

A Review

Species of the Genus *Lithops* as Indoor Ornamental Plants

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Abstract

The plants of the genus *Lithops* are truly the “living stones” of Africa. The species of this genus reached an amazing adaptation by the color and the aspect of their two modified leaves which successfully mimic the substrate of their natural habitats so that they are hard to spot in the wild, and probably because of this they have been discovered by Europeans only in the XIX century. Because the species of the genus *Lithops* have not been naturalized outside the habitats in which they evolved, their cultivation is as much important since many species are vulnerable in their environment (*Lithops francisci*, *Lithops hermetica*, *Lithops weneri*) and hold importance for biodiversity conservation and because of this they can often be found as part of the succulent collections of the botanical gardens. These plants have become more popular in the last years because are not very difficult to maintain and require little space, being a suitable decorative plant for apartments or offices and at the same time the ideal plants for the busy people since the owner doesn't have to worry if they forget to water them for some time. All these plants need is sufficient light and if the very few simple caring rules required are followed thoroughly, these living stones will know how to fully reward with an autumn bloom. This paper presents some popular species from the genus *Lithops* with their morphological characteristics, environmental factors requirements, cultivation techniques as well as utilization possibilities in extending their use in interior design as pot plants.

Keywords: *Lithops*, living stones, *Aizoaceae*, interior design, pot plants.

1. Introduction

The first recorded account of a species from the genus *Lithops* comes from the botanist William John Burchell who discovered a plant in 1811 when picking a “curiously shaped pebble” from the ground in Prieska, South Africa.

The present name of the genus however, is dating from 1922, being attributed by Nicholas Brown, who combined two Greek terms ‘lithos’ meaning stone and ‘ops’ meaning face [4, 21].

The genus *Lithops* belongs to the *Aizoaceae* family. The genus *Mesembryanthemum* in the widest sense, used to contain over 2500 species (including the species belonging to the genus *Lithops*), it has been split into a large number of separate genera; regarding this it must be noted that it was N. E. Brown working at Kew who first discovered that the genus could be conveniently reclassified according to the structure of the seed capsule [4]. At the present time there are known 37 species belonging to the genus *Lithops*, but a clear delimitation of the species within the genus is challenging because the limited number of morphological characters in these reduced succulents, varies intensely between populations, presumably as adaptations to local geological environments [6].

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At the present time, there are hundreds cultivars in the genus *Lithops* available for growing [9].

Most of the information available today about the species of the genus *Lithops*, is the result of the dedicated work done by Professor Desmond Cole [20], who although was not a botanist [20][23] together with his wife Naureen Cole, became a renown author by his books and articles published regarding the genus *Lithops*. Over the years they have visited many localities where *Lithops* grow, and these localities were all assigned what are known as Cole numbers. At each locality, they collected specimen plants, and seeds. These were all assigned codes, and many of the *Lithops* found in cultivation today have these Cole numbers attached (C001-C420); the numbers give information about the original spot where the plants in question come from [21], and at the present time there are interactive maps [16] and complete lists [20] available online.

Distribution

The genus *Lithops* is native to the south part of the African continent and the species were found growing wild in three countries: Namibia, Botswana and South Africa [17, 5].

These distribution areas in the southern part of the African continent can be divided in 3 categories by the annual precipitation levels as follows: the first area in which the annual precipitations levels is between 125-250 mm and representing mainly the western part of the natural general distribution area from Namibia to South Africa, the second area in which the annual precipitation levels are between 250-1000 mm comprising the center and eastern part of the general distribution area, stretching from Namibia to Botswana and South Africa, and the last area in which the highest levels of precipitations can be met (>1000 mm), in south-west of the South Africa [5].

In the last years, as a result of a series of research programs initiated to evaluate the *Lithops* populations in their natural habitats clear data have been presented indicating their decline, and as a consequence some species have been enlisted on red lists. Seven species have been evaluated as having a decreasing trend of their population in their natural habitats, and among these three have a vulnerable status. These three species are: *Lithops francisci*, *Lithops hermetica*, *Lithops weneri* [12]. Some of these species, like *Lithops weneri* have only one population documented with extent of occurrence estimated at 1 km² in Namibia [8]. Other species, like *Lithops hermetica* is known from only one plateau in a restricted diamond mining area and its

population size is suspected to be < 2,000 [2]. Thus it must be noted that the major threats to the decreasing of *Lithops* populations are collecting of specimens from their habitats as the species are highly sought for live plants and seeds and habitat destruction. In regard with the last statement it must be noted that while one subpopulation of *Lithops ruschiorum* (a Namibian endemic) was reported to have disappeared completely solely due to collecting of live plants, another has disappeared at the Rossing uranium mine and as the largest number of plants were counted in the location right next to the tailings dam of the mine any expansion of the dam is likely to destroy more plants [7].

Morphological aspects in *Lithops*

The basic aspect of a *Lithops* plant, when viewed from the top is an oval divided by a fissure across the middle. The two halves of this oval are the leaves, which have adapted to the dry conditions of the plant's habitat by turning into thick, juicy water-storage facilities [17]. This transformation through the processes of evolution occurred when the two opposite leaves fused together along the outer edges, and foreshortened, so as to form an obconic, turbiniform (top-shaped) body [21].

When removed from the ground and viewed side-on, a *Lithops* plant has the shape of an upturned cone, the 'base' of the cone being the flat top of the leaves, and the point being the place where they emerge from the short stem. This leaf pair is called a head [17], body or corpusculum [21].

The fissure extends downwards, between the closely addressed inner surfaces of the leaves, to the meristem situated immediately above the junction of the leaves with the short stem. When the plant flowers, the bud breaks through the line of adhesion in the middle of the fissure, thus opening up the cleft. Sometimes the cleft opens up even without flowering like in *L. vallis-mariae* [21].

The top surface of the modified leaves may be smooth or marked by tubercles or wrinkles, with translucent or opaque spots varying in color, dimension and pattern, called "windows", through which light penetrates the leaves to the chlorophyll collenchymas and activate the photosynthetic process [18, 4].

Usually when the size of a *Lithops* plant is discussed, it is in reference to either their facial diameters, or their size in terms of how many leaf pairs ("heads") they possess.

A plant which has one pair is monocephalous, and one with multiple pairs is polycephalous. Some species never develop more than one head, and others develop many heads with age [21]. The plants that are most often found buried in the ground

are also usually monocephalous, like *Lithops pseudotruncatella*, while clump-forming species, for example *Lithops marmorata*, will obviously expose more leaf surface [4]. The face diameter varies considerably with age and water regime [21].

With direct reference to their color, *Lithops* have been called “living stones”, because they have evolved to mimic the rock and soil in which they naturally grow [4]. It is the colors and patterns decorating the top surface of the leaves which makes these plants so sought-after.

From the reds and browns of *Lithops lesliei*, *Lithops aucampiae*, and *Lithops hookeri* (syn. *turbiniiformis*), to the greys and greens of *Lithops olivacea*, *Lithops marmorata*, and *Lithops salicola*, no two *Lithops* are ever the same [17].

Lithops pseudotruncatella subsp. *groendrayensis* probably have the most light colors and they have been found growing in areas scattered with white pebbles [22].

Identification of the species, subspecies and varieties, belonging to the genus *Lithops* is based on the examination of the vegetative characters of the adult plant (minimum 3-4 years of age) in the growing season, when the plants are resting the bodies shrivel and the colors are not characteristic. Although the size of the leaf pair it is mentioned in different determination systems proposed, it has not been used as this is a very variable feature, largely dependent upon environmental conditions [4]. As follows there are presented the botanical descriptions of three popular species.



Figure 1. Mature plants of *Lithops salicola* and *Lithops dorotheae* at the end of growing season [24, 25]

Lithops salicola, in general terms it can be described as having the facial profile flat to slightly convex and smooth [23], the size up to 30 mm long and 15 mm wide at the fissure and forming large clumps up to 20 or more leaf pairs [4]. Overall the plant has various shades of grey (Figs. 1, 3) and the flowers are white (Fig. 4). The slightly translucent windows are large [23] dark olive green, sometimes brownish and often with distinct pinkish border to the window. Islands are absent to many, pinkish-brown to grayish-green. There are often dark green flecks in the windows which are sometimes reticulate in arrangement. Short reddish-brown lines are sometimes present around the edge of the window. This species have been found growing wild in salt pans in Orange Free State [4].

Lithops dorotheae, has a facial profile convex (Fig. 1) and smooth with the overall color of the plant buff [23] or light brownish-yellow [4]. The windows are dark and strongly contrasted against the islands and the margins, and they can be either

narrow or open, always well defined with bold red (Fig. 1) rubrications [23]. The size of a body is up to 30 mm long and 20 mm wide at the fissure [4].

Lithops aucampiae, presents a facial profile that is flat to slightly convex [23] (Figs. 2, 3) with a body relatively large in size up to 40 mm long and 20 mm wide at the fissure and often forms large clumps. The overall color of the plant is reddish-brown, with the top surface that can vary in both color and markings, and the flower is yellow (Fig. 4) [4]. These markings range from fine dark lines (channels) to wide dark areas representing the windows [23]. The windows are dark olive-green to reddish-brown with numerous antler-like branches in the outer margin. The pellucid dots are occasionally present but certainly not in all specimens [4].

Different subspecies of *Lithops aucampiae*, can present different variations from the description given above which is accurate for ssp. *aucampiae*, but in the case of ssp. *koelemanii*, for example, it

must be noted that the color is redder and the face is void of windows. The *ssp. euniceae* has well-defined marginal (edge of leaf) protrusions while

ssp. euniceae var. *fluminalis* has marginal protrusions that are finer and generally grey in color [23].



Figure 2. Plants of *Lithops aucampiae* and *Lithops dorotheae* at the start of flowering period [24, 25]



Figure 3. *Lithops aucampiae* and *Lithops salicola* at the end of dormancy [24, 25]

Blooming

Lithops plants grow slowly and under maximum light will flower for the first time at three years of age [19].

Within the annual cycle, the bloom occurs after the leaf pair has fully matured. This is usually in autumn, but can take place before the summer solstice in *L. pseudotruncatella* and after the winter solstice in *L. optica*. [4].

The plants are cross-pollinating and self-infertile, [4] the flowers are hermaphrodite and the cultivated plants can be easily pollinated with a small brush [18, 21]. *Lithops* flowers are mainly white, yellow (Fig. 4) or yellow with white centers,

except for those of *Lithops verruculosa* which has various flower colors sometimes even red/pink. The flowers open in the afternoon, and close just after the sun sets.

On days where there is not much sun they do not open at all [21] but while open some emanate a discreet sweet scent.

The fruit is a capsule made up of a number of segments or loculi which matures after 6-9 months from flowering [18]. The seeds are viable up to 10 years if they are stored within the capsule and the proper storage conditions are respected. The capsule opens up when is wet and closes again when it dries up to protect the remaining seeds [19].



Figure 4. Flowers of *Lithops aucampiae* and *Lithops salicola* in full bloom [24, 25]

Light

In cultivation, *Lithops* can be grown under permanent shading [3, 11] but in these conditions the plants grow fast and slender, tend to become elongated and soft, with a lifelong sensitivity to light, [19] and if sufficient light is not provided they gradually lean to one side and the sides of the plants turn greenish [20]. Coloration is also very bad under permanent shading conditions, this is why it is advised to give shading during necessary hours only [19].

In the apartment conditions *Lithops* do well if they receive about 4 or 5 hours of direct sunlight during the early part of the day, and partial shade during the afternoon. Usually a southern window is the best location, but an unobstructed eastern or western exposure is a good alternative [20].

Temperature

Except for the germination process *Lithops* prefers warm days and cool nights. [19] They will grow best if the daytime temperature is kept between 24°C to 35°C during the summer, and not allowed to fall below 10°C during the winter [17] or below 5°C [20] depending on species.

Humidity

The maximum relative humidity in the different regions of their natural habitats varies from 50% to 80 % with the minimum from 25% to 65 % [18]. *Lithops* have a definite yearly cycle of growth and the watering must be correlated accordingly. The most important rule is to let the soil dry out quite a bit between watering and it should not still be wet when it is watered again, since the plants do not tolerate the prolonged soil humidity and soon will begin to rot [20].

Soil

In nature, these plants live in soil containing virtually no humus, this is why the common potting mix must be avoided, generally containing too much organic matter, and purpose made mixes should be used instead [18] that are mainly mineral based [21]. Because *Lithops* plants prefer a soil with good drainage, perlite can be added to the potting mix, also it must dry relatively quick. If it takes more than 5 to 7 days for the soil to dry out the ventilation or the soil texture must be improved. Ideally the pot soil should be mostly dry about 4 days after watering [11].

In a study conducted in the natural habitats of different *Lithops* species to assess the pH values of the soil, it has been shown that the soil pH value can vary significantly even for the same species, but with the large majority growing in soils with pH 5-8. At the extremes there were two species: *Lithops salicola* (pH=10) and *Lithops lesliei minor* (pH=4.9) [1].

Treatments

Preventive broad spectrum fungicide treatment can be applied during growing season, as well as anti-pest treatment with Imidachloprid once a year if required. Although fertilizing it is not normally needed, liquid fertilizer (Wuxal Super, N:P:K = 8:8:8) can be applied 2–3 times a year [19].

Annual cycle

The annual growing cycle in *Lithops* is determined by water and temperature. Drought or high temperatures trigger the plant dormancy. Dormancy can occur either in the winter or in the summer, although only mature, flowering-size plants won't require water at all over winter [15].

The water requirements for different *Lithops* species can vary significantly.

Some species, especially those which originate from the Transvaal and Orange Free State, grow in areas that have a relatively high annual rainfall sometimes as much as 750 mm a year. This is particularly true of *L. lesliei* and *L. aucampiae*.

Other species, particularly those from Little Namaqualand and S.W. Africa, grow in very arid areas which often receive less than 125 mm of rain a year, or sometimes there may be no measurable quantity of rain for several years, because of this, the species from this area, e.g. *L. francisci*, *L. erniana*, *L. comptonii* var. *divergens* and *L.*

otzeniana, are very sensitive to excess water [4].

If the grower wishes to obtain plants that look similar with those from their natural habitats, it is necessary to first make a detailed research regarding the exact place origin/distribution for that species and then conclusive information regarding the local climate must be obtained, especially regarding the water requirements and light intensity tolerated [15].

In general terms, in the temperate climate of the northern hemisphere, a plant of the *Lithops* genus will go through several stages (Table 1) during one year of life: flowering, dormancy and the decline of the mature leaves, the emergence of the new ones and their growing.

Table 1. Annual Cycle in *Lithops* [10]

Period	Plant Status
January - April	The dry period and the end of the dry period - the new leaves emerge - the old leaves dry out
May - July	Main period of growth
August - September	Period of growth, or Dormant if very hot
October	Flowering
November - December	The start of dry period and the fruit development

Watering calendars

The most popular sources dedicated to lithops shortly describe in general terms the annual cycle and give few advices concerning the watering during a year, without being consistently detailed on species.

In the Table 2, there are presented in comparison two variants of watering calendars, one according to a botanical garden and the second according to an author with interests in succulent plants conservation. In the first variant it can be

observed that it is proposed the discontinuing of any watering from December to February and to induce plants into a summer dormancy from May to August, while in the second variant proposed by Fearn (1981), it is advised to cease the watering of the plants from October and to start them again from March, and continuing them throughout summer until September [4]. The watering calendars are largely dependent of environmental factors such as sunlight and temperature.

Table 2. Variants of leading the annual cycle in *Lithops* by reducing or discontinuing the watering with or without summer resting

Month	Variant I [14]	Variant II [4]
January	R, no water	R, no water
February	R, no water	R, no water
March	A, water once/week	A, water once or twice/week
April	A, water once/week	A, water once or twice/week
May	sR, water once every 3-4 weeks	A, water once or twice/week
June	sR, water once every 3-4 weeks	A, water once or twice/week
July	sR, water once every 3-4 weeks	A, water once or twice/week
August	sR, water once every 3-4 weeks	A, water once or twice/week
September	A, water once /week	A, water once or twice/week
October	A, spraying water once/week	R, no water
November	A, spraying water once/week	R, no water
December	R, no water	R, no water

R = resting (dormancy), sR = summer resting (aestival dormancy), A = active (growing)

Cultivation techniques

For the successful growing of *Lithops* plants, it is recommended the terracotta/clay pots instead of the usual plastic ones, because are more porous, and allow the soil to breathe more easily, also the soil dries out a lot faster [17]. The size of the pots is usually related to the size of the plants, and often they are transplanted in larger pots as they grow. It is important to remember that the older plants develop a cylindrical root that can be quite long and the pots need to be able to accommodate it, but the soil in large pots with small plants dries out too slow and can cause the rotting of the plant.

The propagation of the plants can be made either by seed or cuttings for those who are branched, but rooting them is more difficult, so usually are grown from seed [14, 19]. The old authors recommend the seeding to be executed sometimes in September-October [4], the more recent ones suggest that the best time for sowing is March and April, using a prevalently mineral substrate [18]. The best suited sowing substrate is sterilized with particles size of 1–4 mm [19] consisting mainly of fine and coarse sand [21] and pH-value not above 7. This is filled in pots or trays and made completely wet, before seeds are scattered on top. Seeds are not covered with soil, the germination occurs within 7-10 days under light conditions. Pots or trays must be covered with a thin plastic and kept in a shady place at a constant temperature between 15°C - 20°C. After two weeks germination has finished and the containers can be uncovered. Seedlings are sprayed several times a day and will not be allowed to dry up at all for the

first few weeks. More light is given very slowly and full sun during hot days is avoided for the first year [19, 4]. Before prickling young plants, it must pass at least one year or more [20]. *Lithops* grown in small pots may need repotting every few years but if they grow in larger trays they can stay there for many years untouched [19]. Mature *Lithops* plants may be transplanted all year long [10] and sometimes it is a necessity since the plants tend to bury themselves in the soil with the help of their retractile roots, and while this might be very helpful in their arid natural environments, in pots they either rot or do not receive enough light. Plants can be repotted as often as every two years or so, and it is generally good to do this so that their soil can be renewed [21]. During repotting all roots are trimmed except for a 2–3 cm rest of the main root.

This way plants make new roots much faster and it is assured that roots are straight in the new pot since a plant with a long root potted bent dies slowly [19]. They do not need their roots left out to dry like other succulents (especially cacti), but they should not be watered much for the first week after transplanting [3].

Some authors recommend the plants to be potted with three quarters of the plant over the surface of the soil [20] and to top up with a layer of grit which is useful to prevent root collar from rotting [18].

Alternatively, according to the Figure 5, there are proposed three potting methods that should successfully prevent the prolonged water stagnation around the base of the plant and thus significantly reducing the rotting problem.

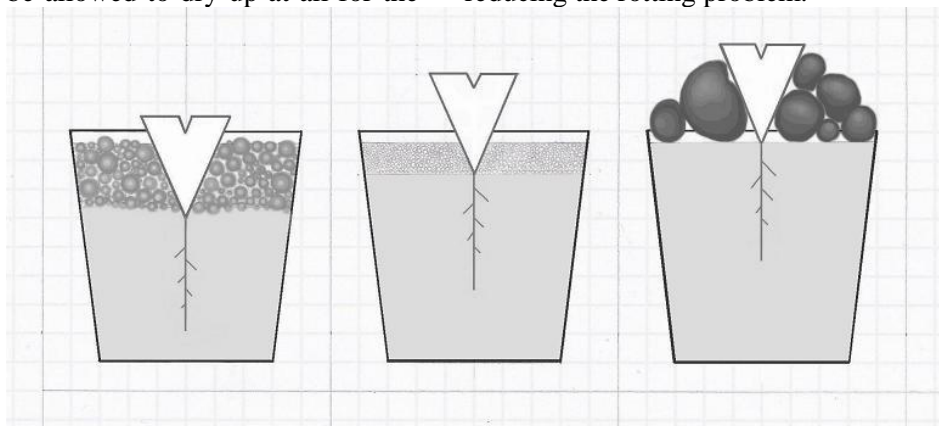


Figure 5. Three potting methods for *Lithops* [24]

In the first case, the leaf pair is planted buried up to the shoulder in the pot similar with the way some species present themselves in their natural habitats. The face with the windows will be the only visible part of the plant, and in this case the plant is

potted deeper and from the base of the “head” upwards the pot is filled with gravel. In the second case, the body is planted half-buried, with sand from the base of the leaves up. And in the third case, the plant has only the root planted in the soil while from

the junction of the leaves with the reduced stem up the body is above the soil surface, in this last case the plant is necessary to be supported from sides with larger pebbles or rocks because it is not able to hold itself in vertical position.

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