


RESEARCH ARTICLE
Properties and Importance of *Prometheum sempervivoides* (Fisch. Ex Bieb.) H. Ohba as Ornamental Plant Naturally Grown in Erzurum

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ABSTRACT

The purpose of this study is to reveal the usage possibilities in the landscape and to bring an alternative species to the ornamental plant sector by determining the form, length and habitat characteristics of *Prometheum sempervivoides* (Fisch. ex Bieb.) H. Ohba taxon, naturally grown in Erzurum province and its close environment. Within the scope of this research, Erzurum province and its surroundings were scanned and it is determined that there are large populations of this taxon in İspir and Aşkale districts. The plant vegetative characteristics of *P. sempervivoides* taxon in the regions where the plant was found were examined. At the same time, the altitude of the regions was determined and the soil structures were observed and the possibilities of use in landscape applications were evaluated. As a result of field trips, photographs of the plants were taken and their point coordinates were determined by GPS. The morphological characteristics of the specie (plant height, stem length, number of leaves, number of branches of the middle cluster, leaf width and length, flower diameter, stem diameter and branch diameter characteristics, habitat) were recorded. Plant height were varied between 9.0- 16.70 cm by taking the average of the data obtained from all locations. The highest plant height data were obtained from POS-4 coded genotypes from a location at an altitude of 1942 m in Aşkale district. Stem length varied between 3.60 and 9.30 cm, and the highest stem height was determined in the averages of POS-4 genotypes. While the maximum number of leaves was determined with an average of 19.00 in POS-10 genotype; POS-9, POS-8 and POS-2 genotypes were also included in the same statistical group. The highest value obtained for the number of branches of the middle cluster was determined in the POS-3 genotype. These values differed between 4.00 and 10.00 number/plant. As a result of the research, it has been revealed that the species can be used in landscape studies due to its efficacy with its flower color and star-shaped flowers, red showy leaves and ground cover properties. In addition, it can be recommended that they can be used in rock gardens, in collections of succulents etc., since they have adapted to different environments such as stony rocky habitats, steep slopes and arid soil conditions.

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Introduction

Natural plants, forming the flora of every region, have long withstood the long-term conditions of all kinds of environmental conditions. These natural plants are the best guides for evaluating the ecological sciences of that region, as they are organisms that have been resistant to environmental stresses for many years (Atashgahi et al., 2009). Therefore, regional floristic research is the most effective method of studying the geographical and floristic origins of each region in order to manage and conserve available genetic resources.

Turkey is among the richest countries in terms of floristic (Avcı, 2014). According to Turkey's Plants List; there are 11,707 plant taxa in our country and 3,649 of them are endemic (Güner et al. 2012). This number is almost equal to the 12,500 gymnosperm and angiosperm plant species in the whole European continent (Sezen et al., 2014).

Although Turkey has rich plant biodiversity, mostly imported plants are used in landscaping applications. This situation puts pressure on natural flora and threatens the ecological balance (Deniz and Şirin, 2005). The life form of each plant is a specific character based on environmental

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conditions and morphological adaptation (Muller-Dombois and Ellenberg, 1974). In other words, plant morphology is directly related to climatic factors. For this reason, the ease of adaptation of natural species to the ecological conditions of the region in which they are found can contribute to the restoration or reduction of degradation in flora (Tuttu et al., 2019). Low maintenance costs are among the benefits of using natural plants in landscaping due to their resistance to extreme climatic conditions, providing food and shelter for wildlife in urban areas, contributing to soil fertility and reducing erosion, and low fertilizer and irrigation needs (Özhatay, 2009). In addition, the use of natural plants in landscape applications will provide ecological, economic and aesthetic benefits, as well as ecological landscape applications will be realized and success will be higher (Var, 1992; Özyavuz, 2011; Tuttu et al., 2019).

Eastern Anatolia of Turkey Region has a rich flora due to the variable climate and different ecological zones (Özgökçe and Özçelik, 2004). This region has a high average altitude and shows a diverse structure with its high mountains and deep valleys. In the city of Erzurum, there are limited ornamental plant species in landscape applications due to the harsh winter conditions. In the 1970s, adaptation studies of existing ornamental plants and some cold-resistant plants were carried out in Erzurum and used in the Atatürk University campus (Tanrıverdi, 1973). 18 plant species grown in the region were taken to the experiment, it was determined that over 90% adaptation of 4 plant species was achieved (Güçlü, 1988). Yılmaz and İrmak (2004) reported that a total of 60 plant species, 36 trees and shrubs (13 species common) and 24 shrubs (5 species common) were used in Erzurum open-green areas. The city of Erzurum is one of the few places with high settlements in the world with an altitude of about 2000 m. In addition to altitude, the extreme climatic conditions also limit the development and diversity of the plant material to be used (Yılmaz and İrmak, 2004). Especially in the landscape of cities where such climatic conditions are extreme in order to gain more ecological and economic benefits, studies using natural plants should be carried out.

In the literature reviews; It has been determined that there are few studies (Güçlü, 1988; Yılmaz and İrmak, 2004; Yılmaz and Yılmaz, 2009) that could serve these purposes for the region. In addition, there is no study made for *Prometheum sempervivoides* (Fischer ex M.Bieb.) H. Ohba taxon naturally grown in stony rocky habitats, extreme altitudes, arid soil conditions, sunny-open areas and is effective with its ground cover features and eye-catching red stem and leaf beauty (Dilaver et al., 2020) was encountered.

Prometheum sempervivoides (Fischer ex M.Bieb.) H. Ohba taxon belongs to the Crassulaceae family. Crassulaceae family has about 1410 species in 34 genera containing three subfamilies, i.e., Crassuloideae, Kalanchoideae and Sempervivoideae. Sedum L., by far the largest genus of Sempervivoideae and indeed of Crassulaceae, contains ca.430 species (Thiede and Egli, 2007). *Prometheum sempervivoides* is known with Turkish names which vary according to the region such as Horozlelesi (Anonymous, 2020a), Ömürotu; İkbâl flower; Kader flower; Ömür flower. It has a succulent

character. It grows on stony and rocky slopes (Tuttu et al., 2019; Dilaver et al., 2020). It has been stated that the taxon are synonyms of *Rosularia sempervivoides* (Fisch. ex M. Bieb.) Boriss., *Sedum kurdistanicum* Fröd., *Sedum sempervivoides* Fisch. ex M.Bieb., *Sedum sempervivum* Ledeb. ex Spreng. (Anonymous, 2020b, Anonymous, 2020c). The characteristic fiery-red flowers of this alpine *Rosularia* is quite unique in the family. Anthems and styles are also red or reddish. Distribution of the taxon is in Turkey (Anatolia), Georgia, Armenia, Caucasus, North Iran. *Rosularia* look similar to *Sempervivum* except that they have bell-shaped blooms instead of star-shaped (Eggl, 2003).

In this context, the aim of the study is determination of the qualities to be an ornamental plant (Dilaver, 2001; Erduran et al., 2010; Arslan, 2010; Gülbağ, 2016; Dilaver et al., 2020) such as habitat, plant height, stem length, number of leaves, number of branches of the middle cluster, leaf width and height, flower diameter, stem diameter and branch diameter of *P. sempervivoides*, naturally grown in the city of Erzurum and its close vicinity and rich in vegetative biodiversity. Thus, it was aimed to provide data for the cultivation and breeding studies and to suggest landscape using possibilities.

Materials and Methods

Study Area

Erzurum city center was established at an altitude of 1800-2000 m and surrounded by 3200 m high mountains. The topographical structure and geographical location of Erzurum creates a severe continental climate throughout the province. When the climate data of Erzurum city is examined, the average temperature for many years is 5.7 °C; The average lowest temperature was observed in January with -14.0 °C and the average highest temperature was observed in August with 27.2 °C. The annual average relative humidity in the region is 63.58%, and the total annual precipitation is 432 mm (Yağanoğlu, 2019). The temperature in the province, whose winter period covers more than 6 months, decreases in October and starts to increase in April. In the settlement, which is one of the coldest cities of our country, the temperature can drop below -25oC in winter. The period of snow cover extends from October to May. Also, in the city, which has a humid continental climate (Kottek et al., 2006), seasonal temperature differences are high (Yavaş and Yılmaz, 2019).

Field trips were organized to the province of Erzurum and its surroundings and large populations of this taxon were found in İspir and Aşkale districts. *P. sempervivoides* plants were collected from ten different locations (Table 2) in the designated regions. Vegetative measurements were taken and observations were made in the natural conditions of the plant (Figure 1, 5). Photographs of the plants were taken and collected and brought to the laboratory for further measurement.

Study Material

The main material of the study is the natural *P. sempervivoides* taxon taken from ten different locations of

İspir and Aşkale districts in Erzurum. The auxiliary material consists of literature data on the subject, photographs and land registration forms were obtained during field studies.

Method

This study was carried out by organizing field trips in Erzurum and its surroundings, three times a year, considering the seasonal life cycle of the plant between 2018-2020. The samples of *P. sempervivoides* were collected from ten

different locations from 2 different districts (Table 2). Photographs of the plants were taken and their vegetative characteristics were measured (Table 3).

Plants were identified using the standard text “Flora of Turkey and the East Aegean Islands” (Davis, 1965-1985; Davis et al., 1988). After the name of the species, its locality, habitat, altitude, date of collection are given.



Figure 1. General view of the plant and the view from the part specified as the middle cluster

Ten plants with the best quality and aesthetics were selected from each of the determined locations. Plant height, stem length, number of leaves, number of branches of the middle cluster, leaf width and length, flower diameter, stem diameter and branch diameter characteristics were measured

in the selected plants and recorded in the charts (Figure 1, 2). In addition, features such as life form (single, biennial, perennial) and habitats (slope, rocky) were noted in the field and plant photographs were taken (Figure 1, 3, 4, 5).

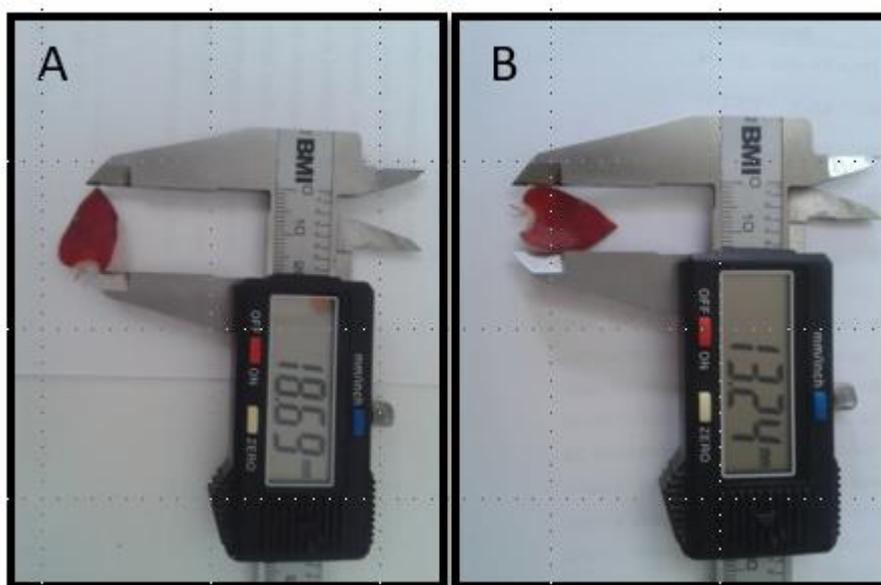


Figure 2. Image representing the plant's leaf height measurement (A); Image representing the leaf width measurement (B)

Data evaluation

In terms of the measured characteristics, the existence of differences between the plants collected from ten different locations of two different districts was determined by analysis of variance. Duncan test at 0.05 significance level was used to distinguish groups from each other in significant differences. SPSS (version 20.0) statistics package program was used in all statistical calculations.

Results

Plant Description

Prometheum sempervivoides is known with Turkish names which vary according to the region such as Horozlelesi

(Anonymous, 2020a), Ömürotu; İkbal flower; Kader flower; Ömür flower. It blooms red in June-August. It is effective with its blood red flowers. It has a slightly short villus structure with an upright posture [regular-vertical form feature (Tuttu et al., 2019)]. The flower-bearing stem emerges from the leaves in the form of rosettes from the base and is about 7-20 cm tall. Each of the leaves is ovoid, flat and pointed and slightly purplish-green in color. The inflorescence, which consists of approximately 30-150 small flowers, is loose. Each flower has 5 pieces and a stem. The petal of each red flower is 6-8 mm long. It grows on open stony and rocky slopes (Tuttu et al., 2019; Dilaver et al., 2020; Messerschmid et al., 2020) (Table 1).

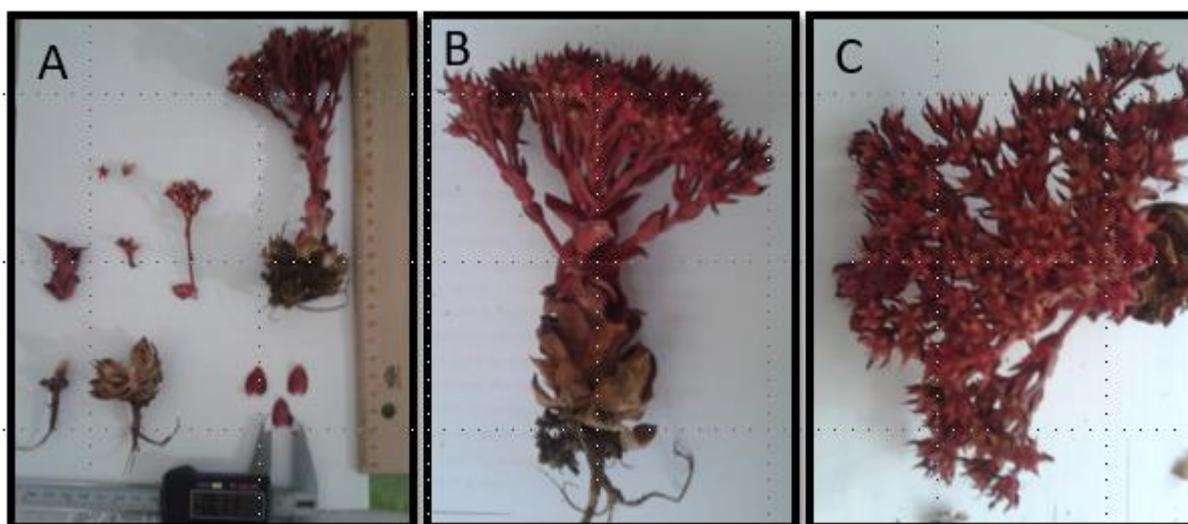


Figure 3. View of the plant's entire morphology (A, B) and view from top of flowers (C)

Table 1. Characters of *Prometheum sempervivoides* (Fischer ex M.Bieb.) H.Ohba defining by Eggli (2005) and Thiede & Eggli (2007) (Messerschmid et al., 2020).

Other Characters of <i>Prometheum sempervivoides</i> (Fischer ex M.Bieb.) H.Ohba	
Clade affiliation	Leucosedum
Inferred phylogeny	Monophyletic
Distribution	N Greece to N Iran, incl. Caucasus
Life form	Annual to perennial herbs
Phyllo taxis	Sessile rosettes, alternate on stems
Inflorescence insertion	Terminal or lateral
Flower merism	5
Petal fusion	Fused for $\leq 1/2$ of Corolla length, never free
Petal colour	Yellow, cream, white, pink or red
Number of stamens	2x petals
Trichomes	Glandular
Rosette branching sympodial	No
Leaf apex	Rounded to mucronate
Filamentin sertion	n.s.
Seeds perfollicle	n.s.
Testa ornamentation	Costate

n.s. - not specified in the literature

Ten locations have been determined in two districts where the species grows in Erzurum, and the altitude range having the plants are found varied between 1447-1942 m. It has been determined that the habitat of the species is rocky places and

its life form is biennial (Figure 5). It was determined that the flowering period was June-August (6-8) (Table 2) (Figure 4).



Figure 4. Views from the flowering period of *Prometheum sempervivoides* and the natural environment of the plant, taken during the field trip



Figure 5. Views of the plants that are in the drying stage and the natural environment of the plant, taken during the field trip on 15 August 2020

Table 2. Information on the locations where plant genotypes are collected

Genotip No	Province	District	Latitude	Longitude	Altitude (m)	Location
POS-1	Erzurum	Aşkale	39° 59'18 "	40° 32'17 "	1935	Askale province, Pırnakapan village
POS-2	Erzurum	Aşkale	39° 59'25 "	40° 32'33 "	1930	Askale province, Pırnakapan village
POS-3	Erzurum	Aşkale	39° 59'32 "	40° 32'23 "	1927	Askale province, Pırnakapan village
POS-4	Erzurum	Aşkale	39° 59'45 "	40° 32'29 "	1942	Askale province, Pırnakapan village
POS-5	Erzurum	Aşkale	39° 59'23 "	40° 32'36 "	1925	Askale province, Pırnakapan village
POS-6	Erzurum	İspir	40° 26'34 "	40° 59'52 "	1447	Ispir province, Korga Mountain
POS-7	Erzurum	İspir	40° 27'42 "	40° 62'55 "	1585	Ispir province, Korga Mountain
POS-8	Erzurum	İspir	40° 26'79 "	40° 57'98 "	1892	Ispir province, Korga Mountain
POS-9	Erzurum	İspir	40° 25'38 "	40° 53'58 "	1500	Ispir province, Korga Mountain
POS-10	Erzurum	İspir	40° 28'12 "	40° 51'63 "	1570	Ispir province, Korga Mountain

The Vegetative Characteristics

The vegetative characteristics of the natural *Prometheum sempervivoides* (Fischer ex M.Bieb.) H.Ohba taxon in the city of Erzurum and its surroundings are given in Table 3. Plant height were varied between 9.0-16.70 cm according to the table 3 created by taking the average of the data obtained from all locations. The highest plant height data were obtained from POS-4 coded genotypes from a location at an altitude of 1942 m in Aşkale district (Tables 2 and 3). Stem length varied between 3.60 and 9.30 cm, and the highest stem height was determined in the averages of POS-4 genotypes. While the

maximum number of leaves was determined with an average of 19.00 in POS-10 genotype; POS-9, POS-8 and POS-2 genotypes were also included in the same statistical group. The middle cluster can be defined as the part that opens from the point where the flower stalks of the plant cluster to the tip of the plant (Figure 1). There is a relationship between the number of branches and flower diameter of the middle cluster. The highest value obtained for the number of branches of the middle cluster was determined in the POS-3 genotype. These values differed between 4.00 and 10.00 number/plant (Table 3).

Table 3. The vegetative characteristics of the natural *Prometheum sempervivoides* (Fischer ex M.Bieb.) H.Ohba taxon in the city of Erzurum and its immediate surroundings

Genotip	Plant height (cm)	Stem height (cm)	Number of leaves per plant	Number of branches of the middle cluster per plant	Leaf width (mm)	Leaf height (mm)
POS-1	9.50 f	3.60 e	13.00 d	6.00 c	13.50 ^{ns}	17.44 bc
POS-2	14.40 bc	7.80 b	17.00 ab	6.00 c	13.24	18.80 bc
POS-3	9.30 f	3.80 e	14.00 cd	10.00 a	13.41	21.92 a
POS-4	16.70 a	9.30 a	16.00 bc	4.00 e	13.25	19.23 b
POS-5	11.50 de	5.50 d	13.00 d	6.00 c	13.08	18.15 bc
POS-6	13.30 cb	6.70 c	14.00 cd	4.00 e	12.85	18.27 bc
POS-7	15.50 ab	8.60 ab	16.00 bc	6.00 c	11.73	19.39 b
POS-8	15.10 a-c	9.20 a	17.00 ab	5.00 d	12.10	16.48 c
POS-9	10.80 ef	6.00 cd	18.00 ab	4.00 e	13.27	10.82 d
POS-10	12.50 bc	6.50 cd	19.00 a	7.00 b	11.82	16.80 bc



Figure 6. View from the dried state of the plant (a) and its seeds (b)

In the light of the obtained data, the leaf width parameter was found to be statistically insignificant and it was determined that there were no significant differences in leaf width among genotypes. Leaf height values were found to be statistically significant and the values varied between 10.82 and 21.92 mm. The highest leaf size data were obtained from POS-3 genotypes (Table 3).

As a result of the study, the flowering and seed-tied samples taken from the locations were waited to dry (Figure 6) and germination was carried out to examine the seed properties. However, their germination has not been successful.

Discussion

Oudolf and Darke (2017) and Oudolf and Gerritsen (2019) stated that natural plants are a wealth and this wealth gains importance by being discovered and utilized in landscapes according to their usage areas. Researchers reported that natural plants do not require any maintenance because they are in their natural habitats. These plants are resistant to all natural phenomena around them because they are compatible with the conditions of their environment (Aydoğdu, 2018). Deniz and Şirin (2005) emphasize that in addition to nature protection, smooth transitions between natural vegetation in rural landscapes and urban landscapes can be achieved, and

thus the balance in the ecosystem and the continuity of this balance can be achieved. The success of achieving these smooth transitions depends on the use of many natural plant species in the urban landscape. Extending the natural plant species to be used in cities is only possible by knowing the design features of the plant species to be used. This can be possible by determining which feature of the plant has the potential to become an ornamental plant with previous studies.

Natural habitats (biotopes) of plants can be determined with these and similar studies, thus, the negative effects of vegetative designs intended to be made in urban open-green areas in applications can be minimized. In this context, according to the observations obtained as a result of our study, it was predicted that the natural *Prometheum sempervivoides* species found in the city of Erzurum and its immediate surroundings can find habitats in stony and rocky areas and at high altitudes such as 1942 m (Table 2) and can be used in this type of unfavorable soil and elevations in vegetal designs. Demircan et al. (2006) have been reported in their study that aimed to put forward tourism potential of Turkey's the succulent plant diversity, that *P. sempervivoides* grows in altitude 1200-2900 m, its habitat is rocky places and its the life form is biennial. The findings and observation results of our study were in parallel with this finding. In addition, the same researchers stated that the flowering period of *Prometheum sempervivoides* species was June-August (6-8). As a result of our field trip observations, its the flowering period was determined as the same months.

Ten locations were determined in two districts where the species grows in Erzurum, and the altitude where the plants are found has varied between 1447-1942 m. It has been determined that the habitat of the species is rocky places and its life form is biennial. Babacan et al. (2017) reported that *Prometheum sempervivoides* (Fischer ex M. Bieb.) H. Ohba identified in open places in an oak forest at an altitude of 1590 m in Tunceli province. It was stated that *Prometheum sempervivoides* species identified from the area of Soguksu National Park (Ankara-Kızılcahamam), grows naturally at an altitude of 1500-1800 m and in 0-20 degrees inclination (Dilaver et al. 2020). The altitude ranges that this species can grow in TÜBİVES records are specified as 1200-2900 m (Anonymous, 2020a).

Due to the global climate change and the intense drought expected to be experienced it is seen that practices are carried out to reduce water consumption all over the world. Drought threat is concerned as well as all over the world and our country. The amount of rainfall that has decreased in recent years is also reflected in the city of Erzurum. For the city of Erzurum, priority should be given to the use of natural species in landscape areas in terms of rational use of water. It will be possible to create, preserve and improve natural environments inside and outside the city and create areas with high aesthetic value by choosing of local species such as *Prometheum sempervivoides*, which are resistant to adverse environmental conditions throughout the city, especially drought and low air temperature. Also, with the use of native species in plant design may break the monotony of the

composition consists of species from the plant cultured with foreign species. By increasing in the visual landscape quality of the city, urban spaces can be used actively. The production of *Prometheum sempervivoides* species with high landscape value revealed in the study should be increased in throughout the country; by means of taking it into culture, researching the reproduction techniques and transferring them to applications or doing breeding studies.

Oudolf and Darke (2017) stated that all landscape design features of natural plants to be used in design should be known. The vegetation period is short due to the fact that the studied taxon is located in the continental climate zone. The flowering period of *Prometheum sempervivoides*, which has eye-catching red flowers, is 3 months, and the star-shaped flowers, which are formed by yellow-colored pollen powders on red during the flowering period, become even more remarkable. In addition, the color turning to burgundy in the period after flowering and the fact that the plant makes a strong impression in this color for a long time is one of the features that can be effective in designs for a long time.

Conclusion

As a result of the study, it has been revealed that the species can be used in landscape studies due to its flower color and star-shaped flowers, and its ability to be effective with its bright red leaves and ground cover properties. In addition, since they have adapted to different environments (stony rocky habitats, steep slopes, arid soil conditions), they can be recommended for use in rock gardens, succulent collections and so on. Also, for future studies, it may be suggested to intensify the research on cultivation and urban adaptation of this species.

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