California’s endemic *Cornus sessilis* in Ukraine

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Introduction

Botanical gardens have been the main centers for the introduction, acclimatization and cultivation of the alien and native, rare and widespread plant species since the 16th century. In the second half of the 20th century, they also began to operate as important centers for the protection and conservation of biodiversity, especially rare endemic and relict plant species worldwide. Ukraine is not an exception (Kondratyuk & Ostapko, 1990; Primack & Miller-Rushing, 2009; Krishnan & Novy, 2016). Botanical gardens now have a unique role to play in the climate change projects of plants of new species from in situ to ex situ is the main focus of the scientific activity of the M. M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine (the NBG). Currently, the NBG collection of the living plants of the temperate zone of Eurasia includes about 20000 species. The gene pool of *Cornus* s. l. in the NBG consists of more than 30 species and 40 cultivars including the insufficiently researched and little-known Californian endemic *C. sessilis*. In Europe, it has been grown since 2017 only in Chateau Perouse Botanic Gardens (Saint-Gilles, France) and in Ukraine only the NBG has it. In this article we evaluate the life cycle of the development *C. sessilis* under conditions of introduction different from the conditions of its natural area. To do this, we used the classic traditional methods of the research on the process of introduction, in particular, botanical plant identification, visual observation, phenology, comparative morphological and biometric descriptors. Morphological descriptors (life form, colour and texture of bark, leaf shape, pubescence character, structure of generative and vegetative buds, inflorescences, flowers, fruits and endocarps) of *C. sessilis* genotypes introduced to the NBG are identical to those of plants from their natural habitats. The weight of fruits and endocarps were determined by us for the first time. The results of biometric analysis of the size of leaves and fruits showed that the plants of *C. sessilis* grown in the NBG had the larger leaf blades, but the smaller fruits as compared to those in the wild. In the NBG the plants underwent a full cycle of seasonal development (from the deployment of buds to the leaf fall, inclusive) for 229 days. In general, the phenological strategy of *C. sessilis* genotypes introduced in the NBG corresponds to that of other species of *Cornus* s. str., including *C. mas* L. Our results indicate that *C. sessilis*, California’s rare endemic species new to Ukraine, has adapted to the new conditions – the plants bear fruits and produce seeds. The experience of successful introduction makes it possible to cultivate a new species to expand the diversity of food, medicinal and reclamation plants of the family Cornaceae as well as the use in synthetic breeding to obtain new cultivars with valuable biological and economic properties. *Cornus sessilis* compatibility test as rootstocks for other species is important for clarifying the theoretical issues of family ties of species Cornaceae and practical – for widespread reproduction of the required cultivars *C. mas* breeding in the NBG on a potentially compatible rootstock *C. sessilis*.

Keywords: miner’s cornel; plant introduction; climate change; phenology; biometrics.

Global climate change and increased land use lead to the loss of biodiversity at all levels of the organization of living organisms – ecosystems, species, landscape population, genetic, molecular biological levels, etc. The reaction of plants to anthropogenic impact, according to experts, may be even stronger than postglacial changes. A shift in the thermal isotherm will cause the plants to either move and adapt, or disappear. Endemic species that make up “biodiversity hotspots” require special attention. *Cornus sessilis* Torr. ex Durand, the object of our research, is part of one of these points – the California Floristic Province. Researchers are now focusing their efforts on developing a climate change – related biodiversity management strategy. In the case of the threat of extinction of the species in nature, there is an important method of preserving it in culture (ex situ). M. M. Gryshko National Botanical Garden at the National Academy of Sciences of Ukraine (the NBG) pays great attention to the introduction of rare endemic species from the different geographical and floristic regions of the world. The gene pool of *Cornus* L. s. 1. in the NBG consists of more than 30 species and 40 cultivars including the insufficiently researched and little-known Californian endemic *C. sessilis*. In Europe, it has been grown since 2017 only in Chateau Perouse Botanic Gardens (Saint-Gilles, France) and in Ukraine only the NBG has it. In this article we evaluate the life cycle of the development *C. sessilis* under conditions of introduction different from the conditions of its natural area. To do this, we used the classic traditional methods of the research on the process of introduction, in particular, botanical plant identification, visual observation, phenology, comparative morphological and biometric descriptors. Morphological descriptors (life form, colour and texture of bark, leaf shape, pubescence character, structure of generative and vegetative buds, inflorescences, flowers, fruits and endocarp) of *C. sessilis* genotypes introduced to the NBG are identical to those of plants from their natural habitats. The weight of fruits and endocarps were determined by us for the first time. The results of biometric analysis of the size of leaves and fruits showed that the plants of *C. sessilis* grown in the NBG had the larger leaf blades, but the smaller fruits as compared to those in the wild. In the NBG the plants underwent a full cycle of seasonal development (from the deployment of buds to the leaf fall, inclusive) for 229 days. In general, the phenological strategy of *C. sessilis* genotypes introduced in the NBG corresponds to that of other species of *Cornus* s. str., including *C. mas* L. Our results indicate that *C. sessilis*, California’s rare endemic species new to Ukraine, has adapted to the new conditions – the plants bear fruits and produce seeds. The experience of successful introduction makes it possible to cultivate a new species to expand the diversity of food, medicinal and reclamation plants of the family Cornaceae as well as the use in synthetic breeding to obtain new cultivars with valuable biological and economic properties. *Cornus sessilis* compatibility test as rootstocks for other species is important for clarifying the theoretical issues of family ties of species Cornaceae and practical – for widespread reproduction of the required cultivars *C. mas* breeding in the NBG on a potentially compatible rootstock *C. sessilis*.

Keywords: miner’s cornel; plant introduction; climate change; phenology; biometrics.
and C. eyeleana Q. Y. Xiang & Y. M. Shui) and African C. volkensii Harms comprise a part of the subgenus Cornus or the genus Cornus L. s. str. in the classic genus systems (Eyde, 1988). The results of modern molecular biological studies have confirmed the monophyletic nature of the genus Cornus s. l. (Xiang et al., 2006, 2008; Xiang & Thomas, 2008; Yu et al., 2017). Within it, the authors identified four main clades, the species of which also differ in their morphological features, particularly: (1) species with red fruits and four large bracts (subgenus Cynogloyn (Raf.) Raf. and Syncarpus (Nakai) Q. Y. Xiang), (2) herbaceous plants with small complex cymoid inflorescences and four petal-like bracts (subgenus Arctocrunia (Endl.) Rchb.), (3) plants with white, blue or blue-black fruits, open cymoid inflorescences with small early falling bracts (subgenus Kruinpiog Raf., Yinquina (Y. M. Zhu) Q. Y. Xiang & Bourdoff, and Mesomora Raf.) and (4) plants with red, yellow or purple-black fruits, umbrella-shaped tassels and four scaly bracts (subgenus Sinocornus Q.Y. Xiang, Afrocrumia (Harms) Wangerin and Cornus). The last clade included six species: C. sessilis together with C. mas, C. officinalis, C. eyeleana, C. chinensis and C. volkensii. They formed a related group, the taxonomic rank of which was defined as the subgenus Cornus (Eyde, 1988; Xiang et al., 2005, 2006, 2008) or the genus Cornus s. str. Its diagnostic morphological descriptors are as follows: tree life form, inconspicuous small bracts, the presence of distinct peduncles, umbrella or umbrel- la-shaped inflorescence and endocarp (fruit stones), perfumed with round-ovate cavities. Such cavities are not observed in any other species of the genus Cornus s. l. (Manchester et al., 2010). In fact, molecular studies have confirmed the phylogenetic hypothesis of Eyde (1988), developed by analyzing the morphological features and fossil remains of dogwood species (Xiang et al., 2006; Atkinson et al., 2016). In the genus Cornus s. str. (or subgenus Cornus) four species are most related morphologically and genetically: C. mas, C. officinalis, C. eyeleana and C. chinensis. They form a separate clade. Cornus sessilis which is somewhat phylogenetically distant from them forms its own clade, a sibling to the previous group. Cornus volkensii is even more separated and forms an independent clade, a sibling to other species. These three groups of species have disjunctive habitats. The natural distribution of the first four species is concentrated in Eurasia, C. sessilis exists only on the North American continent, and C. volkensii—only in Africa. Cornus sessilis has a very narrow natural range. The species is local- ized in the continental United States and bounded by Northern California (ridges Klamath Range and Cascade Range), northern Sierra Nevada, and southern Oregon (the Siskiyou Mountains) (Murrill & Poindexter, 2016). The species is characteristic of the shaded, in whole or in part, ecotopes of (ridges Klamath Range and Cascade Range), northern Sierra Nevada, and distant from them forms its own clade, a sibling to the previous group. Cornus sessilis is even more separated and forms an independent clade, a sibling to other species. These three groups of species have disjunctive habitats. The natural distribution of the first four species is concentrated in Eurasia, C. sessilis exists only on the North American continent, and C. volkensii—only in Africa. Cornus sessilis has a very narrow natural range. 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and HN Bolander: s.n., Forest Hill, barcode 2505699 (http://sweetgum.nybg.org); Harvard University Herbaria & Libraries (barcode 00075359, specimens from four authors mounted on one sheet: H.N. Bolander 4555, H. Mann, Dr. J. M. Bigelow and H. Pratten (https://s3.amazonaws.com/huhwebimages/ED27FC015F6794F1/type/full/75359.jpg); Herbarium of the Museum National d’Histoire Naturelle (MNHN: Collection Vascular plants (P), Paris, France): sheet with specimens of two collections, barcode P04539375 (http://coldb.mnhn.fr/catalognumber/mnhn/p/p04539375). Herbarium specimens housed in the National Museum of Natural History (MNHN) are part of the collection of E. M. Durand donated to the Museum in 1868 https://collections.nlm.nih.gov/catalog/nlm:nlmuid-101200035-bk). The condition of the genotypes of plants grown in the NBG was assessed by visual observation and comparison of the biometric indicators of their leaves and fruits and similar literature data on the plants from the natural groups (Murrell & Pindexter, 2016). We examined the following quantitative characteristics of the plants: length and width of the leaf blade; petiole length; length, diameter and weight of the fruit and endocarp. Quantitative indicators were processed by the methods of variation statistics using the software package PAST 2.10 (Hammer et al., 2001). The main descriptors were used to characterize the samples of leaves, fruits and endocarp: mean (M), standard deviation (SD), minimum and maximum value (min – max) and coefficient of variation (V, %). The normality of the frequency distribution of each trait was checked using the W-test Shapiro – Wilk. Most of the characteristics had a normal distribution, with just one, the length of the petiole, deviating from normal (Shapiro – Wilk test W = 0.89, P < 0.05). The level of variability of the quantitative traits was assessed according to Mamayev’s classification (1975).

Fig. 1. Cornus sessilis Torr. ex Durand in M. M. Gryshko National Botanical Garden: 
A, B – 10 year old plant in summer; C – 10 year old plant in autumn; D, E – shoot with leaves; F – leaves

Fig. 2. The beginning of the growing season Cornus sessilis Torr. ex Durand: A – blooming flower buds; B, C – flowering

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We studied the main phenophases of the plants: budbreak, flowering time, expansion and maturation of leaves, fruiting period, continuation of vegetation and leaves abscission during the 2019 growing season according to the generally accepted methods (Koch et al., 2007; Denny et al., 2014). We recorded the phases of the plant development visually and by periodic photography.

Results

Biometric parameters of leaves and fruits (Table 2, Fig. 5). The mean size of the leaf blade is 7.7 × 3.8 cm, of the petiole – 0.9 cm. The length and width of the leaf blades are characterized by an average level of variability (CV = 15.1% and 14.5%, respectively), the length of petioles has a high level (V = 21.4%). The fruits of the studied plants are small, with the mean size of 10.5 × 6.8 mm, the level of variability is average. The biggest fruits of the studied plants were of the size 12.0 × 7.2 mm. According to our data, the mean weight of the fruit is 0.41 g, endocarp – 0.09 g.

Seasonal rhythm of plant development (Table 3, Fig. 4). Certain phenological phases of the development of C. sessilis, as well as other plants, occur when the accumulation of the corresponding amounts of active and effective temperatures (Table 3). In 2019, the spring development of C. sessilis began in the conditions of significant fluctuations in average daily temperature from –2.2 to +10.7 °C. The first visually noticeable period of the plant development, deployment of generative buds, began in March, when the mean daily temperature was less than the biological minimum (+5 °C).

Table 2

| Parameters          | Leaf blade length | Leaf blade diameter | Leaf blade weight | Petiole length | Petiole diameter | Petiole weight |
|---------------------|-------------------|---------------------|-------------------|----------------|------------------|----------------|
| N                   | 35                | 35                  | 6                 | 6              | 6                | 6              |
| x ± SD              | 9.2 ± 7.7         | 38.0 ± 8.0          | 10.5 ± 6.8        | 0.41 ± 0.41    | 9.4 ± 4.6        | 0.09 ± 0.09    |
| min                 | 7.0               | 5.6                 | 2.7               | 0.9            | 0.3              | 0.06           |
| max                 | 14.0              | 10.4                | 5.3               | 12.0           | 7.2              | 10.4           |
| V, %                | 21.4              | 15.1                | 14.5              | 8.4            | 7.8              | 11.2           |

Notes: N – number of measurements x ± SD – mean and standard deviation, min – minimum value; max – maximum value; CV, % – coefficient of variation; * – the distribution is not significantly normal (Shapiro-Wilk test, W = 0.89, P < 0.05).

This was facilitated by rather high maximum daily temperatures in March as a result of which the average monthly temperature exceeded the norm almost 10 times (Table 3, Fig. 4). According to the meteorological
records (Weather in Kiev: https://rp5.ua/Weather_in_Kiev, Zhulyany (airport)) the temperature was lower than the biological minimum only in the first decade of the month. During the remaining period, it was higher than +5 °C, on some days reaching +16.5 – 19.1 °C. The flowering period of *C. sessilis* plants in the NBG began in the last days of March and lasted almost two weeks (Table 3). Throughout the period, the minimum temperature and amount of effective temperatures were higher compared to the biological minimum, due to which the plants had many generative buds. In each inflorescence, we observed 7 to 13 flowers. But most of the ovaries fell in the beginning of June, leaving 2–3 to 5–7 in each inflorescence.

The development and maturation of the leaves and the growth of vegetative shoots, began at the end of the flowering when the last flowers in the inflorescence opened. At the end of the first decade of July, most annual shoots with mature leaves usually had four internodes 5–11 cm in length. The proximal internodes were the longest. In parallel with the growth of shoots, the fruits developed and increased in size. Fruit ripening continued until the second decade of September. During this period, the plants formed the buds to recover the following year.

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Drought and the high average monthly temperature which was observed in the second half of summer and autumn 2019, led to premature and atypical leaf fall. The leaves on the perennial branches of plants began to fall in mid-September at a sum of the effective temperatures of 2319.4 °C (Table 3). In the second decade of October only a few leaves remained on the annual shoots. In general, the seasonal development cycle of *C. sessilis* plants cultivated in the NBG in 2019 lasted 229 days (Fig. 6).

### Table 3

Seasonal rhythm of plant development *Cornus sessilis* Torr. ex Durand

| Phenological phases | Calendar duration |  Σef °C* |  Σt °C* |
|---------------------|-------------------|---------|---------|
| Bud development     | 01.03-29.03       | 0.0-98.1| 0.0-27.8|
| Flowering           | 30.03-15.04       | 106.3-237.1| 313.1-101.5|
| Leaf development and shoots formation | 16.04-10.07 | 252.5-1864.9| 103.1-1260.6|
| Ripening of fruit   | 11.07-08.08       | 1808.3-2430.6| 1272.0-1681.3|
| Continuation of growing season | 09.08-19.09 | 2450.7-3275.3| 1696.4-2316.0|
| Leaf fall           | 20.09-15.10       | 3283.7-3571.4| 2319.4-2486.9|

Note: * – biological zero point + 5 °C; active and effective temperatures are given at the beginning and end of each phenophase.

The drupes first became yellow, then red and only then acquired their purple-black colour, which is why the species was called cornel miner or cornel chokeberry. The fruits of *C. sessilis* have a bitter-sweet taste. The same inflorescence may have drupes that are at the different stages of maturaity. The number of fruits was gradually decreasing throughout the ripening process. Only a few drupes had reached full maturity. June 2019 marked by the higher than normal average monthly temperature and lower than normal amount of precipitation (Fig. 4). Vegetation of plants continued until the second decade of September. During this period, the plants formed the buds to recover the following year.

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### Discussion

*Cornus sessilis* was described in 1855 by two herbarium collections (Durand, 1855). The first was dated 1851 and collected on the banks of Deer Creek, – a tributary of the Sacramento River (California, USA) by Lieutenant A. W. Whipple (1853–1854) exploring the area from the Mississippi River to the Pacific Ocean near the 35th parallel of Northern latitude. Elements of the typical material are stored in three herbariums, including the New York Botanical Garden: samples of *J. sessilis* Torr. ex Durand plant development in 2019 (Kyiv, the NBG): number of days from March 1; Leaf develop., shoots form. – leaf development and shoots formation; Cont. grow. seas. – continuation of the growing season; 1 – phenological phases

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He received it as a part of the collection of the Philadelphia Academy of Natural Sciences in late 1854. The study of this specimen made it possible to complete and publish the description of the species. Plants grown in the NBG are identical to those described in the literature and depicted on the digitized herbarium specimens. They appear healthy, are optimally developed, having dense foliage and well-developed leaves, they grow intensively. There are no significant signs of diseases or injuries, either mechanical or from pests.

Morphological descriptors reflect not only genetically determined and evolutionarily determined factors, but also the response of the plant to certain living conditions in specific localities (Henry, 2005; Belyakov et al., 2017; Lykholyat et al., 2017; Lykholat et al., 2019; Horčinová Sedláčková et al., 2019). They are widely used to control the condition of plants at all stages of introduction – from the initial control to the “complete” acclimatization and naturalization of new species and varietal testing, as well as to preserve plant biodiversity of aboriginal and global floras (Prickuck & Miller-Rushing, 2009; Krishnan & Novy, 2016; Faraji & Karimi, 2020). They are also important for biological control of global climate change. Living collections of introduced plants and controlled growing conditions make it possible to widely use qualitative and quantitative indicators to capture the adaptation process of species to new living conditions.

Our study showed that the morphological features (life form, colour and texture of the bark, leaf shape, pubescence, structure of generative and vegetative buds, inflorescences, flowers, fruits, endocarp) studied in conditions of introduction of C. sessilis plants are identical to those given in literature (Durand, 1855; Weaver, 1976; Ebye, 1988; Murrell & Poindexter, 2016).

There are no data on a detailed statistical analysis of the size of C. sessilis leaves and fruits in the literature. We are the first to provide them (Table 2, Fig. 5). The differences relate mainly to the biometric parameters of the leaf and fruit. The plants introduced to the NBG had larger leaves compared to the wild plants of the species. Variation of the petiole length was in the interval of 7.0–14.0 mm vs. 5.0–10.0 mm, the length and width of the leaf blades – 5.6–10.4 × 2.7–5.3 cm vs 4.0–9.0 × 2.0–4.0 cm, respectively (Murrell & Poindexter, 2016). The larger size of the leaves of C. sessilis plants grown in the NBG as compared to wild plants in California (USA) is likely due to the better water supply of the first stages of growth and development of leaves. Precipitation in Kyiv falls throughout the year, including July, when the next year buds are formed. In the region where C. sessilis is described (on the example of the city of Sacramento), precipitation falls mostly in winter while in July it is practically absent (Table 1). Formation of the small leaves is also caused by an acidic substrate, which is characteristic for the natural ecotopes of the species. The mesomorphic nature of the leaves is confirmed by their anatomical structure. On the plants of C. sessilis from the NBG, Klymenko & Klymenko (2017) have for the first time studied the anatomical structure of leaves in comparison with those of other species of Cornus s. l. and identified distinctive anatomical features of their leaves: dorsiventral type of the structure, slight thickness, membranous adaxial and indistinctly folded abaxial cuticle, adaxial and abaxial epidermis which were different in thickness, average coefficient of palisade, average coefficient of elongation of palisade cells, large volume of intercellular spaces, little stomata per unit area of the leaf. The authors showed also that the studied species of Cornaceae in the NBG were placed as follows according to the degree of mesomorphicism of their leaves and their adaptive anatomical and ecological specificity: Cornus sessilis – Swida sanguinea (L.) Opiz – Cornus mas – Cynoxylon kousa (Büger ex Hance) Nakai – Cynoxylon floridu Raf. – Cornus officinalis. Therefore, the leaves of C. sessilis are the most mesomorphic, which reflects the species’ high demands on the humidity of habitats. In 2019, only six fully developed fruits reached full maturity. Most fruits shed at the different stages of development due to the drought in the second half of July and August. In July, the total monthly precipitation was close to the norm, 73.0 mm, but half of it, 36.0 mm, fell in one day, on the 14th of July 2019 (https://rp5.ua/Weather_in_Kiev, Zhuliany). In August, the precipitation was much lower than normal. In the region of its natural distribution, the species exist in the ecotopes of wet ravines, river banks and wetlands. Under such conditions, the root system is partially provided with moisture, despite the high air temperature and lack of precipitation. In the NBG, the place of growth of the species is drier compared to the natural ecotopes, which has a particularly negative effect on its root system. Probably, the drought may be the cause of the smaller sizes of the fruits of C. sessilis plants in the conditions of introduction than in the wild plants: 9.6–12.0 × 6.5–7.2 mm vs 10.0–15.0 × 5.0–7.5 mm, respectively. The interval of variation in fruit size is slightly shifted to the smaller side as compared to such in wild plants (Murrell & Poindexter, 2016). In the wild plants, the largest fruits were 15.0 × 7.5 mm, whereas ours – 12.0 × 7.2 mm. The maximum length and diameter of the endocarp and the intervals of its variation in the studied plants were also smaller compared with those in the plants of the natural habitats. The length of the endocarp has a smaller range of variation than that of wild individuals of the species, and the corresponding parameter of its diameter is almost the same as known from the literature (Murrell & Poindexter, 2016). Data on weight of the fruit and the endocarp of C. sessilis are not available in the literature (Table 2). We identified them for the first time. The mean weight of the fruit is characterized by medium levels of variability and the endocarp by low levels of variability (Manuyev, 1975).

The results of our study made it possible to expand and supplement the morphological characteristic of the species.

Deciduous shrubs or trees are 1.8–2.2 m tall. The root system is superficial. It has single or multiple stems, ranging 19.5–147.0 cm in height and two to three centimeters in diameter; greyish-brown, orange or orange-brown bark, which peels off on the stems; burgundy, brown or red branches, densely covered with lentils; green young twigs densely pressed-pubescent. Generative buds are terminal, pubescent with short yellowish-brown hairs, vegetative buds are terminal or axillary, solitary or combined with the generative ones. Leaves have short petioles, 7.0–14.0 mm, their base is extended and semiamplexicaul; leaf blades are elliptical, 5.6–10.4 × 2.7–5.3 cm, with cuneate base and acute or short acuminate apex, adaxial surface green or dark green, sparsely appressed-hairy, abaxial surface grey-green or yellow-green, appressed-hairy, with tufts of erect hairs in axes of secondary veins; 4–5 lateral largest veins per side. Inflorescences are small-flowered; the inflorescence axis is 0–1 mm long; with yellowish or brown bracts, lanceolate with acute apex 0.5–1.0 cm long; free peduncles dilated at the top. Flowers: narrow-conical, pubescent hypanthium; sepals 0.1–0.5 mm long; greenish-yellow lanceolate petals 3–4 mm long. Drupes ellipsoid, 9.6–12.0 × 6.5–7.2 mm, weighing 0.3–0.5 g; in the process of maturation their colour changes from green to yellow, red, then purple-black; endocarp is widely fusiform with two lateral grooves, 8.6–10.4 × 4.1–5.5 mm, weight 0.08–0.10 g.

The seasonal rhythm of plant development has long been used as an indicator of the influence of climatic factors. It also reflects the adaptive capacity of plants in the new living conditions (Shumik et al., 2016; Valencia et al., 2016; Richardson, 2018). Seasonal changes in plant dynamics are some of the strongest biotic signals of climate change, which manifests at all levels of living organization – from biome to intraspecific. Therefore, the area of use of the phenological spectrum has been gradually expanding in modern research, primarily due to the global climate change (Richardson et al., 2013; Anderson, 2016; Tang et al., 2016; Mason et al., 2020). The response of the plants to the periodic (seasonal) changes in climatic conditions is an integral part of studies of the introduction, adaptive and acclimatizing ability of plants, especially the new non-traditional species, as well as the selection of new cultivars and forms of plants (Koch et al., 2007; Denny et al., 2014; Shumik et al., 2016). A detailed study of the complete cycle of C. sessilis phenorhythm, as such, has not yet been performed. There are very general data about the flowering and fruiting period of the plants in their homeland: March to June and August to September, respectively (Murrell & Poindexter, 2016). In the climatic conditions of the NBG, C. sessilis plants have undergone a full cycle of seasonal development (Fig. 4) and preserved, in general, the phenological strategy inherent in its natural ecotopes.

The flowering period of the plants of this species in the climatic conditions of the NBG is close to the similar period of C. mas, many cultivars and forms of which are cultivated successfully in botanical gardens (Klymenko, 1990). In 2019, flowering of C. sessilis in the NBG began on March 30 (Table 3). At the beginning of the flowering, the sum of the effective temperatures was small (31.3 °C), but in March of that year sharp differences between the low nighttime and the high daytime temperatures were often observed. As a result, the average monthly temperature...
ture significantly exceeded the norm (Fig. 2). According to our data, the early cultivars of C. mas bloomed together with C. sessilis. Note that during 1976–1988, the average date of the beginning of flowering of C. mas plants was April 8–15. The average sum of the effective temperatures at this time was 550–690 °C. Only in 1983 the plants bloomed on March 27, when the sum of the effective temperatures was 380 °C (Klimenko, 1990).

The ripening period of the fruit lasted 29 days. The drupes became first yellow, after a while red, and then black. This feature clearly distinguishes C. sessilis from the other species of the genus. Few fruits have reached the period of full maturity. This phenomenon is associated, perhaps, with the self-sterility as the biological characteristic of the species, as well as with the weather conditions of this period.

The growing season of C. sessilis in 2019 lasted 229 days. For comparison, the same period of C. mas in 1980–1988 lasted 190–198 days (Klymenko, 1990). During 2000–2016, the average duration of its growing season increased to 220 days. The average sum of the effective temperatures at the beginning of flowering was higher (62.8 °C) (Klimenko, 1990). During 2000–2016, the average duration of its growing season increased to 220 days. The average sum of the effective temperatures at the beginning of flowering was higher (62.8 °C) (Klimenko, 1990).

We have carried out the initial testing of the plants of the little-studied and little-known California’s endemic C. sessilis, introduced in the NBG. The morphological descriptors (life form, colour and texture of bark, leaf shape, pubescence character, the structure of generative and vegetative buds, inflorescences, flowers, fruits, endocarps) of C. sessilis plants grown in NBG are identical to those of the natural biotope plants. We have de-

Conclusions

We assume that such of the leaf fall as in 2019 is not typical. It was caused by a significant drought and the high temperatures in late summer and autumn (Fig. 4). In C. mas plants, for example, the average date when leaves began to fall is October 20, which is later than in C. sessilis in 2019 (September 20). Thus, the longer vegetation period of C. sessilis (229 days) compared to C. mas is due to its ability to begin development in early spring and at the lower amount of the effective temperatures, which is due to its life in the Mediterranean (California) climate.

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