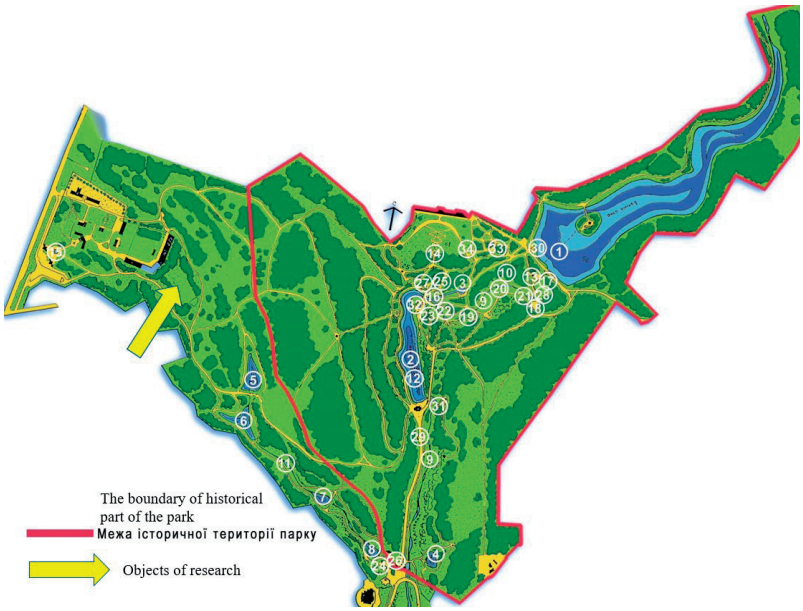

Figure 1. Map showing the placement of water bodies with *L. camtschatcensis* in the"Sofiyivka" National Dendrological Park of the National Academy of Sciences of Ukraine.

The ornamental value of individual plants or groups in plantings was assessed using the scale developed by V.M. Ostapko and N.Yu. Kunets (Ostapko & Kunec, 2009). The developed scale includes 20 main characteristics that characterize the overall appearance, decorative qualities of flowers, inflorescences, shoots, leaves, fruits, and the individual as a whole.

Each sign of decorative qualities is evaluated from 1 to 5 points. To determine the significance of each feature, transfer coefficients were applied. The total amplitude in the overall assessment of the decorative qualities of the plant is calculated by multiplying the decorative qualities estimates by the transfer coefficient. Since the flowers in the inflorescences of representatives of the family *Araceae* are small and inconspicuous, then instead of the decorative assessment of a single flower, we suggest applying similar criteria to assess the decorative qualities of the spathe. Signs of decorative qualities have the following transfer coefficients: the characteristics of the general appearance of the plant: decoration period - 1; duration of flowering - 3; the nature of flowering - 2; Shoot: peduncle strength - 2; color - 1; Leaf: leaf formations - 1; color - 3; resistance to burning - 2; durability - 1; Inflorescence: number on the generative shoot - 2; number of simultaneously open flowers in an inflorescence - 3: density - 2; size - 1; Fruit: color - 3; resistance to fruit shedding - 2; Spathe: the number of open spathe on the plant at the same time - 3; spathe diameter - 1; color - 3; resistance to burning - 2; lodging resistance - 2.

RESULTS AND DISCUSSIONS

In the "Sofiyivka" National Dendrological Park of the National Academy of Sciences of Ukraine, *L. camtschatcensis* is cultivated in the research and introduction area named after V.V.

Mitin (quarter 3). It is planted in an artificial mini-pond (2.5×1.2 m) with a depth of 0.4 m (Figure 1). In the water body, 10 plants of *L. camtschatcensis* were planted, with heights ranging from 10-15 cm and roots measuring 15-20 cm in length, spaced 20-30 cm apart and positioned 5-10 cm deep from the water surface, along the northern side of the pond, under conditions of almost full illumination (Figure 2).

Figure 2. Group of *L. camtschatcensis* plants one year after planting in the artificial mini-pond at the research and introduction area named after V.V. Mitin

During the years 2013-2022, *L. camtschatcensis* has proven itself in relation to ecological factors as a hydrophyte, microthermophyte, sciophyte, mesotroph, glycophyte, and neutrophyte. Over the years of research, in the artificial mini-pond alongside *L. camtschatcensis*, communities have formed with *Butomus umbellatus* L., *Carex strigosa* Huds., *Equisetum hyemale* L., *Mimulus luteus* L., *Nymphoides peltata* (S. G. Gmel.) O. Kuntze, *Potentila indica* (Andrews) T.Wolf, *Schoenoplectus lacustris* (L.) Palla, and *Schoenoplectiella mucronata* (L.) J. Jung & H.K. Choi (Figures 3-4).

Figure 3. Community of hydrophytes, including *L. camtschatcensis*, in the culture of the "Sofiyivka" National Dendrological Park of the National Academy of Sciences of Ukraine during the period of mass flowering

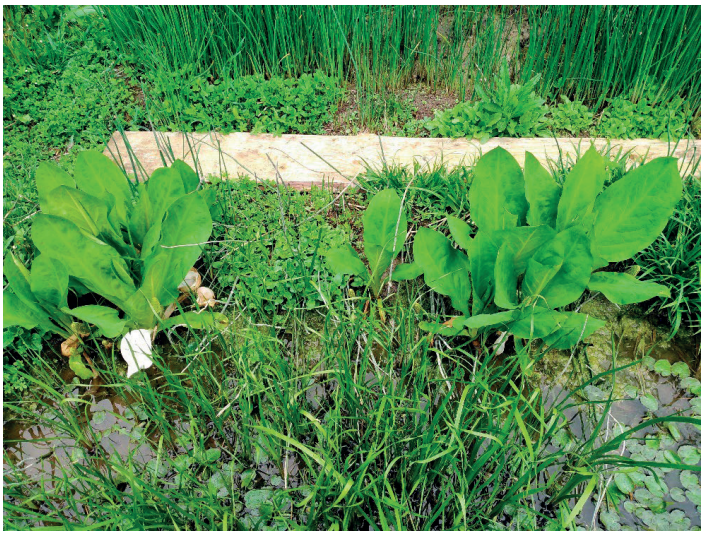

Figure 4. Community of hydrophytes, including *L. camtschatcensis*, in the culture of the "Sofiyivka" National Dendrological Park of the National Academy of Sciences of Ukraine at the end of the flowering period

Every year (up to the age of 10), the height of the plants increased due to the growth of leaves. At the age of 4-5 years, the formation of one inflorescence per plant was noted, and the length of the leaves with petioles was more than 40 cm. The following year, some individuals formed two inflorescences. (Figure 5). The number of seeds in the fruit (72±54 pcs.) depended on the size of the fruits, which were 66.0±14.0 mm in length and 22.0±9.0 mm in width (Chikov, 2020). The introduced plants of *L. camtschatcensis* produce high-quality seeds, with a seed germination of about 50%, indicating the success of their introduction in the conditions of the Right-Bank Forest-Steppe of Ukraine.

Figure. 5. *L. camtschatcensis* during fruiting in the culture of "Sofiyivka" National Dendrological Park

The life cycle of *L. camtschatcensis* begins in early spring (mid April to early May) with flowering, which lasts for about a month. Typically, a generative shoot covered in white bracts appears first, with two leaves on the sides containing underdeveloped leaf blades of lanceolate shape, serving a protective function. Heterophylly is characteristic of *L.*

camtschatcensis. Two weeks later, these leaves bend towards the water and gradually wither, while true leaves emerge from the center near the inflorescence, growing almost vertically. After flowering, the leaves unfold sequentially and grow very rapidly. In June or early July, the number of green leaves reaches its maximum, the largest leaf appears, and the plant biomass is at its peak. From mid-August, leaves with underdeveloped leaf blades develop, and in September, a conical winter bud appears, covered with a small stiff leaf with an underdeveloped leaf blade. From the end of June to mid-August, the seeds float and ripen. The gel-like membrane gradually decomposes and disintegrates. The scattered seeds germinate during the year or after winter. The seedling continues to grow for several years to become a generative plant. Flowering occurs in individuals with leaf lengths ranging from 30 to 70 cm, the size of which depends on the illumination of the area (Fujita, 1997). *L. camtschatcensis* also reproduces vegetatively. In this case, a lateral bud sprouts from the rhizome, which can develop into a vegetative plant. Although *L. camtschatcensis* has two reproductive systems, asexual reproduction is rare (Hokkaido Development Association, 1996).

The visual assessment of the decorative qualities of *L. camtschatcensis* in the collection of hydrophilic plants at the Sofiyivka dendrological park was conducted using the scale developed by V.M. Ostapko and N.Yu. Kunets (Ostapko & Kunec, 2009), which includes 20 main characteristics describing the overall appearance, decorative qualities of the flower, inflorescence, shoots, leaves, fruit, and the plant as a whole (Table 1).

Table 1. Assessment of the decorative qualities of *L. camtschatcensis* according to the scale developed by V.M. Ostapko and N.Yu. Kunets (2009)

Characteristic	Scoring range (min-max)	Transfer coefficient	Feature assessment	Explanation
Characteristics of the general appearance of the plant:				
Decorative Period	2-5	1	3	A specific period of the growing season (spring, summer (April - June))
Duration of flowering	3-15	3	15	Flowering duration exceeds 30 days
Nature of flowering	6-10	2	6	Once per season
Stem:				
Strength of the flower stalk	2-10	2	10	The flower stalks are thick, resistant to bending, and only bend towards the water when the fruits ripen.
Color	1-5	3	3	Light green color, somewhat contrasting with the color of the leaves.
Leaf:				
leaf shape	1-5	1	3	The basal leaves are modified, with the first ones to wither being. The largest the middle ones.
color	3-15	3	6	Light green color
resistance to fading	2-10	2	4	The color of the leaves fades, reducing the decorative effect.
longevity	3-5	1	3	The highest decorative value is observed from the end of flowering to the ripening of the fruits.
Inflorescence: number of flowers on the generative shoot	2-10	2	2	From one to four inflorescences on a generative shoot.
number of flowers simultaneously open in the inflorescence	3-15	3	12	50% of the total amount.
density	6-10	2	10	A type with dense inflorescences.
size	1-5	1	5	Inflorescence length is 15 cm or more.

Bractal leaf spathe: Number of simultaneously open spathe per plant	9-15	3	9	Less than 50%.
spathe diameter (parcel)	1-5	1	5	The diameter of the flower is more than 2 cm.
color	3-15	3	6	Light color.
resistance to fading	2-10	2	4	Fades and changes shade.
lodging resistance	4-10	2	10	Flowers are up to 20% shedding
Fruit: color	3-15	3	15	Fruits are prominently visible, causing admiration
resistance to fruit shedding	4-10	2	10	Shedding occurs only during ripening.
Total score	**40-200**		**141**	**High decorative value.**

In the Lviv Botanical Garden, *L. camtschatcensis* grows at the head of the reservoir with a muddy substrate and shade covering about 80% of its area, showing signs of eutrophication due to the lack of water drainage – the sluice gate is blocked, and there is a significant amount of leaf litter (Shrubovych, 2006). *L. camtschatcensis* in the reservoir is represented by robust plants with large (up to 90×27 cm) leaves and inflorescences with white spathes (approximately 30 cm long). The species thrives well in association with *Caltha palustris* L., *Carex strigosa*, *Filipendula ulmaria* (L.) Maxim., *Geranium phaeum* L., *Houttuynia cordata* Thunb., *Houttuynia cordata* 'Chameleon', *Iris pseudacorus* L., *Lysichiton americanus*, *Lysimachia nummularia* L., *Lysimachia vulgaris* L., *Matteuccia struthiopteris* (L.) Tod., *Plantago major* L., *Ranunculus repens* L., *Thelypteris palustris* Schott., under the canopy of alders (*Alnus* Mill.), willows (*Salix* L.), and poplars (*Populus* L.). Analysis of the experience of cultivating *L. camtschatcensis* in the "Sofiyivka" Dendropark in open areas and in shade in the Lviv National University Botanical Garden showed that the species has higher decorative qualities of habitus in shaded conditions. In our collection, situated in an open sunny area, we observed leaf scorching, so the plants require additional shading.

CONCLUSIONS

In cultivation conditions, *L. camtschatcensis* demonstrated high decorative qualities in terms of: duration of flowering, robustness of the flower stem, density and size of inflorescences, size of the spathe leaf, coloration, and dropping of fruits. The total score of 141 points (range 40-200) confirms the high decorative value of *L. camtschatcensis* in cultivation. In terms of ecological factors, the studied species has proven itself as a hydrophyte, microthermophyte, sciophyte, mesotroph, glycophyte, and neutroph.

In the conditions of the Right-Bank Forest-Steppe of Ukraine, *L. camtschatcensis* is resilient in artificial groupings with *Butomus umbellatus* L., *Caltha palustris* L., *Carex strigosa*, *Equisetum hyemale* L., *Filipendula ulmaria*, *Geranium phaeum*, *Houttuynia cordata*, *Houttuynia cordata* 'Chameleon', *Iris pseudacorus*, *L. americanus*, *Lysimachia nummularia*, *Lysimachia vulgaris*, *Matteuccia struthiopteris*, *Mimulus luteus*, *Nymphoides peltata*, *Plantago major*, *Potentila indica*, *Ranunculus repens*, *Schoenoplectus lacustris,* and *Schoenoplectiella mucronata*, *Thelypteris palustris*.

Under certain conditions, this species can be successfully used for landscaping decorative water bodies in the conditions of the Right-Bank Forest-Steppe of Ukraine. However, considering that another species, *Lysichiton americanus* Hultén & H.St. John, is recognized as invasive and potentially hazardous in the European Union countries, caution is advised with *L. camtschatcensis*, especially in ecologically sensitive natural zones. It is recommended for use in enclosed water bodies where control measures can be implemented.

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