

Biomorphological study of *Puya mirabilis* indoor condition

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Abstract: The results of research on the introduction of the species *Puya mirabilis* (Mez.) L.B. Sm., a species of the *Bromeliaceae* family into the greenhouse are presented in the article. The propagation of the species by seeds, the morphogenesis of juvenile plants in the initial period of development were studied, a biomorphological analysis of old plants was carried out, and the bioecological characteristics were revealed. According to the results of the conducted research, the perspective of the species in the greening of internal interiors in dry subtropical conditions was evaluated.

Keywords: *biomorphology, Bromeliaceae, developmental biology, indoor conditions, introduction, phytodesign, Puya mirabilis, seed propagation*

INTRODUCTION

Attracting new decorative species to indoor conditions allows expanding and enriching the assortment of subtropical and tropical plants used in interior landscaping. From this point of view, the study of new exotic and rare species represent certain interest.

The long-term study of the biological characteristics, growth and development rhythm, fruiting, seed and vegetative propagation of the introduced species in culture conditions allows to evaluate the adaptability of the plants, tolerance to the introduction and to determine the perspective of their use in future greening works. Tropical and subtropical plants, which are used in recent times in the health improvement and greening of the internal ecological environment, are of special importance. Among these plants, *Bromeliaceae* Juss. family has its own place.

The introduction of species of the *Bromeliaceae* family indoor conditions in Azerbaijan and also in the design and greening of various types of internal interiors (residential, industrial and public buildings) is very promising. The species of the family are distinguished

from other plants by having different life forms, high decorative quality and wide ecological amplitude [Gasimov, 2007; Liu et al., 2022].

In recent years scientific research works on the initial development stage, biomorphology, bioecology and agrotechnics of Bromeliad species in greenhouse conditions have been carried out in Azerbaijan [Korovin, 1984; Evers, 2012; Jabaily, Sytsma, 2010; Gasimov, 2012].

Bromeliaceae is one of the largest families in terms of species composition among monocotyledonous flowering plants. According to B. Smith and R. Downs, the family *Bromeliaceae* includes more than 2.500 species belonging to 46 genera [Smith, Downs; 1979].

Puya Molina includes approximately 200 species [Luther, 2004] of terrestrial, rosette-leaved bromeliads. The genus is of ecological, biogeographical and systematic interest [Jabaily, Sytsma; 2010]. Species of the genus are mainly perennial herbs and most of species are epiphytic and are endemic to the American continent. Only one species – *Pitcairnia feliciana* (A. Chev.) Harms & Mildbr. found in tropical West Africa (Guinea), completely isolated from the main area of the family.

The stem is simple or branched, and sometimes together with the inflorescence, it reaches several meters in height. It is distributed mainly in arid regions, mainly in the Andes, from Colombia to central Chile. *Puya* species grow mainly on the rocky slopes of mountains. They grow on the open top of the Andes, receiving maximum sunlight and easily tolerate very sharp daily temperature changes. Some species of *Puya* play a significant role in the formation of vegetation in which it spreads. Many species of the genus have decorative value [Korovin, 1984].

Since the species of the *Puya* genus grow in areas with different ecological conditions, their cultivation in culture causes certain difficulties. Cultivation can be modeled by adjusting and controlling temperature, humidity, and nutrition factors indoor conditions, but it should be noted that the main limiting factor here is the light regime.

P. mirabilis species is an original exotic plant that

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is rare in culture in Azerbaijan. The main purpose of the conducted research is studying the species of *P. mirabilis* in the indoor condition of the Central Botanical Garden (Baku) and enriching the composition of flower-decorative plant assortments used in greening.

MATERIAL AND METHODS

The experiments were carried out at the Central Botanical Garden (CBG) in 2010-2022. The object of the study is the seeds of *P. mirabilis*, obtained from cultivated plants in the CBG and from foreign botanical gardens through exchange between seed collections. New seeds were selected depending on storage conditions, as it is well known that seeds 3-7 months after ripening lose the ability to germinate. Mature seeds can be planted indoors all year round.

The seed propagation of the species and the dynamics of growth and development of young plants under indoor conditions have been studied. Studying the morphogenesis of the plant in the *juvenile* phase was done by analyzing and graphing the newly formed vegetative organs every week, and phenological observation was carried out on the plant throughout the year to reveal its bioecological features.

For analyzing the morphological features, such as germination and development phase of seedlings were considered. The start time of the main phases of the plant growth rhythm in closed conditions was carried out according to the method of E.S. Smirnova [1980]. In laboratory conditions, seed germination was studied by spreading seeds on wet filter paper in Petri dishes.

Morphological features of seed germination and the study of seedling development based in the method of I.G. Serebryakov [1952], the seasonal growth rhythm of *juvenile* plants and the graphic description of the morphogenesis of vegetative organs are given according to V.V. Skripchinsky et al.[1970]. During the study the methods were modified.

The following indicators were taken into account to assess the prospects of a species in culture, growth and development rhythm, reproductive capacity, the degree of resistance of the plant to pests and diseases, the shelf life of decorativeness and the suitability of the species for greening works. At the same time, while developing agrotechnical methods for the cultivation of *P. mirabilis* species, studies were conducted on the selection of optimal substrates.

RESULTS

The results of the introduction of *P. mirabilis* from the

Bromeliaceae family as a promising new decorative exotic plant in culture are presented in the research. As it is well known the species is a perennial, evergreen, monocarpous, terrestrial, xerophytic plant with underground rhizomes. After flowering, the monocarp rosette withers and a new rosette develops from the leaf axil. The trunk is very shortened, the root system is branched. In the 6-8th year of its development in the 4-6 liter pots, the height of the rosette reaches approximately 35 cm, and the width reaches 50 cm. The number of rosettes is 6-8.

The leaves are numerous, light-green, hard, asymmetrically located, narrow-line, curved, elongated needle-shaped tip, often twisted, 55-70 cm long, forming a dense rosette with stems.

The leaves are bare on top and covered with dense white scales on the bottom. It has hook-shaped spines 0.1-0.17 cm long, the edges of which are directed backwards. The thorns are very sharp, hard and green in color. On the old leaves below the rosette, the spines are reddish-brown in color. Leaf remains form a protective covering at the base of the rosette.

From the center of the rosette develops a long, bracts on the flower axis covered with very hard, sparse scales. Lower bracts resemble the leaves of a rosette, upper bracts are gray-green, thin membranous, margins often prickly, ovate-elliptic up to 3.4 cm long and 1.2 cm wide, upper acute tip 0.4-0.7 cm long. The flower axis is almost straight at the beginning, and bends down when the fruit ripens. Flower group - simple, cluster-shaped, 5-15 flowers, 63-75 cm long, about 0.9-1.2 cm in diameter (Fig. 1a). The flowers open acropetally (from the base upwards) in the flower group. The flowers are funnel-shaped, curved, the flower stalk is 1.8-2.1 cm long (Fig. 1b). Sepals are three and the petals are three pieces, free, small sharp, wide, yellow with green spots, bare, 9-10 cm long and 1.2-1.4 cm wide. Stamens are six, free, slightly shorter than petals, glabrous. The fruits ripen in 3.5-4 months. The fruit capsule is brown in color (Fig. 1c), 2.1-3.2 cm long, 1.4-1.7 cm wide, 3-lobed, the fruit stalk is 2.5 cm long. The amount of seeds in one capsule is about 2100 up to 3600. The seeds are small, narrowly triangular, 0.3 to 0.6 cm long and 0.13 to 0.16 cm wide. The seeds have wing-shaped colorless appendages. Thanks to these wing-like appendages, the seed flies and falls at a distance of 1.2-1.6 m from the plant.

During the research period, the developmental stages of the *P. mirabilis* species was studied under indoor conditions. It should be noted that, like other species

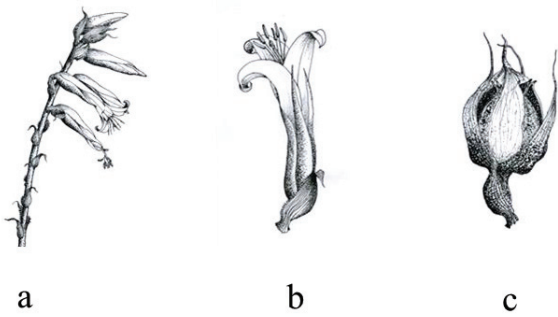


Figure 1. *Puya mirabilis*: a. inflorescence; b. flower; c. fruit.

of this family, the seeds of *P. mirabilis* plant are very small and do not have endosperm [Poddubnaya-Arnoldi 1976]. The immature embryo is small and egg-shaped. In order to determine the growth and development characteristics of *P. mirabilis* under indoor conditions,

the development cycle of the species from seed to mature generative phase was studied.

After harvesting the ripe fruits of the plant, the seeds were washed and cleaned from sugary pulp residues, disinfected with potassium permanganate (KMnO₄) and dried. Various soil mixtures were used for sowing. The substrate used was light, nutritious, porous and had good aeration. The composition of the soil mixture that we most often used for sowing seeds was as follows: sieved leaf rot – 2 parts, finely ground sphagnum peat – 2 parts and sand – 1 part (pH about 4). For seed germination, the constant humidity was 75-85%, and the optimal temperature was 18-20 °C. *P. mirabilis* seeds have a very high germination percentage (up to 90%) under laboratory conditions. From the conducted experiments, it was known that the seeds of *P. mirabilis* begin to swell 3-4 days after sowing and are already visible to the naked eye on the seventh day (Fig. 2, 3).

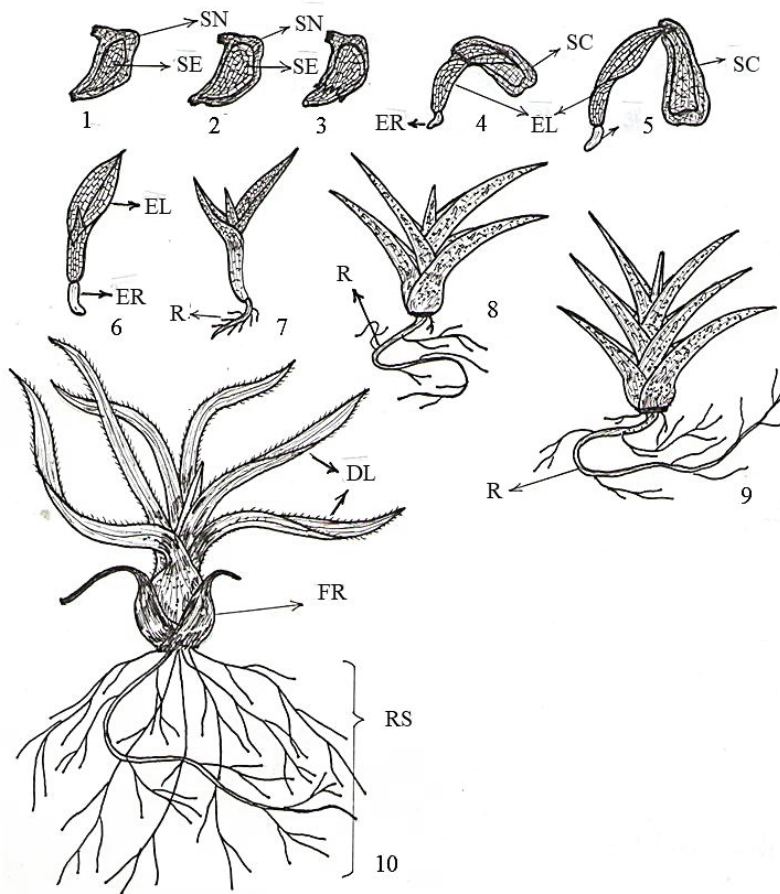


Figure 2. Germination of *P. mirabilis* from seeds and description of morphogenesis of juvenile plants: 1. seed, 2-3. seed swelling, 4-6. formation of the embryonic leaf and rhizome, 7. Sprout, 8-9. Sprouts of 4-month-old; 10. 3-year old seedling. SN – seed net; SE – seed embryo; ER – embryonic root; SC – seed coat; EL – embryo leaf; R – root; DL – definitive leaf; FR – formed rosette; RS – root system.

This plant is characterized by the above-ground type of germination. Seed germination begins with the bursting of the seed coat, and the cotyledon (0.1-0.7 mm long) that initiates the primary root emerges along with the hypocotyl. Its kernels cover the embryo shoot with its ring-shaped base, and the tip remains in the seed coat for a long time, then it goes outside and becomes a photosynthetic organ. The resulting sprout develops very quickly.

A few days after the formation of sprouts, the growth of the main root stops and gradually dies, as a result, lateral roots begin to develop. The sprouts of the plant enter the *juvenile* phase after 9-14 days. These plants are up to 0.4-0.6 cm tall and up to 1.1 cm in diam. The leaves are oblong, light green, 0.2-0.8 cm long and 0.2-0.17 cm wide. As a result of the lack of epicotyl formation and subsequent intercalary development, a rosette sprout begins to form. A rosette consisting of 6-8 leaves, 0.5-1 cm long, with a more or less well-developed root is formed in the plant. The young plant enters the *immature* phase after 2.5-4 months.

Immature plants are about 2-2.3 cm high and 4.2 cm wide, leaves are about 10-14, oblong, green, 1.3-2.7 cm long, 0.2-0.5 cm wide, with tender-green spines. After the main root is destroyed, additional roots up to 3.8-4.1 cm in length develop. The immature phase lasts 1-1.6 years. The immature phase lasts 1-1.6 years.

Virginil plants have rosettes up to 9-12 cm high and 12-15 cm in diam. The leaves forming the rosette

are 6-14 cm long and 0.5-0.7 cm wide at the base. The spines on the leaf are green, more or less hard. The root is fringed and well developed. The virginal period of the plant lasts 2.2-3.1 years.

The 4th, 3rd and 5th year of plant development goes into the *young generative* phase of the generative cycle. At this time, the height of the plant is up to 14-18 cm. The spines on the leaf are reddish in color near the base. The plant blooms for the first time in the young generative phase.

In order to study the seasonal rhythm of development in the old *P. mirabilis* plant during the research period, multi-year phenological observations were made to determine the start time of the main phases of development. It was found that the growth of plants slows down due to the drop in air temperature in the greenhouse during the autumn-winter period. The start of flowering is not fixed and varies from year to year. Flowering in plants is observed in winter-spring and spring-summer. The flowering period lasts 7-10 days and each flower lasts only 1 or 2 days.

As a result of the conducted studies, it was determined that in greenhouse conditions, *P. mirabilis* plant has a period of relative calm in October-April, and maximum growth is observed in July-August. Then the growth process gradually decreases, and starting from November, the plant goes into a period of relative calm, which lasts until March-April. In *P. mirabilis*, the growth and development of the vegetative part ends

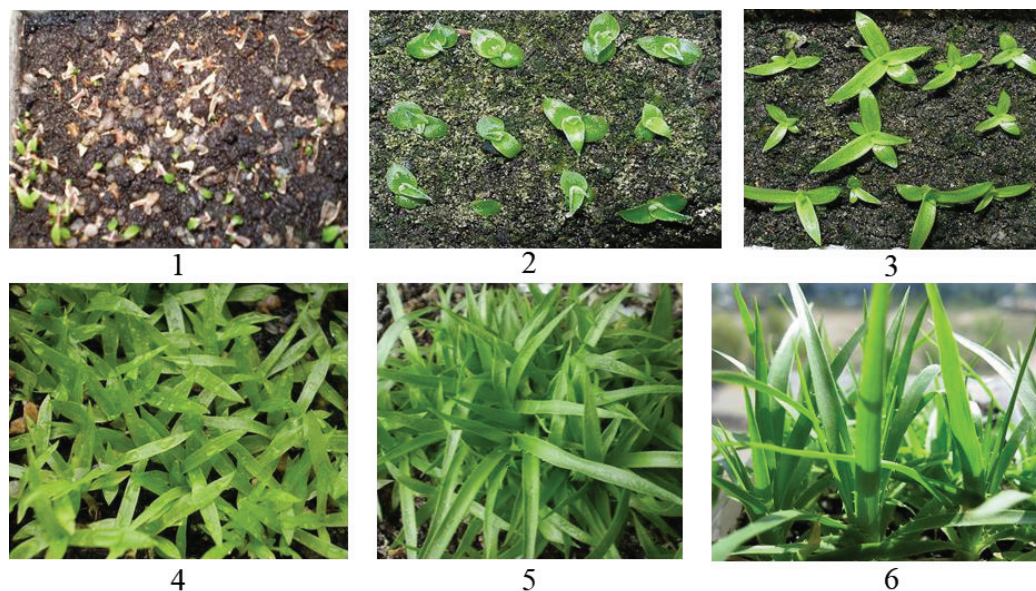


Figure 3. Various developmental stages of *P. mirabilis* seedlings: 1. seed germination; 2-3. sprouts; 4. 4-month-old sprout; 5-6. juvenile plants.

with the beginning of *generative* development. The development cycle of *P. mirabilis* plant from seed to seed takes place within 5-6 years.

To reveal the bioecological characteristics of *P. mirabilis*, the plant was cultivated in various microclimate and soil conditions.

As a result of long-term observations, it was found that plants are not demanding of light. So, they grow well in conditions under direct sunlight, and at the same time in shady and semi-shady places.

In order for a plant to grow normally in a pot, it must have good drainage. The plants are watered twice a week during active growth in spring until mid-October, then gradually reduced to once a week. After the seeds ripen, it is necessary to cut and separate the dried flower axis from the rosette so that this plant can quickly recover and help form a new rosette. *P. mirabilis* is quite tolerant to pests and diseases. The successful formation and maturation of seeds and the ability of the plant to self-regenerate from seed once again confirm that *P. mirabilis* is well adapted to the new cultivation conditions in the CBG greenhouse.

Based on the conducted research, the *P. mirabilis* species can be recommended for use in winter gardens as an exotic plant, in the phytodesign of interiors and in landscaping of buildings used for various functional purposes. Taking into account the results of many years of research, it can be concluded that *P. mirabilis* is a very promising plant for interior design and landscaping as a new decorative exotic plant.

REFERENCE

- Artyushenko Z.T. (1990) Atlas of descriptive morphology of higher plants. Seed. – L: Nauka, 204 p. [Артюшенко, З.Т. (1990) Атлас описательной морфологии высших растений. Семя. - Л., Наука, - 1990, - 204с.]
- Evers M. *Puya mirabilis* - New Crop Summary & Recommendations. Series: New Floricultural Crops: Formulation of Production Schedules for Wild, Nondomesticated Species 2012, University of Minnesota
- Gasimov Sh.N. (2007) Results of the introduction of species of the family *Bromeliaceae* Juss Proceedings of the Central Botanical Garden. 8: 66-77. [Гасымов Ш.Н. (2007) Итоги интродукции видов семейства *Bromeliaceae* Juss. Труды Центрального ботанического сада. 8: 66-77.]
- Gasimov Sh.N. (2010) Cycle of development and stages of organogenesis of monocarpic bromeliads (Bromeliaceae Juss.). *Bulletin of the Moscow state regional university, ser. nat. sci.*, 4: 48-51. [Гасымов, Ш.Н. Цикл развития и этапы органогенеза монокарпических бромелиевых (*Bromeliaceae* Juss.). Вестник Московского государственного областного университета, сер. естеств. науки, 4: 48-51]
- Gasimov Sh.N. Biomorphology and ecological basis of cultivation of tropical plants (*Bromeliaceae* Juss., *Orchidaceae* Juss.) under sheltered conditions. Baku: Elm, 2020, 440 p. [Qasimov Ş.N. Örtülü şəraitdə tropik bitkilərin (*Bromeliaceae* Juss., *Orchidaceae* Juss.) biomorfologiyası və becərilməsinin ekoloji əsasları. Bakı: Elm, 2020, 440 s.]
- Gasimov Sh.N., Efendiyev P.M. (2012) Biomorphology of juvenile plants of bromelia (*Bromeliaceae* Juss.) family. Proceedings of the Institute of Botany of ANAS, - 2012, 32: 363-367 [Qasimov Ş.N., Əfəndiyev P.M. (2012) Bromeliya (*Bromeliaceae* Juss.) fəsiləsinin yuvenil bitkilərinin biomorfologiyası. 32: 363-367].
<http://www.kleo.ru>; <http://www.epiphyte.ru/articles/2004/07/28/156/>
<http://www.theplantlist.org/1.1/browse/A/Bromeliaceae/>
- Jabaily RS, Sytsma KJ. Phylogenetics of *Puya* (*Bromeliaceae*): Placement, major lineages, and evolution of Chilean species. *Am. J. Bot.* 2010, 97(2):337-56. doi: 10.3732/ajb.0900107.
- Korovin S.E. Bromeliads in nature and culture. In: S.E. Korovin, V.N. Chekanova, M.: Nauka, 1984, 168 p. [Коровин, С.Е. Бромелии в природе и культуре. В книге: С.Е. Коровин, В.Н. Чеканова. М.: Наука, 1984, 168 с.]
- Liu L, Zhang YQ, Tumi L, Suni ML, Arakaki M, Burgess KS, Ge XJ. Genetic markers in Andean *Puya* species (*Bromeliaceae*) with implications on plastome evolution and phylogeny. *Ecol. Evol.* 2022. 12(8): e9159. doi: 10.1002/ece3.9159.
- Luther, H. 2004 . An alphabetical list of bromeliad binomials, 9th ed. Bromeliad Society International, Sarasota, Florida, USA.
- Nevado B, Wong ELY, Osborne OG, Filatov DA. Adaptive Evolution Is Common in Rapid Evolutionary Radiations. *Current Biology*, CB. 2019, 29(18):3081-3086. e5. DOI: 10.1016/j.cub.2019.07.059.
- Poddubnaya-Arnoldi V.A. Cytoembryology of angiosperms. V.A. M.: Nauka, 1976, 508 pp. [Поддубная-Арнольди, В.А. Цитозембриология

- покрытосеменных растений. В.А. М.: Наука, 1976, 508 с.]
- Serebryakov I.G. Morphology of vegetative organs of higher plants. M.: Sov. nauka, 1952, 391 p. [Серебряков, И.Г. Морфология вегетативных органов высших растений. - М.: Сов. наука, 1952, 391 с.]
- Skripchinsky V.V. (1970) Methodology for studying and graphically depicting the morphogenesis of monocarpic shoots and the rhythms of seasonal development of herbaceous plants. Proceedings of the Stavropol Research Institute of Agriculture, Stavropol, part 2, issue 10: 3-15 [Скрипчинский В.В. (1970) Методика изучения и графического изображения морфогенеза монокарпического побега и ритмов сезонного развития травянистых растений. Труды Ставропольского НИИ СХ, Ставрополь, 1970, часть 2, вып. 10: 3-15.]
- Smirnova E.S. (1980) Methods of growing plants in interiors. Bull. GBS AS USSR, 117: 36–40 [Смирнова Е.С. (1980) Методика наблюдений за растениями в интерьерах. Бюл. ГБС АН СССР, 117: 36–40]
- Smith B. Downs R. (1979) Flora Neotropica: Bromeliadeae (Bromeliaceae). 14: 1493-2142.
- WFO (2024): World Flora Online. Published on the Internet; <http://www.worldfloraonline.org>. Accessed on: 09 Feb 2024

Örtülü şəraitdə *Puya mirabilis* növünün biomorfoloji tədqiqi

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Məqalədə *Bromeliaceae* fəsiləsindən olan *Puya mirabilis* (Mez.) L.B. Sm. növünün Mərkəzi Nəbatat

Bağının oranjereyalarına introduksiyası ilə bağlı uzun illər aparılan tədqiqatların nəticələri verilmişdir. Növün toxumla çoxaldılması, ilkin inkişaf dövründə yuvenil bitkilərin morfogenezi öyrənilmiş, yaşlı bitkilərin biomorfoloji analizi aparılmış və bioekoloji xüsusiyyətləri araşdırılmışdır. Aparılan tədqiqatın nəticəsinə görə növün quru subtropik şəraitdə daxili interyerlərin yaşıllaşdırılmasında perspektivliyi qiymətləndirilmişdir.

Açar sözlər: biomorfolojiya, *Bromeliaceae*, inkişaf biologiyası, örtülü şərait, introduksiya, fitodizayn, *Puya mirabilis*, toxumla çoxalma

Изучение биоморфологии *Puya mirabilis* в закрытом грунте

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В статье представлены результаты многолетних исследований по интродукции вида *Puya mirabilis* (Mez.) L.B. Sm. из семейства *Bromeliaceae* в оранжерею Центрального ботанического сада. Изучено размножение вида семенами, морфогенез ювенильных растений в начальный период развития, проведен биоморфологический анализ старых растений и выявлены биоэкологические характеристики. По результатам проведенных исследований оценена перспективность вида в озеленении внутренних помещений в условиях сухих субтропиков.

Ключевые слова: биоморфология, *Bromeliaceae*, биология развития, комнатные условия, интродукция, фитодизайн, *Puya mirabilis*, распространение семян