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**NEW COLD-RESISTANT VARIETIES OF WATER LILIES IN LANDSCAPING
ARTIFICIAL RESERVOIRS IN CONDITIONS OF SIMFEROPOL CITY**S.V. KHALYAVINA¹, J.K. KASHIRSKAYA²¹ Nikitsky Botanical Gardens - National Scientific Center, Yalta² Solo Entrepreneur, Florist amateur Simferopol**Introduction**

Water lilies are widely recognized among the most attractive ornamental plants for decorating water surface of ponds. They are an important part in the life of such complex ecological system as a reservoir. Blades of their floating leaves close significant portion of the water surface do not let it to overheat under the scorching sun in hot summers; protect from the wind during periods of bad weather. They form favourable conditions for normal existence of water biocenosis, enrich it with oxygen, serve as a food source for its inhabitants and place for spawning fish, as well as participate in the process of water purification.

Water lily has long been used in ethnomedicine as a medicinal plant. Rhizome of white lily contains many nutrients: starch (49%), protein (8%) and sugar (20%). Young white water lily rhizomes are eatable when roasted or boiled [7, 11]. Studying valuable features of water lilies in the introduction conditions of Foothill Crimea, we identified some biochemical features of white lilies (*Nymphaea alba* L.) as for accumulation of the compounds causing its scent. Composition of refining oil extracted from the flowers was determined. In its composition high content of saturated hydrocarbons, volatile aromatic compounds of terpene origin and compounds with high biological activity was found [13].

For the first time botanists began to speak about water lilies on a professional level in 1735 - there were scientific works of J.P. de Tournefort, where under the name "water rose" an unusually spectacular plants and their exotic bloom were described. In 1753, Carl Linnaeus named the genus (*Nymphaea*). Systematically family Nymphaeaceae (*Nymphaeacea*) was identified in 1806 by R.A. Salisbury. Modern genus includes 60 species; most of them are typical in the zones with tropical and subtropical climate. In flora of Russia three species are presented: European white waterlily (*N. alba* L.), snow-white water lily (*N. candida* C. Presl) and pygmy water lily (*N. tetragona* Georgi). All these species have white flowers, although occasionally there are populations with pink ones [7 - 9]. In the Crimea water lily does not occur in wild [6].

The first attempts to grow lilies in Europe associated with the introduction of thermophilic blue water lily (*N. caerulea* Savign), imported from Egypt in 1801 and planted on the territory of National Museum of Natural History in Paris (Musée de «Histoire naturelle») [7, 9]. Blooming of tropical and subtropical water lilies differs from the representatives of temperate climate zone so that in addition to morning and afternoon flowering, they demonstrate the night blooming. Besides, flowers in tropical nymphaes are of exotic form and flavor, bright colors, including blue, rare and revered in ornamental horticulture. Due to the wide area and diversity of environmental factors affect different species of water lilies have various morphological features of their root system. There are four ecobiomorphological groups: rhizomatous, tuberous, conditionally-rhizomatous and conditionally-stolonate. At the basis of all the existing cultivars of French and American breeding wintering in our waters, there are five types of rhizomatous lilies: white water lily (*N. alba*), pure-white water lily (*N. candida*), fragrant water lily (*N. odorata* Aiton), pygmy

water lily (*N. tetragona*), tuber water lily (*N. tuberosa* Paine) [9]. In the English-language literature rhizomatous lilies are called “hardy winter water lily” [16, 17].

In Europe mass cultivation of species, varieties and cultivars of water lilies began in the mid XVIII - the second half of the XIX century. Creator of the first cold-resistant hybrid lilies was the Frenchman Joseph Bory Latour Marliac. Based on his breeding studies, he received the first cold-resistant cultivars of brightly colored lilies in 1877. According to researches by the International Water Lily Society, for thirty years of his work, until death in 1911, J. Latour Marliac created no less than 60 cultivars of water lilies [16, 17]. For over a hundred years hybrids by J. Latour Marliac dominate the market as a great part of modern assortment of this culture [15], but in recent years in the collections of botanical gardens and florists fans new cultivars, mostly of American and Thai selection began to appear. In water lilies selection originators seek to create new plants with outstanding and/or new decorative features, based on the perception of the whole plant (general habitus) and morphological characteristics of leaf blade and flower, its degree of doubleness, color and form, and so on.

We investigated ornamental and economically valuable biological features of modern breeding cold-resistant cultivars of water lilies in the collection of BG TNU named after V.I. Vernadsky and in the private collection of water lilies in Simferopol to study perspectives for supplement the collection funds in BG TNU with new cultivars.

Materials and Methods

Formation of water lily collection in the Botanical Garden of TNU began in 2009 and it is based on introduction aimed in collecting and demonstrating maximum morphological and biological diversity and giving assess of their efficiency for decorative water gardening in the conditions of Simferopol city. The collection is landscape-integrated - cultivars are exhibited in the garden ponds, now it has two species and 20 varieties of water lilies [12, 14] of different selection periods [15, 16]. To the collection of BG TNU water lilies came from A.V. Fomin Botanical Garden (Kyiv), the Botanical Garden of Ivan Franko National University (Lviv) and the Arboretum of Bolestraszyce (Poland), from private collections [14].

Almost at the same time or some earlier in Simferopol city private collections of water lilies were established by water gardening enthusiasts. One of them - the collection of water lilies by Kashirskaia Yu.K., began to take shape in 1998 and at present time has 68 cultivars of water lilies including more than 40 varieties, created in the late XX - beginning of the XXI centuries - representatives of the new, mostly American and Thai selection. This collection is made up of plants obtained from nurseries in Germany, Poland and private aquatic plants collections of near abroad.

Investigations were carried out in 2009 - 2014 in the ponds of TNU Botanical Garden and private water collection of the open air plants in Simferopol. These collections are in the similar edaphic-climatic conditions and located in the southeastern part of Simferopol city, on the left bank of the river Salgir. Climate in Simferopol is temperate continental, arid with hot summers and cool winters. The average annual temperature 9.2 – 10.3 °C; the average year $t^{\circ}\text{C}_{\text{min}} = -30.0$ °C (January); the average year $t^{\circ}\text{C}_{\text{max}} = + 39,0$ °C (July); annual precipitation 450-500 mm. Number of days per year with $t^{\circ}\text{C} > 5,0$ °C is 220 - 230, that coincides with the length of vegetative season in this region. The mean annual sum $t^{\circ}\text{C} > 10$ °C are 3175 °C. The frost-free period is 160 - 200 days [2].

During the observation period the average daily temperature in winter was between - 1.9 °C to 2.8 °C, in summer - from 21.6 °C to 26.3 °C. The average air temperature in January - from -3.1 °C to 1.7 °C, in July - from 22.6 °C to 26.7 °C, that corresponds to the average long-term indexes [1, 2]. In winter 2012 the lowest average daily air temperature (- 1.91 °C) and minimum daily temperature (-23.1 °C) were noted in February. Maximum summer daily temperature (33.6 °C) was recorded in August 2010. Minimum precipitation were in 2011, 2012 and 2013 - 304.3 mm, 300.3 mm and 303.7 mm, respectively; maximum

(544.0 mm) - in 2010. During the study, the mean maximum water temperature in the reservoir in summer + 19,4 °C was registered in July 2014, absolute maximum + 24,6 °C was recorded in July 2012 and 2014; the average minimum water temperature + 17,1 °C and absolute minimum + 10,1 °C - in August 2010.

The objects of the study were cold-resistant modern cultivars of water lilies registered by the International Water Lily Society since 1990 to the present time: three lilies in TNU BG collection: N. 'Inner Light' (Kirk Strawn, 1997), N. 'Georgia Peach' (Strawn, 1998), N. 'Lemon Mist' (Strawn, 1997) and forty-three cultivars in the private collection of water lilies: N. 'Perry's Double White' (Slocum, 1990), N. 'White Sultan' (Kirk Strawn, 1991), N. 'White Sensation' (Slocum, 1991), N. 'Rattana Ubol' (Pairat Songpanich, 2003), N. 'Franz Berthold' (Franz Berthold jun., 2001), N. 'Bernice Ikins' (Kirk Strawn, 1996), N. 'Mayla' (Strawn, 1993), N. 'Celebrechion' (Strawn, 1994), N. 'Lily Pons' (Slocum, 1992), N. 'Starburst' (Strawn, 1997), N. 'Nigel' (Kirk Strawn, 1993), N. 'Yuh Ling' (Kirk Strawn, 1992), N. 'Red Spaider' (Kirk Strawn, 1993), N. 'Fireball' (Slocum, 1999), N. 'Red Paradise' (Slocum, 1999), N. 'Burgundy Princess' (Strawn, 1993), N. 'Hidden Violet' (McDonald, 2007), N. 'Liou' (Strawn, 1993), N. 'Perry's Double Yellow' (Slocum Water Gardens, 1996), N. 'Yellow Sensation' (Slocum, 1991), N. 'Yellow Queen' (Slocum, 1991), N. 'Gold Medal' (Slocum, 1991), N. 'Lemon Mist' (Strawn, 1997), N. 'Innerlight' (Kirk Strawn, 1997), N. 'Texas Dawn' (Kenneth Landon, 1990), N. 'Little Sue' (Kirk Strawn, 1993), N. 'Colorado' (Kirk Strawn, 1994), N. 'Perry's Autumn Sunset' (Perry's Water Gardens, 2003), N. 'Orange Sunset' (Slocum, 1996), N. 'Barbara Dobbins' (Kirk Strawn, 1996), N. 'Sunny Pink' (Kirk Strawn, 1997), N. 'Peach and Cream' (Slocum, 1992), N. 'Clyde Ikins' (Kirk Strawn, 1996), N. 'Nefelis' (Protopapas, 2004), N. 'Blushing Bride' (Perry's Water Gardens, 1997), N. 'Pink Grapefruit' (Kirk Strawn, 1997), N. 'Peach Lily' (Strawn, 1999), N. 'Almost Black' (Slocum, 1994), N. 'Black Princess' (Slocum, 1998), N. 'Greg's Orange Beauty' (Perry Water Garden, 1996), N. 'Wanwisa' (Best New Waterlily 2010, Nopchai Chansilpa, Thailand), N. 'Siam Purple 1' (Pairat Songpanich, 2007), N. 'Siam Purple 2' (Pairat Songpanich, 2009).

We used common methods for introduction investigation [3 - 5]. Varietal identification of plants based on reputable sources of information [9, 16, 17].

Results and discussion

Evaluation of ornamental features in water lilies species and cultivars is first of all determined with characteristics based on morphological signs variability. Phenological and economic and biological parameters are among important indexes, the most significant of which are terms and duration of flowering, flowering productivity, resistance to diseases, pests and unfavourable weather conditions [5].

On the base of the evaluation we found that studied water lilies cultivars are characterized with differences in growth intensity, duration of the flowering period, in the shape and diameter of flower and leaf blade, leaf and corolla color, and in the degree of flowers doubleness.

By growth intensity: pygmy water lilies, with flower diameter 5 - 8 cm: N. 'Perry's Baby Red'; medium height, flower diameter - up to 15 cm, N. 'Red Paradise', N. 'Black Princess', N. 'Barbara Dobbins', N. 'Celebrechion', N. 'Lily Pons', N. 'Yuh Ling', N. 'Red Spaider', N. 'Hidden Violet', N. 'Colorado', N. 'Peach and Cream', N. 'Nefelis', N. 'Peach Lily', N. 'Siam Purple 1', N. 'Siam Purple 2' etc., vigorous (large): N. 'Perry's Double White', N. 'Bernice Ikins', N. 'Mayla', N. 'Fireball', N. 'Perry's Double Yellow', N. 'Yellow Sensation', N. 'Yellow Queen', N. 'Lemon Mist', N. 'Inner Light', N. 'Texas Dawn', N. 'Perry's Autumn Sunset', N. 'Wanwisa' etc., very large - flower diameter up to 25 cm: N. 'White Sensation', N. 'Sunny Pink', N. 'Orange Sunset', N. 'Rattana Ubol', N. 'Gold Medal', N. 'Sunny Pink', N.

'Pink Grapefruit'. The most interesting for exhibition in the ponds of Botanical garden are middle-height and large water lily varieties.

According to duration of flowering period: in the conditions of Simferopol water lilies blooming is mass, starts in the last decade of May and ends in late September, and under prolonged warm autumn it may continue till late October. Cultivars N. 'Inner Light', N. 'Perry's Orange Sunset', N. 'Georgia Peach' demonstrated up to 150 days blooming. In the conditions of not deep, fast sun warmed reservoirs with water column height of 0.5 - 0.6 m during the thaws in February water lily N. 'Colorado' blooming was noted sometimes.

Due to leaf colour: compared "retro" varieties, some of which have variegated leaf coloring, in a group of new breeding cultivars multicolored specks appeared on leaves: N. 'Gregg's Orange Beauty' (star-shaped flower, diameter of about 12 cm, with 36 – 37 narrow petals; outer petals are pink, central - are yellow. Leaf is elliptic, dark green, diameter 19 - 21 cm, with many spots of brown and maroon-brown color) (Fig. 1), N. 'Blushing Bride'; water lily cultivars with blue flowers N. 'Siam Purpul 1', N. 'Siam Purpul 2' have purple-brown specks on the ventral side of the leaf blade and bright purple - on its dorsal side.

Flower shape: together with traditional "Nymphaeaceae" form of the flower other well recognized shapes appear: spherical - in N. 'Firebal' (flower is of spherical shape, 14 - 18 cm in diameter, with 48 – 50 red petals, light outside and darker in the center of the flower. Leaf is round, dark green, about 26 cm in diameter, with closed section) (Fig. 2); cupped: N. 'Black Princess' (flower intense dark red, cup-shaped, 14 cm in diameter, with 34-36



Fig. 1 *Nymphaea* 'Gregg's Orange Beauty'



Fig. 2 *Nymphaea* 'Fireball'

narrow petals. To date - this is one of the most dark-coloured cultivars. Leaf is almost round, dark green, 20 cm in diameter, with a slightly open incision) (Fig. 3), N. 'Red Paradise', N. 'Orange Sunset', N. 'Siam Purpul 1'; N. 'Siam Purpul 2'; tulip-shaped: N. 'Little Sue'; goblet-shaped: N. 'Burgundy Princess'; chrysanthemum-shaped: N. 'Lily Pons'; peony-shaped: N. 'Blushing Bride'; stellate: N. 'Sunny Pink', N. 'Gregg's Orange Beauty', N. 'Lemon Mist', N. 'Virginia'.

Flower doubleness degree: more than 30 petals such cultivars have: N. 'Black Princess', N. 'Peaches and cream', N. 'Siam Purpul 2'; more than 40 petals: N. 'Fireball', N. 'Mayla' (flower is chrysanthemum-shaped, 13 - 17 cm in diameter, with 40 broadly lanceolate petals of bright pink color. Leaf is round, olive green, smooth, 18 - 20 cm in diameter) (Fig. 4.) N. 'Blushing Bride'.



Fig. 3 Nymphaea 'Black Princess'



Fig. 4 Nymphaea 'Mayla'

Flower color: together with the traditional white, pink, yellow and red water lily flowers new varieties with dark red flowers (considered black) appear: N. 'Black Princess', N. 'Almost Black'; bicolor (outer petals are bright pink, inner ones - cream): N. 'Peaches and cream' (32 - 37 lanceolate petals form a stellate flower, diameter 15 - 20 cm. The outer petals are bright pink, inner are of light yellow color. Flowers rise above the water surface. Leaf is nearly round, green, with reddish-brown elongated spots, 19 - 22 cm in diameter, with a small incision blade) (Fig. 5), N. 'Sunny Pink', N. 'Greg's Orange Beauty'; Peach: N. 'Blushing Bride', N. 'Barbara Dobbins', N. 'Georgia Peach' (flower during the blossom rises up to 10 cm above the water surface, its diameter 15 - 18 cm. In the early blooming flowers are pale pink with yellow tinge and further flower becomes more saturated yellow with pink tinge. Leaves are nearly round, dark green, young leaves with reddish-brown spots, diameter 15 - 18 cm. Cultivar has abundant flowering) (Fig. 6); colorful petals: N. 'Wanwisa' (Flower is stellate, diameter 12 - 13 cm. Petals are red with yellow strokes. Sometimes a few flower petals are yellow. Leaf is elliptic, diameter of 16 - 17 cm. Young leaves are bright purple, adult leaves have clearly visible marble pattern of brown colour) (Fig. 7). Blue-violet corolla color previously typical only for tropical water lilies – presents in N. 'Siam Purpul 1', N. 'Siam Purpul 2' (32-36 bright blue-violet petals and orange stamens form a cup-shaped flower, diameter 12 - 13 cm. Leaf is round, green, 18 cm in diameter, dark red-brown with more marbling on the low side) (Fig. 8).

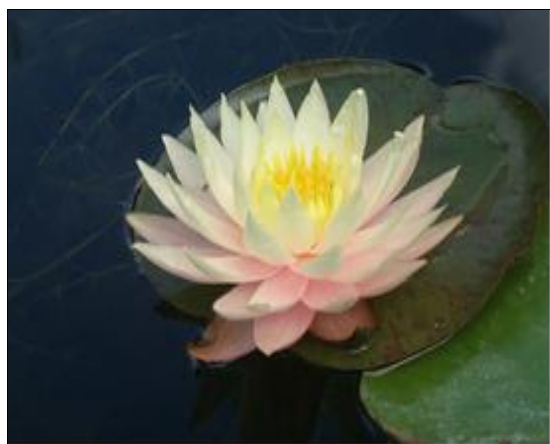
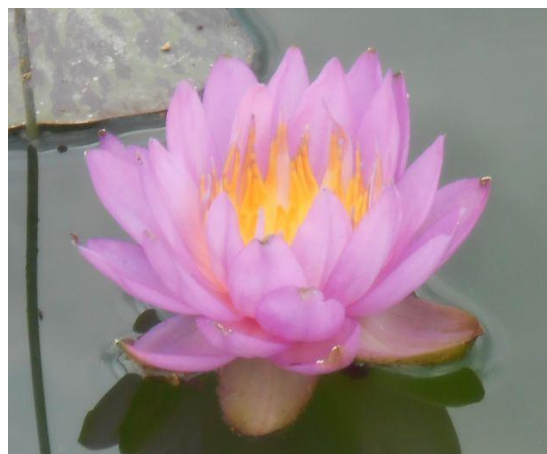


Fig. 5 Nymphaea 'Peaches and cream'.



Fig. 6 Nymphaea 'Georgia Peach'

Fig. 7 *Nymphaea* 'Wanwisa'Fig.8 *Nymphaea* 'Siam Purpule 2'

Conclusions

According to the estimation of the International Water Lily Society, modern world assortment of cold-resistant water lilies has about 300 cultivars [16] that can satisfy the variety of aesthetic preferences of water gardening enthusiasts, but if the collections of amateur gardeners can be formed under the influence of their tastes and preferences, fashion trends, market demand, then for supplement of water lilies collection in BG TNU named after V.I. Vernadsky number of criteria are proposed to use. Formation of the collection should be based on the principles of existing standard classification of varieties, with the advice of botanical gardens and other organizations engaged in water lilies cultivation. Collection should demonstrate the diversity of world assortment of the culture and include both "retro" and modern cultivars. Cultivars that are grade-winners of special exhibitions (for complex of signs) and ones interesting for breeding programs (possessing certain genotypes) should be exhibited

Perspectives for development of water lilies collection fund in Botanical Garden of Tauride National University named after V.I. Vernadsky we observe on the basis of its further supplement with water lilies cultivars according to the complex analysis of their decorative characteristics on the identified features. Among presented assortment water lilies we can recommend: N. 'White Sensation', N. 'Sunny Pink', N. 'Orange Sunset', N. 'Rattana Ubol', N. 'Gold Medal', N. 'Sunny Pink', N. 'Pink Grapefruit', N. 'Red Paradise', N. 'Black Princess', N. 'Barbara Dobbins', N. 'Celebrechion', N. 'Lily Pons', N. 'Red Spaider', N. 'Hidden Violet', N. 'Colorado', N. 'Peach and Cream', N. 'Nefelis', N. 'Peach Lily', N. 'Siam Purple 1', N. 'Siam Purple 2', N. 'Perry's Double White', N. 'Bernice Ikins', N. 'Mayla', N. 'Fireball', N. 'Perry's Double Yellow', N. 'Yellow Sensation', N. 'Yellow Queen', N. 'Lemon Mist', N. 'Inner Light', N. 'Texas Dawn', N. 'Perry's Autumn Sunset', N. 'Wanwisa'.

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The article covers the main morphological characteristics of the flower and leaf of new varieties of cold-water lilies of Simferopol collection. The possibility to replenish the water lilies collection of BS TNU named after Vernadsky V.I. by new modern varieties was studied as well.

Key words: collection of water lilies varieties, new varieties, the Botanical Garden, the ornamental characteristics, economically valued characteristics, the introduction.