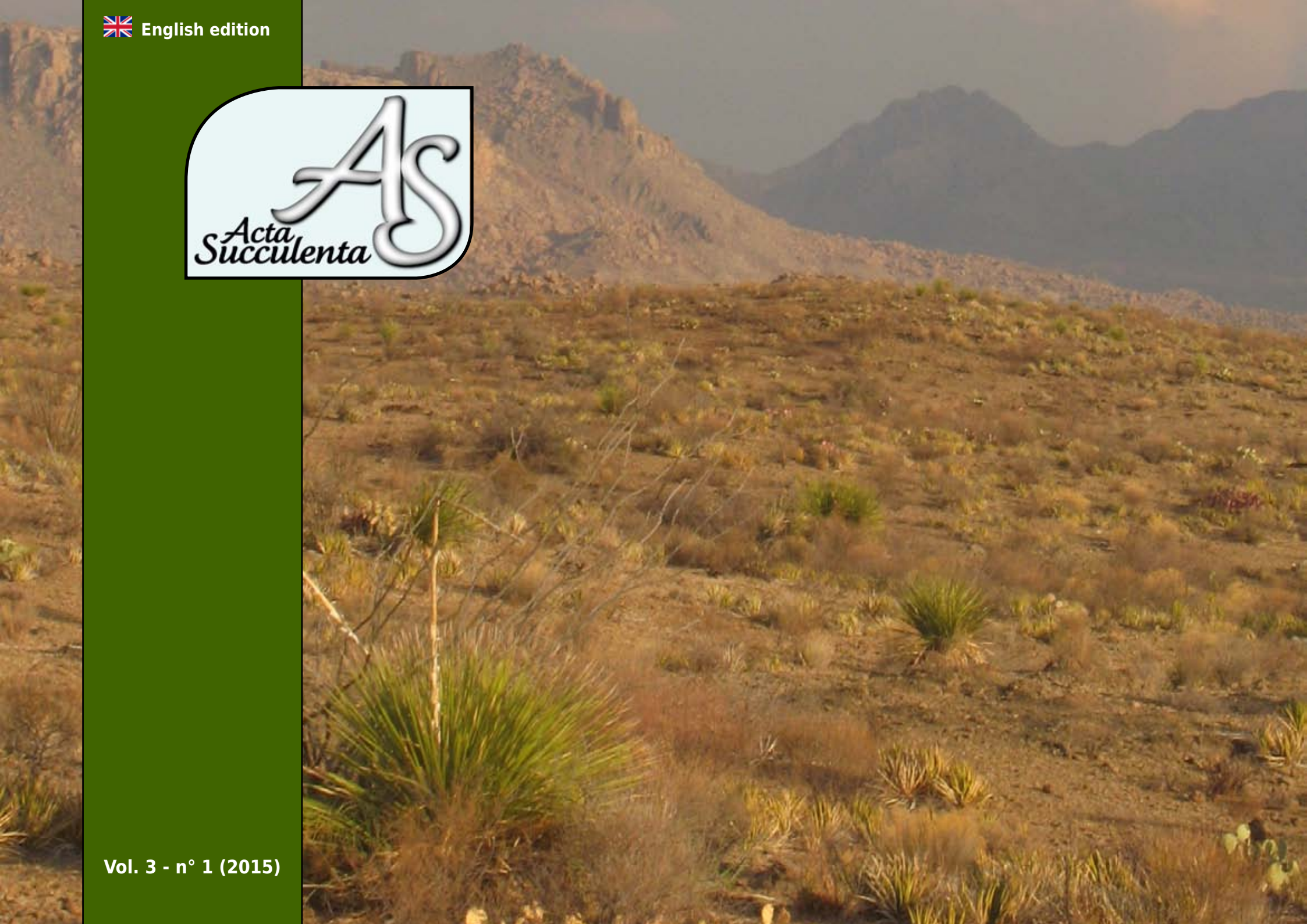
English edition

Acta Succulenta



Vol. 3 - n° 1 (2015)

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Acta Succulenta

Volume 3 - n° 1

05 February 2015

Cover photo: San Miguel, Coahuila (Mexico).

EDITORIAL

Every year, here in Europe, I'm amazed by the beauty of the pendulous, white racemes of Robinia pseudoacacia, *which fill the air with their unforgettable scent.*

Unfortunately, R. pseudoacacia *is an allochthonous species here, a native of the eastern USA.*

The globalisation of the world also involves a "biological globalisation": non-native species, belonging both to flora and fauna, are imported everywhere around the world, sometimes involuntarily, sometimes in order to embellish private gardens, or to supply the pet market. Regularly, these species escape from captivity and start colonizing the surrounding environment, often with serious consequences on the native ecosystems.

*A monster like Wels catfish (*Silurus glanis*) is now widespread in Western Europe, the Red Eared Slider (*Trachemys scripta elegans*) is almost cosmopolitan and threatens the survival of many native turtles around the world, Ailanthus (*Ailanthus altissima*) is suffocating the native vegetation in far too many places...*

These examples are only a drop in the ocean of allochthonous and invasive species, which are increasing day by day.

Too often we heard as a justification: "I didn't know...", but in the 21th century, even with the globalization of knowledge, ignorance is hardly an acceptable excuse.

Even the world of succulent plants is affected by this problem, as you can read in this issue about Carpobrotus edulis.

Davide Donati

A Kenyan succulent adventure

by Al Laius

Over twenty five years had passed since I was last in Kenya where I worked for a while as a Tour Manager for an Adventure Travel company taking clients on camping safaris.

I had fond memories of vast open spaces, wonderful birdlife and friendly people living an unhurried and traditional lifestyle.

Back to Kenya

Well, I was in for a surprise when I finally arrived there in February 2014 and began travelling around the country in search of *Sansevieria* and other succulents. During those 25 years the human population had almost doubled from 22 million to over 42 million today. This population pressure has led to an increased destruction of habitats for both flora and fauna, through construction, agricultural encroachment and increased grazing. Towns and villages now stretched ribbon-like for many kilometres along roads and where previously a few metres wide verge of natural vegetation (often including succulents) ran along the edges of roads, now these had been cultivated and crops had been planted right up to the tarmac itself.

I was fortunate to be guided in my travels on this trip by Len Newton, recently retired Professor of Botany at Kenyatta University, Nairobi. My other travelling companion, Nick Gash was particularly interested in caudiciform plants, but the main focus of the trip was to try and see as many sansevierias as possible in two weeks while trying to remain safe by avoiding Western-style shopping malls and any region that was close to Somalia, as Al-Shabaab had been quite active recently especially in the coastal areas north of Malindi – we did not fancy being kidnapped.

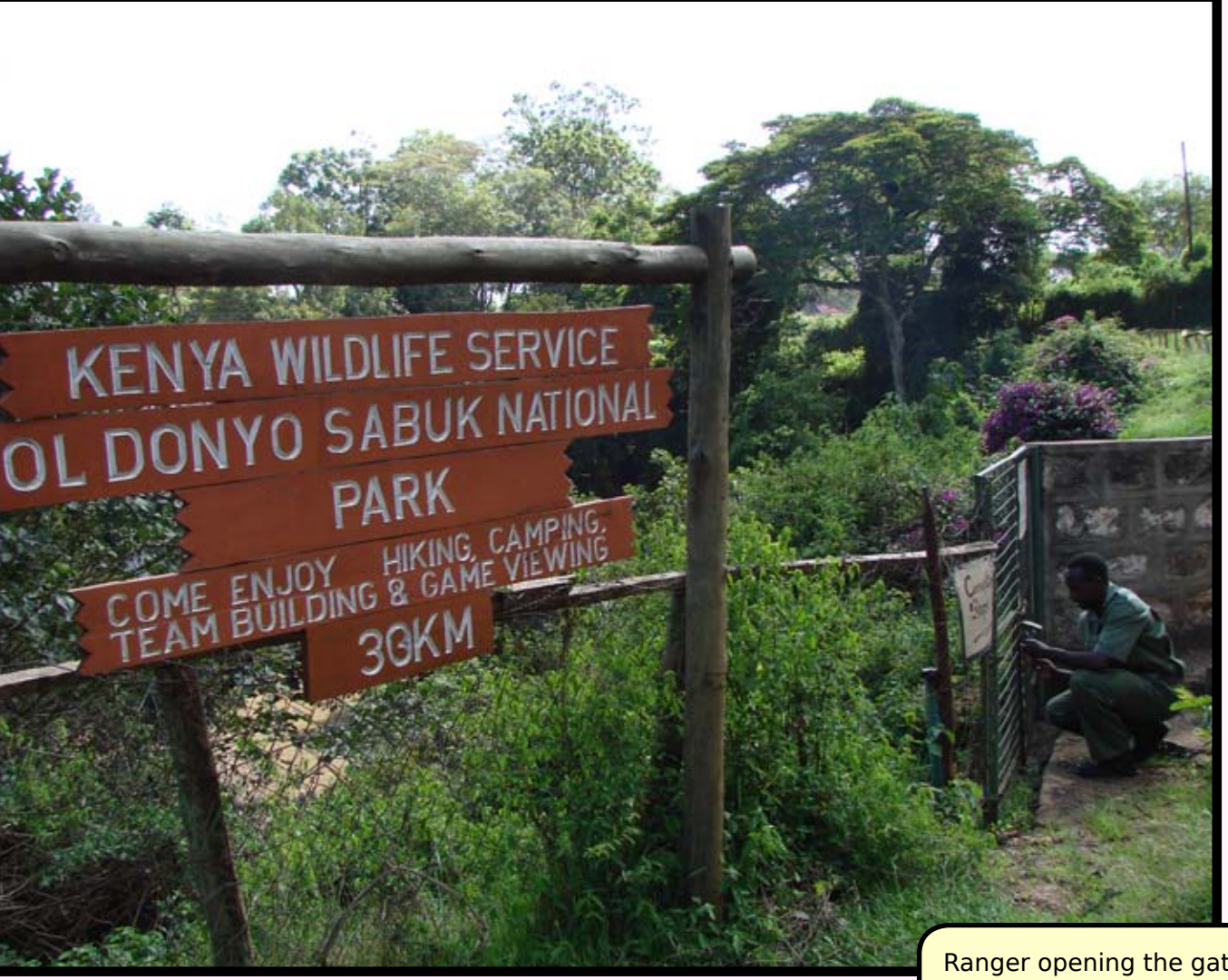
Although my main passion was to search for *Sansevieria* in habitat, I was continually delighted by the variety of other succulents encountered, and in particular the various euphorbias and aloes. We shall look at a variety of succulents encountered and celebrate their diversity as well as commenting on the dangers that many of their habitats face.

Nairobi and its surroundings

After a noisy first night at a 3 star African hotel (chosen due to its proximity to where Len lived) where a local band playing half the night and the banging of metal doors in the corridors due to other nocturnal activities kept me awake, I emerged bleary-eyed for breakfast, excited by the prospect of the day ahead. Len had wisely suggested a day of acclimatisation (we were about 1670 metres above sea level) and so we visited the University where he still has an office and were able to see succulents growing in the gardens there.

I was thrilled to find a few plants of the recently described *Sansevieria lineata* from Uganda growing in plain sight. A Ugandan endemic with a critically endangered status, it was first described by Tom Forrest (2013:11); cuttings brought to Nairobi had taken root easily and a number of plants were seen. However, even here the plants were likely to become endangered as an overzealous gardener on a weeding job had not realised the significance of these plants and most of them had been hacked to pieces with leaves tossed into a corner along with other 'weedy' material. Other interesting plants here included *Cissus adeyana*, *Adenia globosa* and *Euphorbia cussonioides*, which was what we were going to look for in habitat that afternoon.

Sansevieria lineata growing alongside an arborescent sansevieria at Kenyatta University Botanical Department gardens.



Ranger opening the gate for us at Chania Falls

Euphorbia cussonioides was first described by Peter Bally in 1958 and at that time there were a number of healthy populations both north and south of Nairobi. The species has long disappeared from its type locality as this tree-like *Euphorbia* (up to 25 metres tall) is a plant of the highland forests that originally occurred all around Nairobi, but have long since been cut down to make way for agriculture. Despite its fleshy branches, it is not a true xerophyte and once the protection of other forest trees has gone, it can no longer survive. However, survive it does in just a very few locations. Behind the Blue Posts Hotel near the Chania Falls at Thika, a walk down into the riverine forest led us to a small cluster of tall *E. cussonioides* trees. The ranger earned his tip that day as he took us to the area right below where the trees were and we were able to look around for seedlings or younger plants – unfortunately we did not find any. For the time being these splendid tree-euphorbias are protected and inaccessible – but for how much longer? Other interesting plants found were *Aloe deserti*, *Vanilla polylepis*, *Scadoxus multiflorus* and *Drimia* sp.

That night I moved rooms so that I was farther away from the restaurant/disco area and on the backside away from the busy road out front and the traffic noise. I still did not sleep well as the mosquitoes found their way in through holes in the net and buzzed around my ears.

A young plant of *Euphorbia cussonioides* growing in the university gardens.

Scadoxus multiflorus flowering by the riverside.

Northern Kenya

Lake Baringo, one of the Rift Valley lakes, was calling today and soon enough we were on our way. I thought our first stop of the day was rather odd because surely such a large herd of goats and sheep would chew their way through everything succulent! This was a common sight during much of our trip actually. However, looking in between cracks in the rocks we found a number of *Huernia keniensis* along with *Aloe kedongensis*, *Cotyledon barbeyi* and *Kalanchoe lanceolata*.

Overgrazing has severely impacted on many succulent plant populations in Kenya.

Huernia keniensis

The equator crossing was uneventful and we were glad to be *en-route* again after being surrounded and hounded by souvenir sellers.

Sansevieria suffruticosa was located easily enough and even more interesting was a field full of *Aloe lateritia* var. *graminicola* that showed incredible variability (Kolm & Newton, 2011) between plants growing very close together. *Aloe lateritia* var. *graminicola* occurs only in central and northern Kenya. The leaf ends here had been chewed off or more likely they had dried up, but what was most noticeable about this population was the variation throughout, with some plants having plain leaves and other being quite well spotted. This is the most common of the maculate species in E. Africa and over the years opinions have varied as to its status in relation to other species in the group. A recent study (Wabuyele *et al*., 2007) has concluded that *A. lateritia* and its subspecies are conspecific with *A. macrocarpa*, which has priority. For the time being I will stick with *A. lateritia*.

Sansevieria suffruticosa

Aloe lateritia var. graminicola

I will never forget the Tamarind Gardens Hotel, which despite having a room that was heated-up like an oven during the day and a non-working fan, provided me with my first good night's sleep. The first sound I heard was the footsteps of birds on the tin roof at daybreak, but then it was time to rise and take a cold shower anyway.


Desmidorchis foetida

A full day's plant hunting beckoned and it was no time before we had found two very similar looking plants; *Desmidorchis foetida* and *Desmidorchis retrospiciens* (*acutangula*). Although nowadays both are treated under *Caralluma*, I will retain the old names for ease of reference. Indeed in the recently published online journal *The Cactician*, Roy Mottram has re-validated *Desmidorchis retrospiciens* by publishing its lectotype (Mottram, 2013). Though the stems are very similar, once the plants are in flower they are easy to distinguish and *D. foetida* has 'frilly' flowers, which are actually vibratile hairs that make flies think they have found rotting material – it looks like heat rising from the action of bacterial decay. Do flies actually think?? *D. retrospiciens* has larger stems and darker, more purple flowers with only very small vibratile hairs and it is easily recognised when not in flower due to its large chunky stems, which can reach one metre high – it is the largest of all stapeliads. Both species are quite smelly and it is unwise to get too close to them.


Desmidorchis retrospiciens

Other plants seen this day included *Aloe secundiflora*, *A. tugenensis*, *Euphorbia magnicapsula*, *E. heterospina* subsp. *baringoensis*, *Caralluma decapuae*, *Kleinia odora*, *Edithcolea grandis*, *Cissus quadrangularis* var. *aculeatangula*, *Calotropis procera*, *Sansevieria robusta* and *S. frequens*.

A true scientist as Len Newton will stop at nothing, not even before the awful smell of a flowering *Desmidorchis*...

Euphorbia heterospina **subsp.** *baringoensis*

Sansevieria robusta [near Lake Bogoria]

Some late afternoon shopping at the local supermarket was essential before we headed back for dinner and another peaceful (but sweaty) night's sleep.

Back to Nairobi

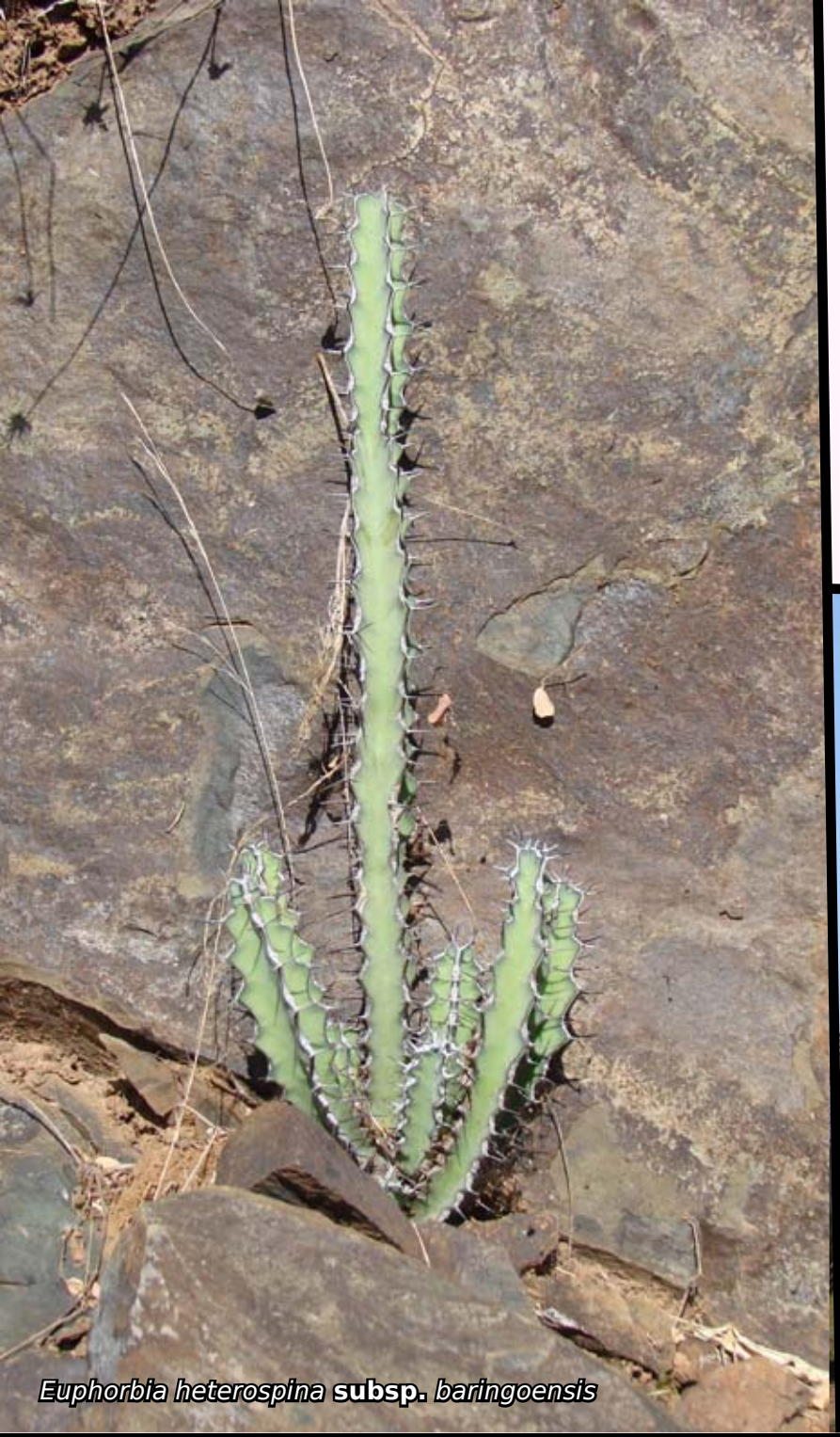
We headed back to Nairobi the following day as the rest of our journey was going to involve exploring areas south and south-east of the capital. I was dreading going back to that hotel but as it was Sunday night I thought that things would be quiet as people were resting and preparing themselves for the working week ahead.

This was mainly a travelling day and we did not stop to see many succulents. *Euphorbia magnicapsula*, which we had encountered the previous day, was still fairly abundant and a close up of the seed-pods explains why this species has its epithet.

Euphorbia magnicapsula

We had already seen *Euphorbia heterospina* subsp. *baringoensis* too, and as with any cactus or succulent trip, one always encounters plants growing in the most unlikely places and one always marvels at their tenacity to survive in such arid environments.

A succulent that I was not expecting to see was *Agave*, yet huge plantations of *Agave sisalana* covered hundreds of hectares on both sides of the road near Nakuru.



Euphorbia heterospina **subsp.** *baringoensis*

Agave sisalana

Agricultural encroachment is affecting *Aloe kedongensis*, which is found only in the Naivasha District. This shrubby species named for the Kedong valley, grows on rocky ground in dense bush and has also been used as hedging around small farms. However, it was noticeable that these hedges were being ripped out as farmers were expanding their fields and bringing cultivation right up to the roadside. It is these roadside verges that were in danger of vanishing throughout our trip.

Aloe kedongensis used as hedging

The Nairobi hotel was very lively for a Sunday evening I thought, as we arrived and the place was full with various functions, live music and hundreds of people eating and partying. We were the only white people staying there and we wanted a good night's sleep as we had an early start and a long journey the next day. The locals has other ideas though and continued to party on well into the small hours.

Blue Springs Hotel, our hotel in Nairobi, interior comfort was unfortunately not up to the outside appearance!

Monadenium stapelioides

Magadi and the Rift Valley

A run down the Magadi Road was on the schedule for Monday. Leaving Nairobi at 1661metres above sea level, the landscape along the road was awesome as the road passed over the Ngong Hills to suddenly plunge into the deepest heart of the Rift Valley.

Lake Magadi (595 metres a.s.l.), as most lakes of the Rift Valley are, is an alkaline lake surrounded by volcanic hills. The town of Magadi as well as the soda lake are owned and exploited by a multinational company (Tata Chemicals) who export the valuable sodium carbonate (soda ash). The Magadi area is known for being one of the hottest and driest parts of Kenya as we were about to discover for ourselves. Our target today was a couple of euphorbias; *E. scarlatina* and *E. similiramea*. However, the former was not in flower and the latter is rather shrubby so they are not shown here. Much more photogenic was *Cissus cactiformis* and *Monadenium stapelioides*. The *Monadenium* was initially hard to spot as the area had been heavily grazed and the maximum stem length was around 10 cm with most stems having been chewed to the ground. In cultivation this grows taller.

Cissus cactiformis

Some particularly fine stands of *Sansevieria robusta* adorned our lunch stop by the dried up river bed where we also had a chance to observe some wildlife. The Weaver-bird nests were very impressive and a feat of engineering.

Sansevieria robusta

South-eastern Kenya

A repositioning day saw us reach Voi in south-east Kenya, where we based ourselves for a few days.

Mount Kasigau

One of our main targets was to search for succulents on the lower slopes of Mt. Kasigau, which rises suddenly from the semi-arid *Acacia-Commiphora* bushland. Mt. Kasigau is the most north-eastern mountain in the ancient crystalline Eastern Arc Mountains that are now included as part of the Eastern Afromontane Biodiversity Hotspot. These mountains are noted for their species richness, high concentration of endemic species and highly fragmented condition. The main peak, Nyangala (1640 metres a.s.l.) consists of old granitoid gneiss and also forms vertical cliffs above Jora village, one of the five villages at the mountain's base. The Kasigau Trust Lands manage the area and there is an awareness of and commitment to conservation. The Kasigau Taita are small-holder farmers who cultivate crops and raise livestock at the base of the mountain between the bushand and lower montane woodlands. However the slopes of the mountain are rocky and cannot support agriculture and apart from some grazing by goats, the vegetation is largely safe from further degradation.

Mount Kasigau

Having parked our vehicle at the chiefs' compound of Rukanga village, we sought an audience with the chief to ask for permission to go exploring up the mountain. The chief was in a good mood and was very welcoming as well as being well-informed on the plant life of the area and conservation issues. He was however even more interested to know about the up-coming World War I celebrations being held in the UK – apparently British soldiers used Mt. Kasigau as a base during the great war.

For us this was a succulent hunter's paradise. *Sansevieria volkensii* and *robusta* were seen in abundance along the roadside even before we had reached Kasigau. As soon as we started hiking up the mountain we saw *Sansevieria powellii*, 1.3 metres high and with leaves twisting all around – these were mature, flowering sized plants. We zigzagged our way upwards, constantly stopping to take photos and were amazed at the diversity of succulents at every step. *Euphorbia bussei* var.*kibwezensis*, *E. tirucalli* and *E. heterochroma* subsp. *tsavoensis* were everywhere. *Cissus rotundifolia*, *Aeollanthus repens*, *Caralluma arachnoidea* subsp. *arachnoidea* and *Gerrardanthus lobatus* followed in close succession. There were plenty of different sansevierias too with *S. powellii*, *S. raffillii* and *S. ballyi*; the latter was particularly abundant.

Euphorbia heterochroma subsp. *tsavoensis*

Caralluma arachnoidea subsp. *arachnoidea*

Gerrardanthus lobatus

Sansevieria ballyi

Apart from the sansevierias there were two endemics that we had come to see here. The rare *Aloe classenii* was the most exciting find of the day (it is also found at Kizima, east of Kasigau). Together with *Euphorbia classenii*, which is found only at this location (Carter, 1991); this *Aloe* was discovered by George Classen who worked in Kenya as a water engineer in the 1960s. As his work took him to remote parts of the country and influenced by his friendship with Peter Bally to take advantage of the opportunities his travels offered, he collected succulents, which he took back to plant in his Nairobi garden.

Aloe classenii

Euphorbia classenii

The Taita Hills

Another excursion in the Voi area took us to the base of the Taita Hills where we wanted to see if *Aloe ballyi* still existed. As already mentioned population pressure has led to an increased destruction of plants in the wild through construction, agricultural encroachment and increased grazing. A striking example of this was at a known location of the magnificent tree-like *Aloe ballyi*, which our guide, Len Newton had visited as recently as the previous August (just 5 months earlier). Then, there were just a few populations in the area around Mwatate (the type locality), yet when we visited we could not find any until, just as we were about to give up looking we finally spotted a few plants several kilometres further along the road growing not far from the track. Upon closer inspection though it was obvious that this piece of land was being cleared for agricultural development and a number of the aloes had already been chopped down. *Aloe ballyi* does survive in other places in Kenya and Tanzania (Newton, 2007) but is listed as 'Endangered' and it is a great pity that it has disappeared completely from its type locality.

Aloe ballyi [near Mwatate]

Toward Malindi

It was time to head for the coast as I was due to give a presentation to the Malindi Branch of the Kenya Horticultural Society in the evening. We were looking forward to it after the dry heat of the plains it was going to be cool and refreshing by the coast, though of course with increased humidity.

Plant hunting never stopped though and soon enough we were encountering such gems as *Adenium obesum* and *Aloe parvidens*. At first glance this was thought to be *A. deserti* but without seeing the plants in flower it was difficult to tell just from the leaves alone. *Sansevieria volkensii* was present along the roadside for 10 km or so and *S. powellii* was abundant at Mackinnon Road. We also found some very poor specimens of *S. ascendens* very close to the type locality, on land that was earmarked for building, so no doubt this population will have soon vanished.

Adenium obesum

Aloe parvidens

Sansevieria volkensii

Sansevieria powellii

Euphorbia wakefieldii

Further along we came across some peculiar rock outcrops that were completely at odds with the surrounding landscape. These were Kambe Limestone cliffs and upon closer inspection lots of crevices and deep holes in the ground were visible. The rock itself was also exceedingly sharp and it was easy to cut oneself providing one didn't tumble into a hole first. I managed to fall over backwards whilst photographing *Euphorbia wakefieldii*. An endangered species, it is a succulent tree, only known from a few populations confined to coral cliffs and limestone outcrops in the Mombasa/Kilifi area (though also reported from the South Pare Mountains in Tanzania). *Sansevieria kirkii* var. *kirkii*, *Aloe volkensii* subsp. *volkensii* and a *Cynanchum* sp. were also found here.

Kambe limestone outcrop

Coastal areas

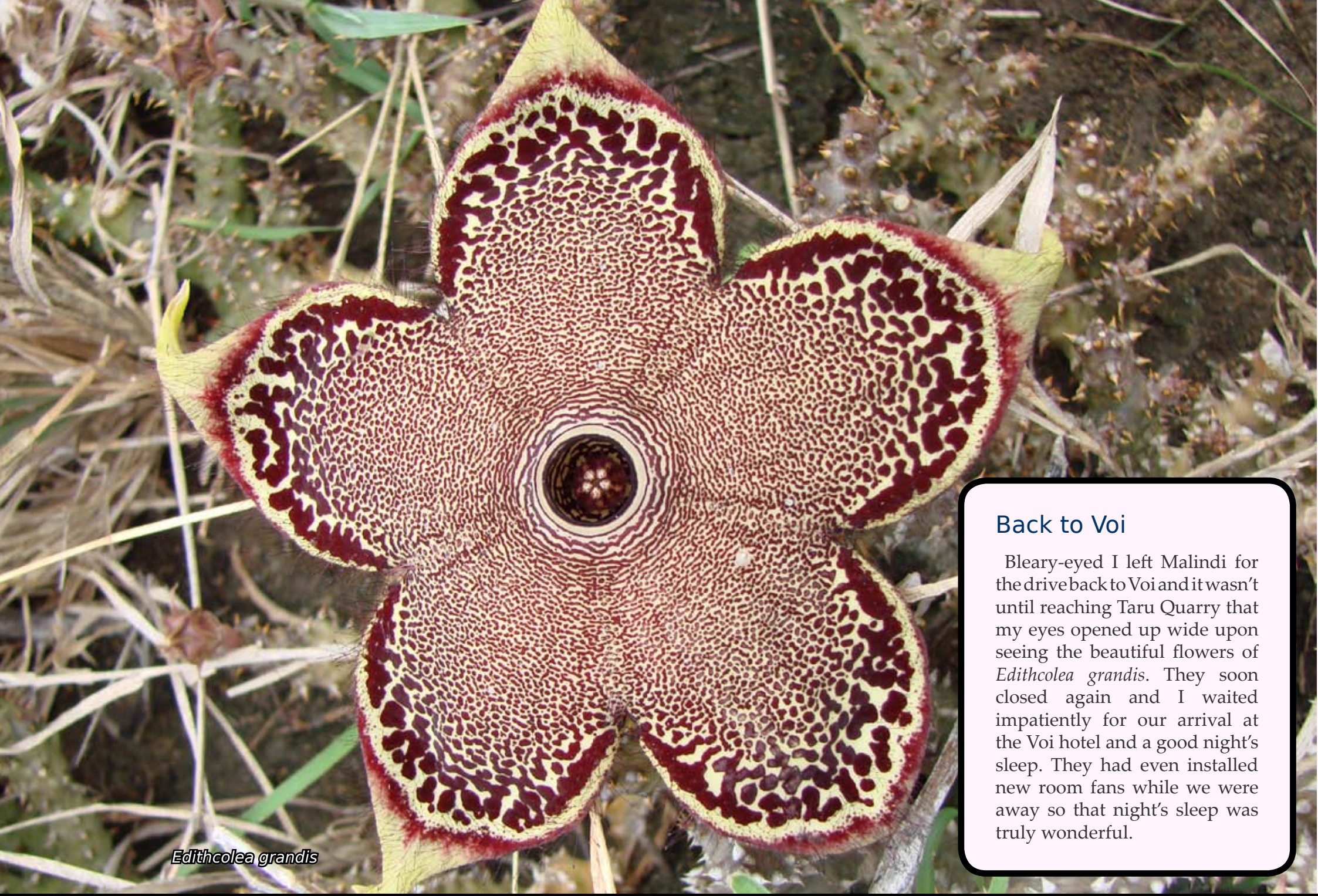
Travelling cross country on rough red-laterite dirt roads we soon reached the coast at Kilifi where we searched for *Aloe kilifiensis* along Kilifi Creek. Len had seen it here previously, hanging over the cliffs but most of the land had now been fenced off and was under development for private residences or hotels, and no plants were found.

We saw only the common *Aloe rabaiensis* along with a number of sansevierias such as *S. conspicua* and *S. arborescens*. We continued to Malindi to check into the hotel so I could freshen-up before my presentation. I was alarmed to discover that the cheap hotel was right next door to a large mosque (the coastal areas of Kenya are strongly Muslim) and guess what, tomorrow was Friday, the day of prayer.


Kilifi Creek


Mosque of Malindi

I don't know what was worse:
the buzzing of mosquitoes all night,
the whirring of a noisy fan overhead
or the constant calls to prayer which
began at a very early hour and
continued on a regular basis.



Edithcolea grandis

Back to Voi

Bleary-eyed I left Malindi for the drive back to Voi and it wasn't until reaching Taru Quarry that my eyes opened up wide upon seeing the beautiful flowers of *Edithcolea grandis*. They soon closed again and I waited impatiently for our arrival at the Voi hotel and a good night's sleep. They had even installed new room fans while we were away so that night's sleep was truly wonderful.

Back to Nairobi again

Fully rested and refreshed, we started heading back for Nairobi but stopped just 20 km up the road to explore a small hill (Manga). The target here was to find *Aloe ukambensis*; probably one of the most attractive of all *Aloe* species, which grows in the south-eastern highlands of Kenya on partially bare outcrops of granite or gneiss. It is not just the leaves which are so mouth-wateringly gorgeous with their longitudinal dark green lines, but also the flame-red capitate racemes, and I was lucky enough to find a few plants in flower. This involved scrambling up quite a steep rocky outcrop, which was rather slippery and dangerous due to the rain that had fallen earlier than morning. On my descent after having photographed the plants I heard a distinct rustling in the vegetation above – this was lion country after all! Needless to say I didn't linger and we were soon on our way for the long drive to the capital, stopping only where plants were seen by the roadside.

Aloe ukambensis

Euphorbia bussei subsp. kibwezensis

Euphorbia robecchii

Other worthwhile stops en-route were for a couple of euphorbias and an area rich in caudiciform plants. *Euphorbia robecchii* is a large growing tree-euphorbia with fresh green spineless branches on mature growth but quite spiny and grey in colour on new growth and juvenile plants. *Euphorbia bussei* subsp. *kibwezensis* was growing together with various *Gerrardanthus* sp., *Sansevieria* sp., *Cynanchum* sp., and *Aloe* sp. This area 10 km west of Kibwezi was a desolate plain consisting of volcanic rocks from old lava flows. It was a wonder that any plants grew here at all, yet roots had managed to find their way down through the sharp rocks and into something more nutritious below.

A variety of caudiciform and tuberous succulents were seen here.

Based back in Nairobi, there was still time to visit local attractions as well as having a few day trips to go looking for succulents.

Kajiado

One of these day trips was to Kajiado, south of Nairobi. The Kajiado Marble Quarry road was one of the roughest we had been on and a real bone-shaker. This was a good day for looking at the variability of *Sansevieria raffillii* as the area was rich with this species and many photographs were taken for comparison. The shrubby and unphotogenic *Euphorbia similiramea* was present here and there but the main plant we had come to see was *Euphorbia serendipita*, which was first described by Len Newton (1993) from this very location. He had spotted a spiny *Euphorbia* by the roadside as he was passing by in 1988, but as it was getting dark and he had to reach Nairobi by nightfall he was only able to take a cutting. As that cutting did not flower in his garden he made no attempt to identify the species and it was only in 1990 when Susan Holmes visited him and looked around his garden that she remarked that it might be an undescribed species.

A juvenile plant of Sansevieria raffillii

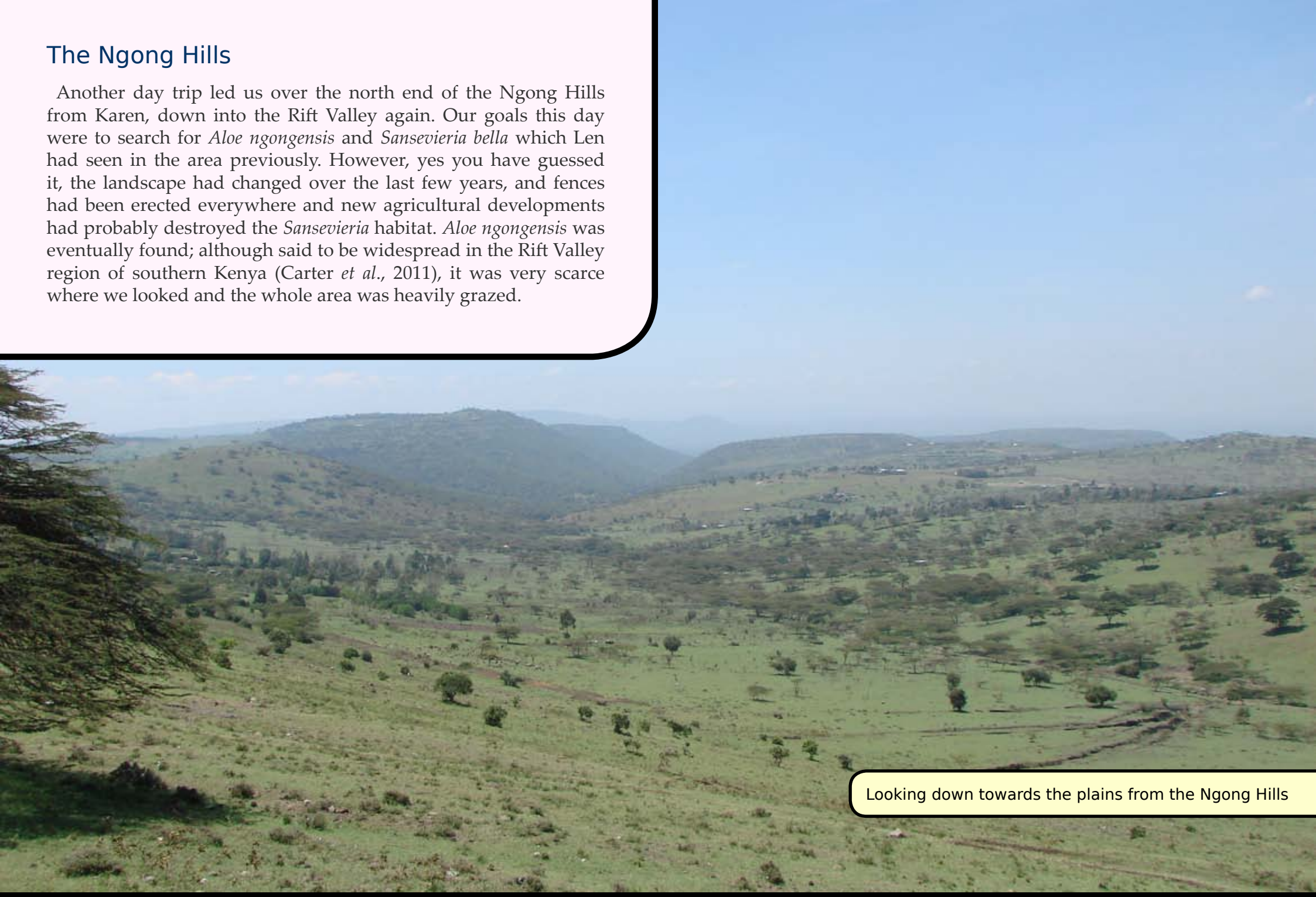
Kajiado Marble Quarry road

A few months later he returned to the locality where he had collected the cutting and discovered that there were a few populations in the area. Subsequent studies confirmed that it was indeed a distinct and undescribed species; a serendipitous discovery in an area where he would not have thought of searching for new taxa.

Euphorbia serendipita at the type locality.

The Ngong Hills

Another day trip led us over the north end of the Ngong Hills from Karen, down into the Rift Valley again. Our goals this day were to search for *Aloe ngongensis* and *Sansevieria bella* which Len had seen in the area previously. However, yes you have guessed it, the landscape had changed over the last few years, and fences had been erected everywhere and new agricultural developments had probably destroyed the *Sansevieria* habitat. *Aloe ngongensis* was eventually found; although said to be widespread in the Rift Valley region of southern Kenya (Carter *et al*., 2011), it was very scarce where we looked and the whole area was heavily grazed.



Looking down towards the plains from the Ngong Hills

Although there appears to be some greenery in the photograph it also seems that there are quite a few bare patches and one can only imagine how much more desert-like this landscape can become if the rains fail. Desertification can be confused, at least temporally, with drought, and indeed a lack of rain can reduce the productivity of the land, however there is a growing consensus that desertification actually arises from the interaction between people and their environment (Campbell, 1986). Droughts can act as a catalyst that accelerates any existing processes of land degradation (such as over grazing) and rapid population growth combined with changes in land use can set in motion the process of desertification.

Habitat of *Aloe ngongensis*

Aloe ngongensis

As mentioned above, we could not find *Sansevieria bella* and the only other succulents we saw that day were *Monadenium stapelioides* and *Kleinia petraea* which is also known as *Senecio jacobsenii*.

Kleinia petraea

Monadenium stapelioides

Good bye Kenya

Our time in Kenya was coming to an end. With a few visits to private gardens and one to a public one at the Nairobi National Museum, which as well as housing the EA Herbarium, contained a small succulent garden dedicated to Peter Bally, this really was our last look at succulent plants in Kenya. ■

Acknowledgments:

This trip would not have been possible without the expertise and guidance of Len Newton, now retired Professor of Botany at Kenyatta University. Len can assist in organising succulent plant study trips in E. Africa and can be contacted by email: **ellyen@yahoo.com.** I would also like to thank my travelling companion, Nick Gash, who kept me sane and provided white tea when it was most needed.

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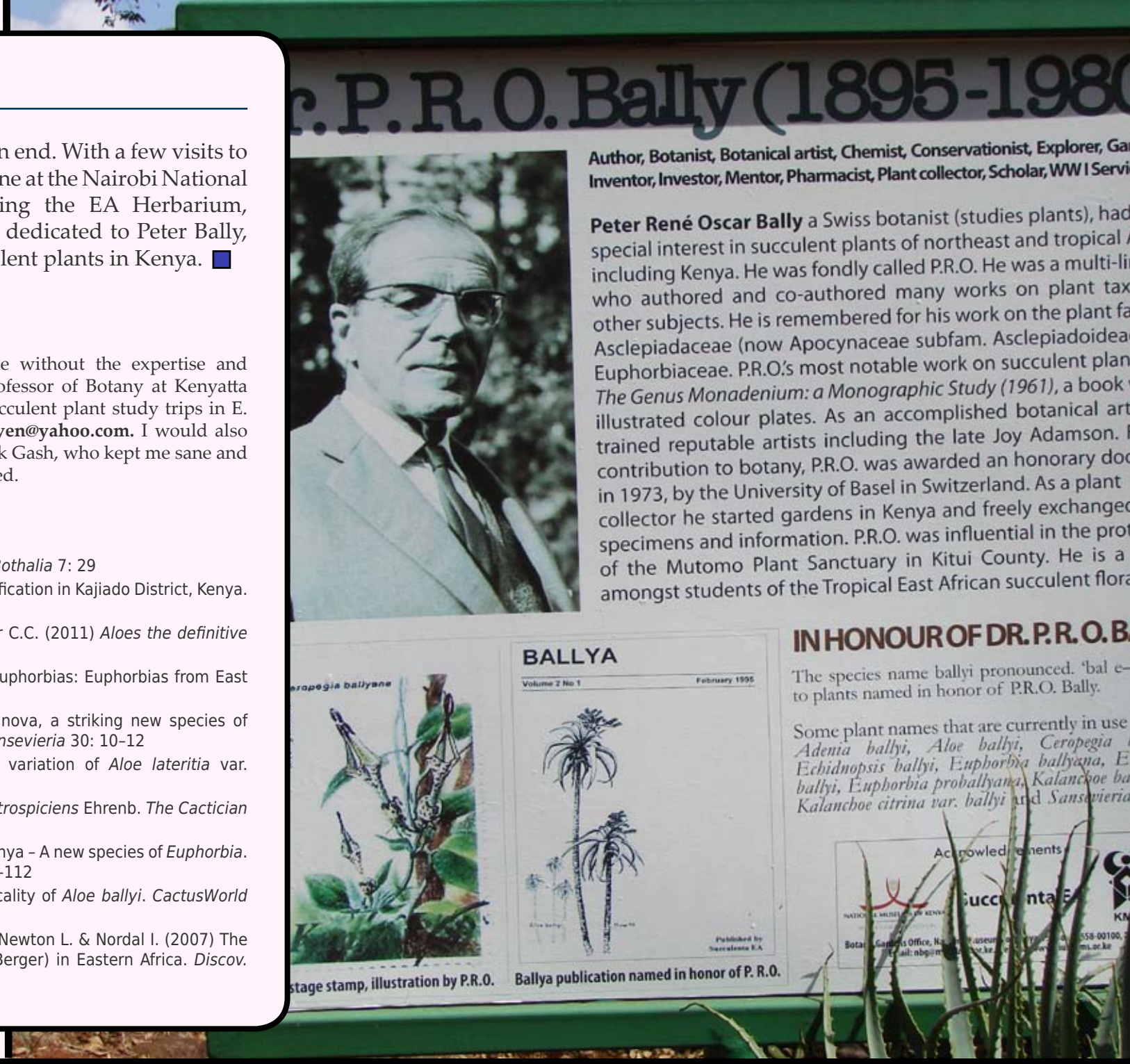


Carpobrotus, the carpet of death

by Gérard Dumont and Antoine Mazzacurati

C. acinaciformis

C. edulis

The genus *Carpobrotus* (*Aizoaceae*) is represented on European coasts by two closely related species: *Carpobrotus acinaciformis* (L.), Bolus. and *Carpobrotus edulis* (L.), N.E.Br. They only differ in some morphological details and share, alas, the same ecology. If we state "alas" it's because, from the perspective of all the European maritime succulents that we are considering in this series of papers, these plants are invaders, dangerous invaders, killers.

Up to now, our goal was to make you love the maritime succulent plants we have told you about; this time it will be to make you hate them! Or rather not, because no plant is hateful in itself, but it will be to make you aware of human stupidity. These plants are called "Clutches of witches" (*Griffes de sorcières*) in France, so it is the sorcerer's apprentices who recklessly scattered them all along the coast, and especially those who continue to do so, that we want to make you hate...

History of the invasion

Carpobrotus[1] was introduced from South Africa, where it originated, into Europe in the late seventeenth century, first in botanical gardens and then it was soon used for horticultural purposes (ornamental and sloping soil fixation). But it was in the nineteenth century and especially in the twentieth that it began to be planted extensively along the coast, particularly in the Mediterranean area and on all coasts with a mild climate. Unfortunately, it continues today to be widely used in this context. *Carpobrotus* is indeed a plant of high value in a horticultural point of view, both for its opulent foliage and its large flowers and, because of the strength and density of its vegetation, it is a great ground cover on slopes and banks and requires virtually no maintenance in favourable sites because it naturally suffocates all the "weeds" that attempt to compete.

Carpobrotus is without equivalent in its ability to quickly cover dry, sunny areas in coastal environments; as its thick waxy foliage tolerates wind and spray well, it quickly became a common plant in seafront gardens, the miracle solution for very exposed gardens where "nothing grows" because for most gardeners, the natural flora or "nothing" are the same...

What had to happen has happened: this plant so easy to grow and so accommodating in maritime situation quickly escaped from gardens and naturalized on all coasts with a mild climate...

1 In the remainder of this article, we will group most often the two invasive species in Europe under the term *Carpobrotus* considering them as a homogeneous group or a single plant, because the limits of these two taxa in the invasive populations are often blurred and their behaviour is the same.

Ecology

Once naturalized in coastal areas where the climate permits, *Carpobrotus* unfortunately behaves as a highly invasive plant. Let's start by defining this concept, which is sometimes misunderstood.

What is an invasive plant?

An invasive plant, in the strict and ecological meaning of the term, is:

1. An ***exotic and allochtonous*** plant, that is to say, a plant found outside its natural past or present distribution area (= exotic plant), and non-native in the host environment (= allochtonous plant).
2. A plant whose initial presence was initially the result of an ***artificial introduction***, whether voluntary or involuntary (poorly sorted seeds, escape from cultivation, ship ballast, organic packaging, mud under cars, etc.).
3. A plant capable of ***maintaining itself and spreading over the long term*** in the host environment.
4. A plant whose presence in the host environment ***disrupts the natural balance of this environment***, that is to say, that alters its composition (in addition to its presence) and its structure or modifies its functioning.

This shows that the notions of proliferation or ability to be widely dispersed, although they are often associated, are independent of the notion of ecological invasiveness. The impact on the host environment primarily bases this notion of invasiveness. A plant may be relatively small in absolute numbers and nevertheless may have serious consequences on very specialized ecosystems and then be a real invasive plant while other apparently more proliferating and ubiquitous plants will fit more harmoniously with the native flora[(2)] and then one prefers to speak of "naturalized" plants instead of "invasive" plants. Also, don't confuse "invasive" plant and "overrunning" plant (some native thorns, for example, are plants with very overrunning behaviour but they are not invasive plants in an ecological sense!).

2 This incorporation is sometimes so harmonious that when it is old, botanists struggle to know if some plants are indigenous or not...

Carpobrotus unfortunately matches perfectly the four criteria of invasiveness mentioned above. It is even a typical example of the invasive plant[3].

A fifth criterion is not necessary to define an invasive plant, but it is almost constant: *the great difficulty in eradicating the allochtonous plant once its invasive behaviour is expressed*. There is therefore a need for caution when importing exotic plants: a plant is an organism living in interaction with its environment and its subsequent behaviour in a new environment can not be 100% predictable; a rare and endangered plant in its original environment can be a formidable and invincible invader once out of the environment in which it was balanced.

3 Another example of a highly invasive succulent plant was mentioned in *Acta Succulenta*: the many *Opuntia* of Burbank unwisely introduced in Australia and elsewhere as a forage and fruit plant. See: D. Guillot Ortiz & al. (2014), First observations of Opuntia 'Papiki' as allochthonous in Iberian Peninsula, In *Acta Succulenta* 2 (3): 329-341.

Mechanisms of the invasiveness

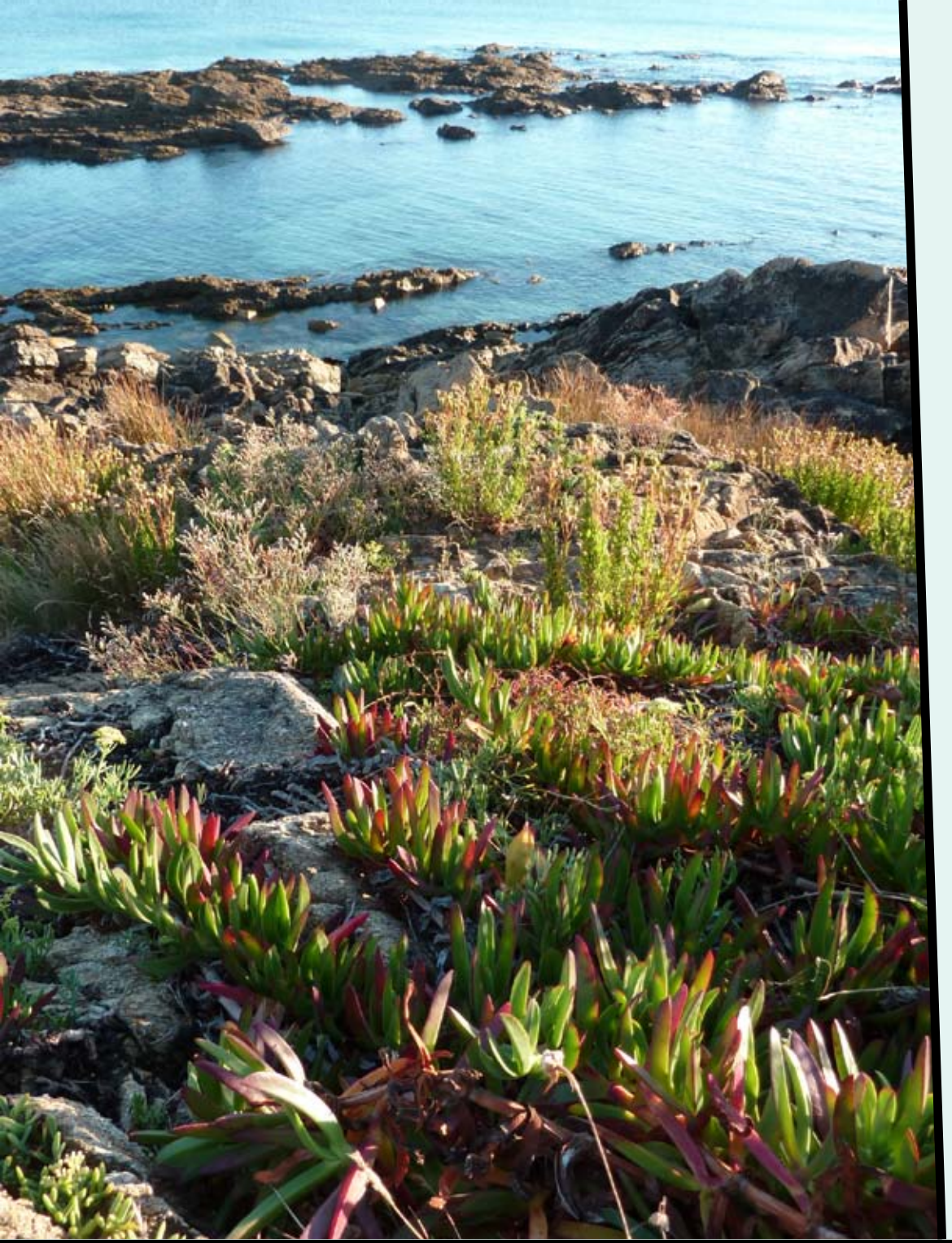
The reasons of this uncontrollable explosion after introduction of an allochtonous plant in the host environment are many.

Some reasons are purely environmental and easy to understand: increased competitiveness of the allochtonous plant through lack of effective competition by the autochtonous plants, local absence of parasites and predators, etc.

Some other reasons are sometimes related to real genetic variations:

The sudden change of environment disrupts the mechanisms of natural selection by the involuntary selection of individuals which are not fully representative of the original population: the introduced individuals necessarily represent only a small part of the range of the genetic variability of the plant in its original environment. The overall behaviour of the introduced population will be hence slightly different and, especially, will evolve differently from that of the original population since the selective mechanisms will act on a different and narrower genetic substratum; it's what is called the "founder effect" in population genetics.

The sudden change of environment may favour the selection of some random mutations that would have given no selective advantage in the original environment but give one in the host environment where they can express themselves and then be quickly passed on. Hence a very rapid genetic drift can occur between the original populations and the exported populations that sometimes achieve the invasive capacity secondarily in their host environment although they did not show any invasiveness initially.



It seems that these phenomena of genetic drift of the introduced populations are involved in the genesis of the invasive aggressiveness of *Carpobrotus*[4].

The consequence of the invasive behaviour of an allochtonous plant introduced into a host environment is always the same: a more or less rapid and more or less important drop of the biodiversity inside the host environment, thus affecting the flora as well as the fauna. *Carpobrotus* is a perfect illustration of this phenomenon.

The only glimmer of hope in this gloomy picture, which is quite often observed after an initial aggressive phase, is a relative decrease in the invasive behaviour of an organism over time[5]: the allochtonous organism gradually adapts to its host ecosystem more harmoniously or the ecosystem reacts effectively and changes to find a new balance harmoniously integrating the allochtonous, or a little of both. In the case of *Carpobrotus*, we are, unfortunately, still in the aggressive phase (for over a century!) and there is no reason to think that this state can improve in the short term, on the contrary.

4 Unexpected morphological and karyological changes in invasive Carpobrotus (Aizoaceae) in Provence (S-E France) compared to native South African species, in *Comptes-Rendues Biologies*, 334 (4): 311-319 (2011)

5 The typical example is the alga *Caulerpa taxifolia* (Vahl) C.Agardh which invaded the western basin of the Mediterranean in the space of a few years and raised serious concerns, and now tends to decrease everywhere.

The strong spines of the prostrate gorses (*Ulex* spp.) in the moors on cliff tops on acid rock can repel all herbivores and walkers, but they can do nothing against *Carpobrotus* that will completely smother them in a few years.

Carpobrotus behaviour in its biotopes of adoption

In Europe, *Carpobrotus* behaves in the Atlantic area as a strictly maritime plant, but can extend a bit further inland in the Mediterranean area, while keeping there a clear preference for coastal environments that suit them perfectly and where its growth and competitiveness are optimal.

In the North Atlantic area (France and the British Isles), its preferred habitats are gently sloping rocky places, especially the degraded rocks more or less granularly disintegrated or the sandy tops of micro-cliffs from which it falls downward the sea as large draperies. The ideal for this plant seems to be at first establishing itself horizontally or almost on a ledge then growing down more or less vertically. In this zone, it can be found also in the white dune, but with less frequency than in rocky areas.

The further south and towards Mediterranean latitudes, the more *Carpobrotus* tends to broadly colonize the dune environments: mostly the semi-fixed dune and the grey dune, because it has more difficulty to withstand burying the indigenous plants from the front of the white dune. However its preferential environments remain rocky environments and essentially acid rocks, but its presence in the sandy dune environment rich in shell micro-debris as well as on some limestone rocks, demonstrates, if not its total indifference to the substrate and its reaction, at least a large adaptability to various substrates. This adaptability is perhaps related to its ability to acidify the soil (cf. infra) thus to adapt the substrate to its own requirements.

Carpobrotus is very heliophilous. It is moderately salt-tolerant: it is very tolerant of salt spray and salt deposits on its foliage (aerohalophyte) but has a much lower tolerance to the high salinity of the substrate than some native halophytes. Yet it successfully competes with them on maritime rocks and it seems reaching down pretty close to the water as they do. This apparent contradiction is explained by the fact that the native halophytes are rooted on the spot while *Carpobrotus* is, in this case, usually rooted several meters higher, thus in less salted substrate and then goes down to the water in drapery to cover and gradually replace the native halophytes.

Carpobrotus in dune environment

The growth of *Carpobrotus* is particularly exuberant: fast, very dense and mat-forming: in good weather, it actually grows "before your eyes" and one individual in optimal conditions can spread several square meters in year! ... and its growth pattern, densely branched along the stems and these rooting at nodes, that increasing the footprint of the plant does not slow down over time but is instead exponential[6]!

Over time, the stem carpets superimpose on each other to form a heavy compact and opaque mass (dead leaves don't come off the stems and form a thick litter under them). The problem is that no native maritime plant can fight against such vigour and such a density of vegetation and in the fighting to cover the other, the winner is always the ficoide, smothering everything beneath it. Even the indestructible *Crithmum maritimum* L.[7] cannot resist for very long when *Carpobrotus* begins to expand its dense mats on the rocks which the former has colonized for millennia.

Apart from invaded natural habitats, *Carpobrotus* is also frequently found in manmade environments like old walls and even on some mossy roofs on the waterfront. When it lives there for long, it's sometimes difficult to know whether this plant was once deliberately planted there or if it was installed itself there spontaneously.

6 T.Sintes & al. (2007), Clonal growth dynamics of the invasive Carpobrotus affine acinaciformis in Mediterranean coastal systems: A non-linear model, in *Ecological Modelling* 206(1-2): 110-118.
7 G.Dumont & A.Mazzacurati (2013), *Crithmum maritimum*, the succulent of storms, in *Acta Succulenta* 1(1): 21-44.

The agony of the natural flora of maritime rocks:
Crithmum maritimum (divided leaves and greenish umbels) and *Inula crithmoides* (yellow flowers and brownish pompoms), two maritime succulents we've introduced in the previous issues of *Acta Succulenta* live their last summer here, unable to compete against the carpet of *Carpobrotus* that covers them inexorably. The blue inflorescences are those of *Limonium dodartii*, it will eventually suffer the same fate.

Consequences of the invasion

An area invaded by *Carpobrotus* quickly and inexorably becomes a vast monospecific carpet from which any other plant species is gone. Maritime lichens disappear from invaded rocks simultaneously with higher plants. The insect fauna and all the microfauna are also depleted because few native organisms can live at the expense or in the shelter of this cumbersome foreigner. The macrofauna may also be seriously disturbed when, for example, *Carpobrotus* invades and covers what was once a site of nesting seabirds... The only ones to be satisfied are rodents (rats, rabbits) that consume its fruits but these rodents being often themselves invasive species in island environments, so that this *invasive mutualism* only compounds the problem!

The presence of *Carpobrotus* modifies the underlying substrate by gradual acidification due to the organic matter load created by the abundant litter and the difficulty and slowness of the mineralization thereof. There also seems to exist some chemical mechanisms of inhibiting the germination of plants other than itself in areas invaded by *Carpobrotus*[8].

Paradoxically, this perfect ground cover is a potential source of further erosion in the marine environment because once the carpet of *Carpobrotus* is removed, in the context of fighting against the plant, there remains a vast area of bare ground, lifeless and therefore much more susceptible to erosion by wind and waves that this area was before it was colonized by *Carpobrotus*. In addition, by removing the thick carpets of this plant, one often removes all together the litter and the thin original substrate adhering to it, so that by eliminating the invasive plant one eliminates also the stock of dormant seeds which are possibly remnants of the indigenous population prior to the invasion. This can hence compromise the reconstitution of the prior ecosystem in places.

This triple problem of soil modification, erosion and sterilization, created by the presence of *Carpobrotus*, poses in a big problem some places for the eradication of this plant and shows how important it is to intervene before it's too late, that is to say BEFORE the complete disappearance of the native vegetation in every invaded spot.

8 C.Conser & E.F.Connor (2009), in *Biological invasions* 11(2): 349-358.

Relations between the two species

Although very similar, the two common species on European coasts, *Carpobrotus edulis* and *Carpobrotus acinaciformis* rarely coexist in the same spot. Yet the only plant capable of holding back the local expansion of *C. edulis* is *C. acinaciformis* and vice versa! In some spots, you find just one and elsewhere the other, without understanding an ecological explanation for this (their needs and behaviour seem identical). When there is a mixture of pink flowers and yellow flowers in the same spot, it is often *C. edulis* alone, whose flower colour varies from yellowish-white to pinkish in one population and not the vivid purplish rose of *C. acinaciformis*.

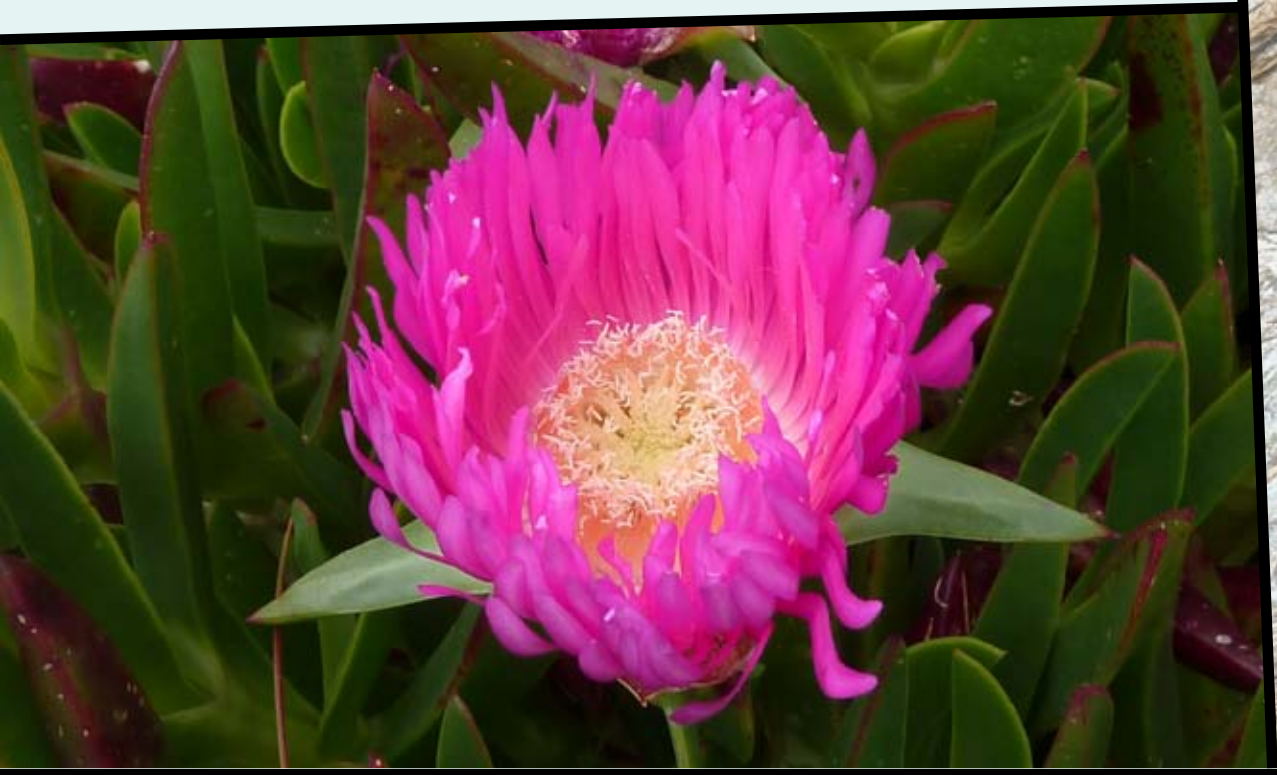
Only the prevalence of the vegetative propagation, which leads the gardeners of a place to all "cultivate" the same species of *Carpobrotus* and often the same clone of it, moves forward an explanation, but this one may be not alone. Overall, it seems that *Carpobrotus edulis* is most frequently mentioned in the literature in invasive situations, but this name being often used with a wide meaning, including *C. acinaciformis*, it is impossible to have a clear idea of the respective importance of these two species across Europe; it's the same for their hybrids.

Dispersal patterns

It is necessary to distinguish roughly two zones: the North Atlantic zone (coast of the Armorican Massif, Cotentin, British Isles) with mild winters but cool, relatively humid summers and the "Mediterranean" zone in its broadest definition (Iberian Peninsula and Mediterranean basin) with hot dry summers, with all the islands associated with these two zones.

In the North Atlantic zone:

In this zone, the propagation of *Carpobrotus* is essentially vegetative, by spontaneous layering and by dispersal of broken fragments that root quickly: essentially garden waste thrown on the coast, scraping of the mats by animals, etc., and perhaps also by floating fragments and long-range transportation then projection by the waves on the rocks. This thalassochory, if true, might explain its prescence in some of the remote spots away from coastal gardens.



The importance of sexual reproduction for dispersal of the plant is secondary in this zone. The nectariferous flower attracts insects (especially Hymenoptera) and the flowers are pollinated but *C. acinaciformis* generally does not succeed in producing viable seeds in the climate of the North Atlantic coast, or it produces a little and seldom. Only *C. edulis* succeeds to produce mature seeds, but again not anywhere and not every summer, depending on weather conditions and local microclimates. Dispersal of these is necessarily linked to the consumption of fruits, mainly by rodents (rabbits, rats, voles...) because the fruit is indehiscent and not deciduous. In this zone, the rodents actually sometimes nibble the fruits but they apparently do not constitute for them a highly appreciated food, probably because they ripen badly under these latitudes and are therefore insufficiently sweet to be attractive. Most fruits therefore slowly rot on the plant or are liquefied by freezing and the seeds, when they are viable, then germinate usually beneath the plant or nearby. Sexual dissemination thus remains generally low and very localised. The reality of effective sexual reproduction in the Atlantic zone can be nevertheless observed by the frequent variability of the flowers (petal length and intensity of colours) [9] on some old carpets of *C. edulis*, that shows that they are multiclonal carpets. Carpets of *C. acinaciformis* are on the contrary very homogeneous, confirming the predominance of vegetative propagation for it.

9 Taking into account that in the *Aizoaceae*, the petals continue to elongate after spreading, it is this growth that drives the opening and closing mechanisms of the corolla; also taking into account the trend of gradual pinking of the corolla approaching the wilting stage.

It should be noted that this difficulty in the ripening of its fruit does not lower the local invasiveness of *Carpobrotus*, on the contrary, it appears! Indeed, fruiting is a costly process for energy and resource for the plant; anything that is not consumed by fruiting will therefore benefit the vegetative vigour...

In the "Mediterranean" area (broadly defined):

In this zone, the importance of the sexual reproduction of *Carpobrotus* is much higher than in the North Atlantic zone. This is probably related to the fact that its fruits ripen normally and are therefore very attractive for rodents, which then will disperse the seeds in their droppings[10]. Consumption of *Carpobrotus* fruits by rodents is a proven fact and it has been shown that digestive passing then promoted seed germination (probable partial attack of the seed testa by digestive juices). One study[11] even revealed a surprising phenomenon: the long-distance dispersal of seeds is not related to rodents themselves, who are rather home loving animals but mostly to cats who eat them! The seeds pass from a digestive tract to another to end up where the cat will decide to relieve itself...

The vegetative dispersal mechanisms mentioned for the previous zone are of course present in this area too.

It should be noted also that many documents also indicate the possibility of dispersal of *Carpobrotus* by some seabirds using fragments of it in their nest. Noteworthy, but we lack properly documented references or personal observations to confirm that.

10 The mechanism of transport and dispersal of a plant by eating fruits then discharging of intact seeds in feces is named endozoochory. This is one of the modalites of zoochory: this term naming the dispersal by animals, regardless of the precise mechanism (endozoochory or exozoochory).

11 Bourgeois K. & al. (2004) Extreme invasional meltdown: multi-trophic interactions catalyse. Mediterranean island invasions, in *Proceedings 10th MEDECOS Conference*.

THE DUNE IS FRAGILE.

IT IS THE LAST BULWARK AGAINST THE SEA.

LET'S PROTECT IT.

THE MUNICIPALITY OF [---]

Black humour or unconsciousness?
This portion of dune is completely invaded by *Carpobrotus*. This sign placed by a Breton municipality, with the laudable intention of protecting a fragile natural environment, only protects the worst enemy of the latter! As long as the coastal municipalities and their residents have not become aware of the problem, the fight against this invasive plant will be difficult. There is still some way to go...

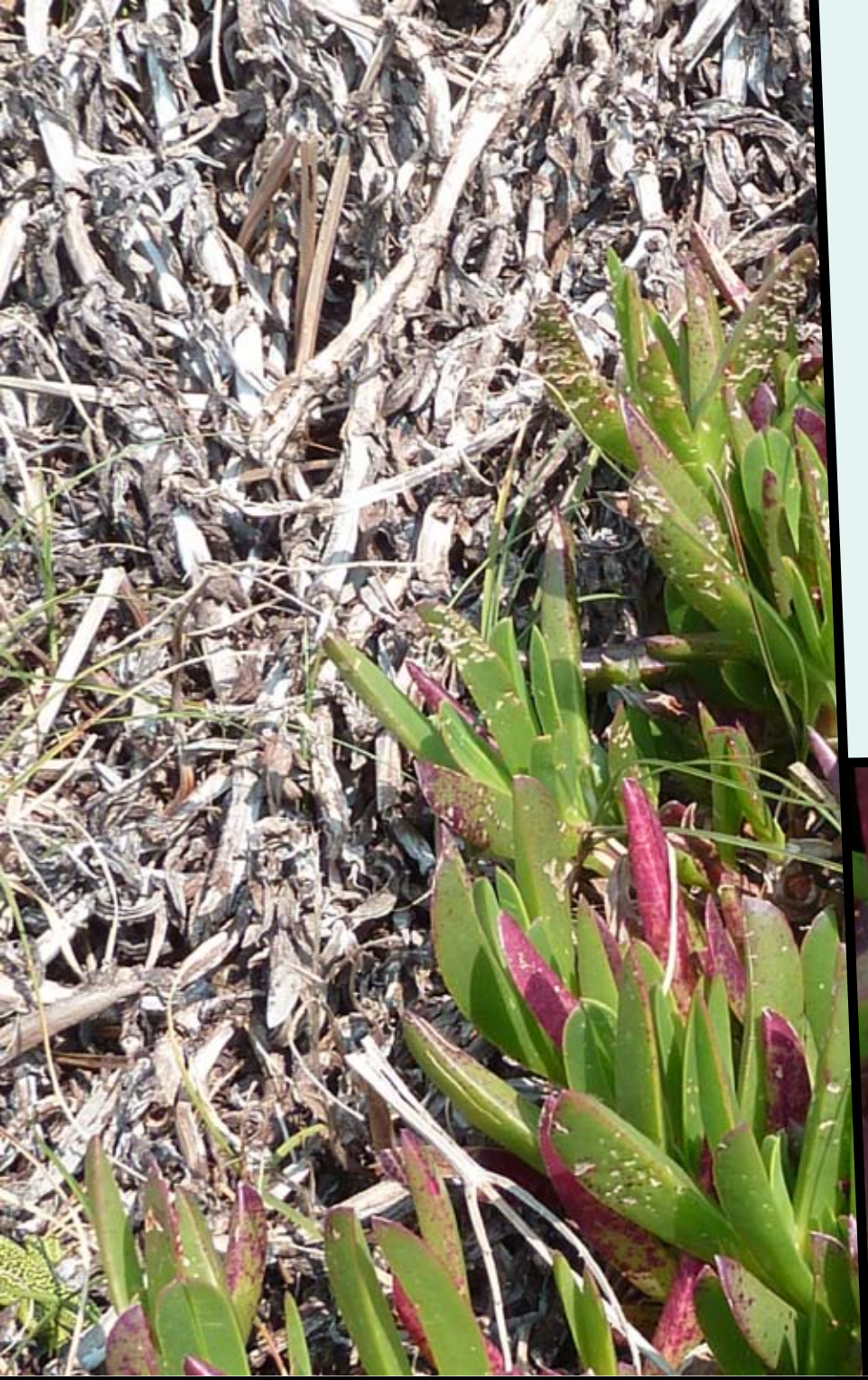
Its only real enemy: the frost

Carpobrotus is fortunately a frost sensitive plant and the frost is the only thing that succeeds in limiting its uncontrollable extension.

In fact, *Carpobrotus* is fairly resistant to frost compared to the average of plants of its family, *Aizoaceae*, since it can support a few degrees below zero in wet conditions: -2°C or -3°C but not much more when it is waterlogged, which is always the case in winter on ocean coasts[12]. Below that, it begins to deteriorate and the beautiful carpet turns to a blackish mush if the frost increases or persists, and that's good because the native flora does not suffer from the small frosts that kill *Carpobrotus*, thus restoring the balance. But if a few fragments remain alive inside this viscous slurry, the deadly carpet will recover quickly, long before the native plants will be able to re-conquer their space. Alas, once a carpet of *Carpobrotus* is installed, it is rare that some fragments do not survive in the thick litter produced by the plant, which is a good insulator against the cold. Even when everything seems dead after freezing, it is not uncommon to see the emergence of spring shoots, it is even the rule...

12 It withstands lower temperatures if wintered dry: -5° to -6°C without problems, and possibly even less but over a very short period.

The top of this carpet of *Carpobrotus* froze during the winter, but the lower part remained alive and quickly regains the dead zone [photo taken in early spring].

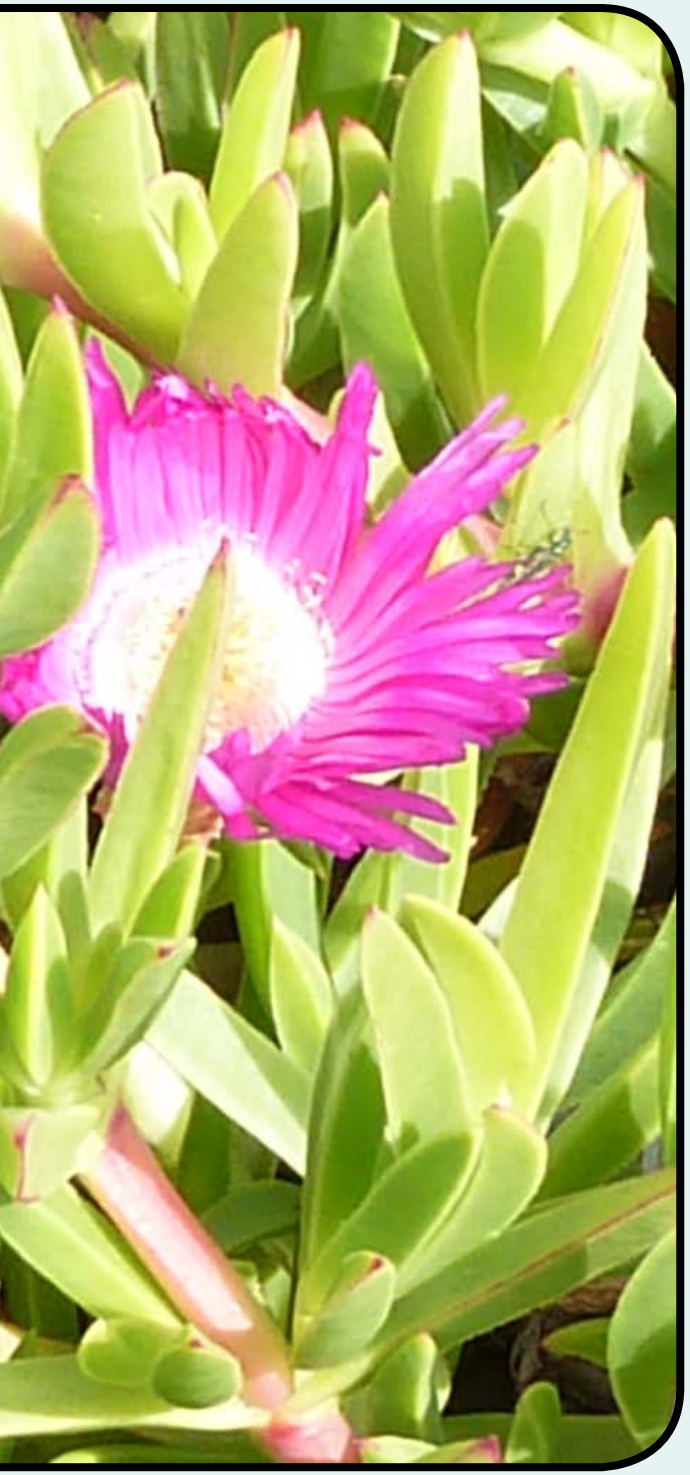


Thus the presence and thickness of the litter of old leaves has a great importance for the hardiness of this plant under our latitudes and partly explains the rather disparate data that can be read here and there about the minimum temperatures it withstands. Other factors affecting its hardiness are local exposure and topography conditions and probably some interclonal variations.

The hardiness of both species seems rather the same.

Carpobrotus is by nature a plant with a coastal affinity and its frost susceptibility makes it a strict maritime plant on the North Atlantic coast. It is common on large carpets to see at the end of winter that the most terrestrial margin of the carpet is completely frozen while the portion falling toward the sea is still alive, the latter restoring itself quickly as the first plant every summer.

Paradoxically, the partial freezing can sometimes be a factor favouring the vegetative dispersal of this plant, especially when it grows on coastal rocks as drapery: if the upper part of the plant is killed by frost, the lower parts remained alive will come off more easily and be torn by wind or waves and then scattered away.



Description

Plant: perennial; trailing or drooping stems, much branched, erect at the apex, rooting spontaneously on contact with the ground. The stems easily reach several meters in length.

Roots: fibrous and dense superficial network.

Leaves: opposite-decussate, with visible internodes (several centimetres); not stalked, decurrent insertion and discreetly amplexicaule; elongated limbs (about ten centimetres), glabrous, succulent, triangular section (more equilateral in *C. edulis*, more isosceles in *C. acinaciformis*) with sharp angles and toothless margins, finely micro-serrated keel toward the apex; flat upper face, slightly widened at the summit (in *C. acinaciformis*) and more or less curved inwards especially toward the apex (especially in *C. acinaciformis*); more or less glaucous green, blushing at high exposure when the nights are cool.

Flower: hermaphrodite; large (diam. 5-12 cm), terminal, solitary. Bloom starting in April and spread throughout the summer with a maximum during the second half of spring. The flower opens only in full sun. 4-5 fleshy sepals (two significantly longer in *C. edulis*, subequal in *C. acinaciformis*) petals (actually petaloid staminodes) many, indefinite in number, yellowish-white to pale yellowish-pink in *C. edulis*, blushing while withering, purple bright pink (magenta) in *C. acinaciformis*; numerous stamens in indefinite number (several hundred).

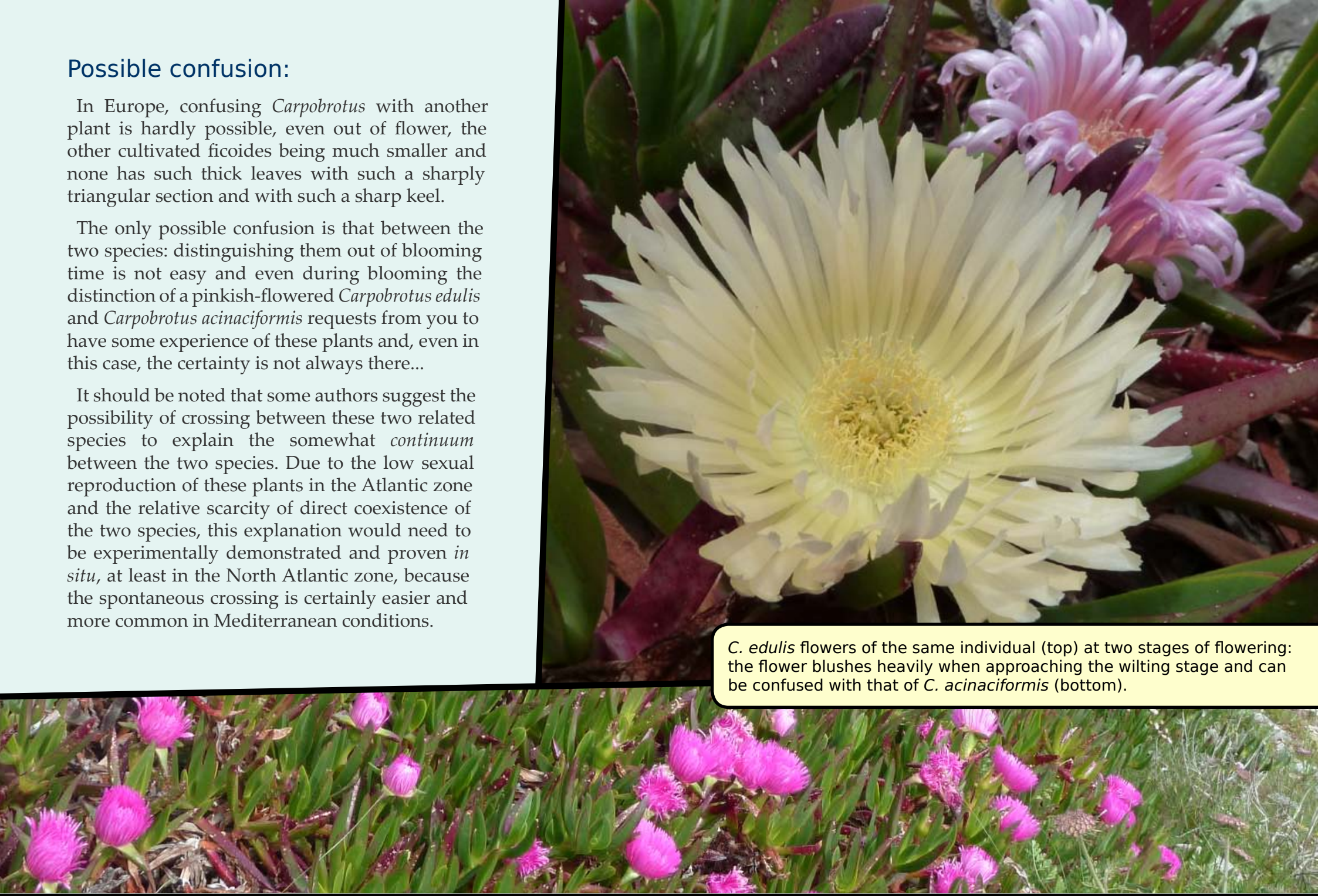
Fruit: conical-ovoid, fleshy and indehiscent when ripe, persisting long on the plant; more or less persistent sepals; green turning yellowish or reddish when ripe; the valvar mechanism with complex opening typical of most *Aizoaceae* is absent. Quite small and numerous seeds embedded in a mucilaginous translucent substance.

Possible confusion:

In Europe, confusing *Carpobrotus* with another plant is hardly possible, even out of flower, the other cultivated ficoides being much smaller and none has such thick leaves with such a sharply triangular section and with such a sharp keel.

The only possible confusion is that between the two species: distinguishing them out of blooming time is not easy and even during blooming the distinction of a pinkish-flowered *Carpobrotus edulis* and *Carpobrotus acinaciformis* requests from you to have some experience of these plants and, even in this case, the certainty is not always there...

It should be noted that some authors suggest the possibility of crossing between these two related species to explain the somewhat *continuum* between the two species. Due to the low sexual reproduction of these plants in the Atlantic zone and the relative scarcity of direct coexistence of the two species, this explanation would need to be experimentally demonstrated and proven *in situ*, at least in the North Atlantic zone, because the spontaneous crossing is certainly easier and more common in Mediterranean conditions.



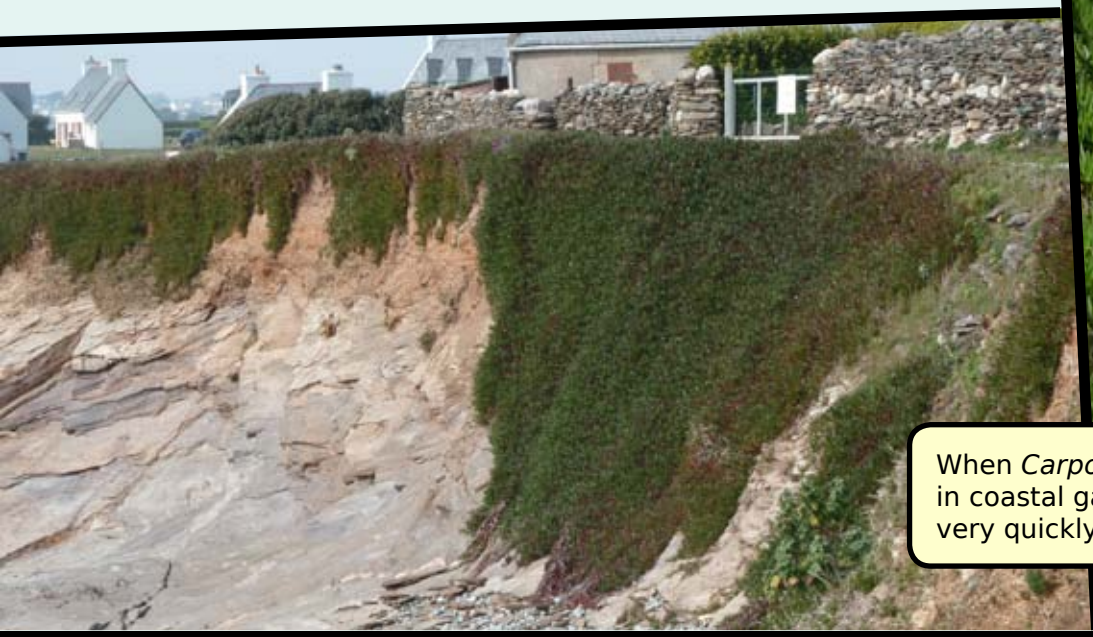
C. edulis flowers of the same individual (top) at two stages of flowering: the flower blushes heavily when approaching the wilting stage and can be confused with that of *C. acinaciformis* (bottom).

Use

In its native area, Southern Africa, local people consumed the fruits of *Carpobrotus*. In addition to its use as food, its fruits and leaves were used for various medicinal purposes.

The fleshy fruit of *Carpobrotus* evokes the appearance of a fig and is edible, but it rarely reaches a sufficient ripeness in the Atlantic zone, where it is barely sweet and too astringent and acid to be truly edible. In the Mediterranean area, the fruits ripen well and you can taste it but should do so sparingly because they have a reputation as laxatives...

In Europe, the use of *Carpobrotus* as food has always remained anecdotal: in addition to its fruit, its stems and leaves can be eaten cooked or pickled. Before its broad horticultural use for purely ornamental purposes, it was used in the past (in the nineteenth and early twentieth century) to fix the dunes and sloping soils at the seaside.



When *Carpobrotus* is grown in coastal gardens, it escapes very quickly out of them...

Distribution

Natural area:

Southern Africa, in the coastal areas of the Eastern Cape, on the coastline or on the hills not far from the sea.

Area of naturalization:

It is now at worldwide level, thus huge. The naturalized populations of *Carpobrotus* are now the overwhelming majority of the wild populations of this plant. Because of the magnitude of this diffusion and the aggressive nature of it, *Carpobrotus edulis* is listed by the IUCN[13] in the Global Invasive Species Database.

The climate of the Cape being close to the Mediterranean climate, the implantation of *Carpobrotus* in the Mediterranean was easy, as in all regions with a Mediterranean climate (the Californian coast, for example, is invaded) and more broadly, the plant is now present on the cliffs and sometimes the dunes of the all coastal areas with mild winters. Imprudently planted everywhere, *Carpobrotus* now poses a global problem!

In the European Atlantic area, *Carpobrotus* is abundant on the coast of the Iberian Peninsula. Further north, it is mainly present in the mildest regions, such as Brittany, Cornwall and Irish coasts. It is particularly common and invasive in the islands, both Atlantic and Mediterranean ones.

13 International Union for Conservation of Nature.

Notes of cultivation

If you live in coastal areas, an absolute rule:
DO NOT GROW THIS PLANT!

In addition, it would be, in our opinion, desirable that the cultivation of this plant is totally prohibited in all coastal areas with a mild climate and that its destruction is imposed by regulation.

At first, it would be necessary, as a minimum, that its trade is strictly prohibited; it is shocking and incomprehensible that in 2014 one continues to freely sell (garden centres, nurseries, Internet...) a plant that has long been recognized as one of the most problematic invasive plants on the planet! When we realize that some nurserymen inform their customers of the invasive behaviour of this plant, showing that they are aware of it, but still continue to sell it and that some landscape gardeners still use it abundantly in making "Mediterranean gardens" or "seaside gardens" under mild climate, one can only be indignant by this irresponsible behaviour that dishonours their profession.

In addition to regulation, massive awareness campaigns for individuals and municipalities should be carried out in coastal areas to finally put a stop at the use of this plant for ornamental purposes or as ground cover. Some coastal municipalities have recognized the problem and fight against the plant, but they are still in the minority.

If you live inland far from the sea, there is little risk that *Carpobrotus* escapes from cultivation and if it would do, the first winter would completely destroy it. There are thus, in theory, no reasons to not cultivate it if you want, but be very careful who you will give it afterwards because *THIS PLANT IS A BIOLOGICAL TIME BOMB* and from hand to hand you cannot be sure it does not eventually end its trip in a coastal garden...

Carpobrotus offered for sale in a garden centre just a few miles from the sea! Ignorance or total disregard for environmental issues? Probably a bit of both...

Conditions of cultivation

Carpobrotus is so vigorous than it cannot be easily cultivated in a pot, even in a large pot; it survives easily in it but it vegetates, becomes stunted and doesn't flower or barely; in short, it is not very nice in a pot but in the ground it will be superb and will grow faster than we can write this text. To keep it (what a strange idea!) in areas where it is frost-sensitive, simply make a few cuttings during the fall, keep frost-free over winter and then plant them in the ground in spring.

Carpobrotus only tolerates full sun; it etiolates quickly in the shade or partial shade and, if the shade is accompanied by moisture, snails will attack it (we can only encourage them!).

Carpobrotus withstands drought very well but if you want to admire all the power of its vegetation, it will need abundant and regular water supplies therefore a few waterings in the summer are required if the climate in your area does not provide them spontaneously.

If local conditions allow, *Carpobrotus* is quite suitable (covering capacity, drought resistance, shallow roots and vigour) and very pretty for making a green roof. However it is a very bad idea to use it for that because some birds (crows, *Columbidae*, robins...) love scratching green roofs during the winter and throw away plant fragments... In addition, its waterlogged thick carpets weigh very heavily and the roof structure must be planned accordingly.

Propagation

The question does not arise or, more exactly, the question is rather how to prevent *Carpobrotus* propagation than knowing how to do it!

The creeping stems root spontaneously and rooting of cuttings is fast with a success rate close to 100% and seeding is, it seems, just as easy, but who would still have the idea of multiplying this plant by seedlings? What to do then with these seedlings? Giving them away? Bad idea...

Where and how to get this plant?

Preferably in nature (we are talking here about Europe, not Southern Africa). Pull out all what you want and much more if possible, you will never pull out too much of this plague! Waste! Crush! Destroy! For once, vandalism and thoughtless harvesting of wild succulent plant are working for the protection of nature, enjoy! The only precaution to be taken during your raid: be careful to preserve the surviving indigenous plants, if any remain, and not to degrade the soil.

If you are spontaneously offered *Carpobrotus* cuttings, accept politely but explain to the giver the risk for the environment by distributing this green plague.

Especially do not buy it in the trade, because its trading MUST stop.

When invasion is moderate, as here, pull them all out! Keep some cuttings if you want but destroy the remaining (incineration, composting).

Note at the bottom left, the pretty pink tufts of *Sedum anglicum* which will soon disappear under *Carpobrotus* if you do not intervene.

Which one to cultivate?

When asked what species of *Carpobrotus* choose, the only sensible answer should be: none!

When choosing between the two species, *Carpobrotus edulis* and *C. acinaciformis*, if you don't see the plant in flower, their identification will be a lottery. If you trust the possible labelling or whoever gave it to you, the risk of error is roughly 50%... No, actually, because *edulis* is the name the most frequently used, so the laws of chance make it is slightly more likely that this will be actually the correct name! If you are sure of the identification of what you're offered, you should choose *Carpobrotus acinaciformis*, which is the species with the most beautiful flowers, in our opinion.

And the day you will get tired of this plant, don't give it to anyone, destroy it!

Alternatives

The culture of *Carpobrotus* is particularly unjustified because there are some other creeping *Aizoaceae* which are equally or even more beautiful, and which can be grown like it in coastal environments while posing less environmental problems. The indestructible *Delosperma cooperi* (Hook.f.) L.Bolus is the best example. In addition, the latter is much hardier (it is even fully frost-hardy in sea area) and much more floriferous than *Carpobrotus*. There are many others, because the "ficoides" group is large.

Delosperma cooperi

The winter-hardy creeping ficoids with low invasive potential are numerous (species and cultivars, mostly coming from the Drakensberg mountains and foothills) but none tolerates winter moisture of coastal areas as well as *Delosperma cooperi*.

Delosperma aberdeenense

Delosperma **'Graaff-Reinet'**

Protection and restrictions

As you would have suspected, *Carpobrotus* is not subject to any protective measures in any European country...

On the other hand, some restrictive regulatory measures are taken against it, but they are still very timid:

In **France**, the Arrêté of 13 July 2010 concerning the rules for good agricultural and environmental conditions, declares *Carpobrobuts edulis* and *C. acinaciformis* as proven invasive plants and prohibits their use as herbaceous vegetation cover in permanent buffer zones around cultivated fields.

The Annex I of the Arrêté n° 2007-4901/GNC of 23 October 2007 puts *Carpobrotus edulis* in the list of harmful organisms whose introduction is prohibited in New-Caledonia (this territory is administratively in France but is not in the European field, discussed here).

In **Italy**, although invasive species are considered a threat to the environment and ecosystems, *Carpobrobuts edulis* and *C. acinaciformis* are often cultivated even on the beaches, where they regularly escape from cultivation.

A bit of nomenclature

- ***Carpobrotus acinaciformis*** (L.) Bolus

Carpobrotus acinaciformis (L.) Bolus, *Fl. Pl. South Africa* 7: tab. 247 (1927)

Type [*Mesembryanthemum acinaciforme*] : (Lectotypus) J.J.Dillenius, *Hort. Eltham*. 2 : 282, tab. 211, fig. 270 (1732) // design. Preston & Sell, in *Watsonia* 17 : 238 (1989)

Family: *Aizoaceae* (syn. p.p. *Mesembryanthemaceae*).

Synonymy:

≡ [basionyme] *Mesembryanthemum acinaciforme* L., *Sp. Pl.* 1: 485. (1753)
≡ *Abryanthemum acinaciforme* (L.) Rothm., in *Notizbl. Bot. Gart. Berlin-Dahlem* 15(3): 413 (1941)
= *Carpobrotus edulis* var. *rubescens* Druce, *Plant notes* 7: 771 (1925)

The genus name "*Carpobrotus*" was built with the Greek words *Karpos* (*Carpus* in Latin) meaning "fruit" and *Brotos* meaning "blood" or "food".

The species name "*acinaciformis*" means "in the form of a sabre" by reference to the leaf morphology.

Illustration designated as lectotype of *Carpobrotus acinaciformis* [Dillenius, Hort. Eltham. 2 : 282, tab. 211, fig. 270]

• *Carpobrotus edulis* (L.), N.E.Br.

Carpobrotus edulis (L.), N.E.Br., in E.Phillips, *Gen. S. Afr. Fl. Pl.* : 249 (1926)

Type [*Mesembryanthemum edule*] : (Lectotypus) J.J.Dillenius, *Hort. Eltham.* 2 : 283, tab. 212, fig. 272 (1732) // design. S.T.Blake, *Contr. Queensland Herb.* 9: 17 (1969)

Synonymy:

≡ [basionyme] *Mesembryanthemum edule* L., *Syst. Nat.*, ed. 10, 2: 1060 (1759)
≡ *Mesembryanthemum acinaciforme* [var.] *flavum* L., *Sp. Pl.* 1: 485. (1753)
≡ *Abryanthemum edule* (L.) Neck ex Rothm., in *Notizbl. Bot. Gart. Berlin-Dahlem* 15(3): 413 (1941)

The species name "*edulis*" means "edible".

It should be noted that "*Carpobrotus edulis*" is often used as a catch-all name covering either the two species living in naturalization in Europe.

Vernacular names

(GB) Sea fig, Hottentot fig, Cape fig, Pigface.

(FR) Griffe de sorcière, Doigts de sorcier/sorcière, Figuier des Hottentots, Ficoïde en sabre, Figue de mer.

(IT) Fico degli Ottentotti, fico del Capo.

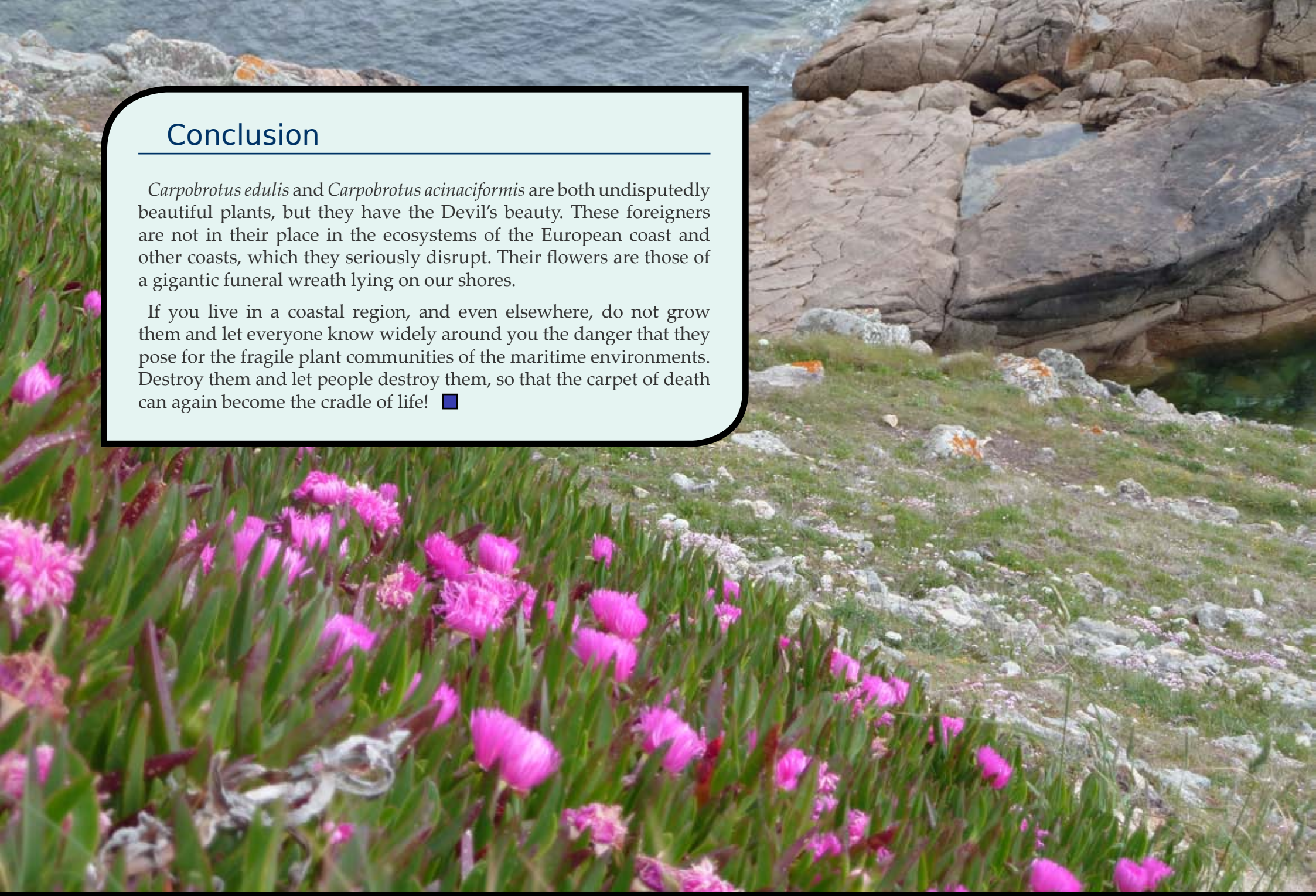
Illustration designated as lectotype of *Carpobrotus edulis* [Dillenius, Hort. Eltham. 2 : 284, tab. 212, fig. 272]

Considerations on the value of these nomenclatural names

As we have reported, it is likely that the invasive populations no longer fully correspond to the original populations from which they derive (genetic drift after introduction and escape of cultivation, hybridisation and introgression between the two species, etc.).

It's hence a bit pointless to try to make the invasive plants match with precision one or the other of these species as they have been described. Don't forget that the currently invasive populations were not originally wild plants but plants escaped from cultivation and then naturalized.

You can also see often used in the literature the names *Carpobrotus* aff. *edulis* and *C.* aff. *acinaciformis* (or *Carpobrotus* cf. *edulis* and *C.* cf. *acinaciformis*). While often motivated by the difficult distinction of these plants, this naming is certainly the most rigorous taxonomically because, when we speak about the indigenous *Carpobrotus* from Southern African and the allochtonous invasive European *Carpobrotus* (or others), we certainly speak not exactly about the same taxa. The invasive populations of *Carpobrotus* are a group in *continuum* that is, in our opinion, certainly more rigorous to treat as a single but complex autonomous entity. This is the point of view that we have adopted here by writing "*Carpobrotus*" without more precision. Would it be justified to give a new taxonomic status of this group? The question remains...



Conclusion

Carpobrotus edulis and *Carpobrotus acinaciformis* are both undisputedly beautiful plants, but they have the Devil's beauty. These foreigners are not in their place in the ecosystems of the European coast and other coasts, which they seriously disrupt. Their flowers are those of a gigantic funeral wreath lying on our shores.

If you live in a coastal region, and even elsewhere, do not grow them and let everyone know widely around you the danger that they pose for the fragile plant communities of the maritime environments. Destroy them and let people destroy them, so that the carpet of death can again become the cradle of life! ■

Mammillaria paulii, a poorly known gem

by Davide Donati

The genus *Mammillaria* Haw. is one of the largest genera belonging to the family *Cactaceae*, composed of hundreds of species, distributed in northern and Central America. These plants are generally small to medium sized, globular to elongate, always characterized by flowers which are produced at the para-apical axils of the tubercles, and often form a ring around the stem.

Among *Mammillaria*, it's possible to recognize an interesting group of plants, once belonging to a distinct genus: *Dolichothele* Britton & Rose. These plants are generally characterized by their small size, globose to depressed stem, taproot, soft tubercles and, above all, large, bright yellow flowers, often scented.

These plants are often grown for their beauty, but there is among them a species rather poorly known and rarely grown: *Mammillaria paulii* Linzen.

Ecology

Mammillaria paulii can be defined as a mountain and alpine cactus, which grows at high elevations, between 1800 to 2300 m asl. The area is characterized by alpine meadow (pastizal) and pine and oak woods, sometimes covered by a thin layer of snow.

As with other *Dolicothele*, it often grows in part or full shade, under shrubs or trees, in calcareous soils which are rich in humus. As reported in the original description, rainfall is frequent and abundant in the area, so this plant is adapted to live in rather humid conditions, sometimes among mosses and lichens, where it's often the only cactus growing.

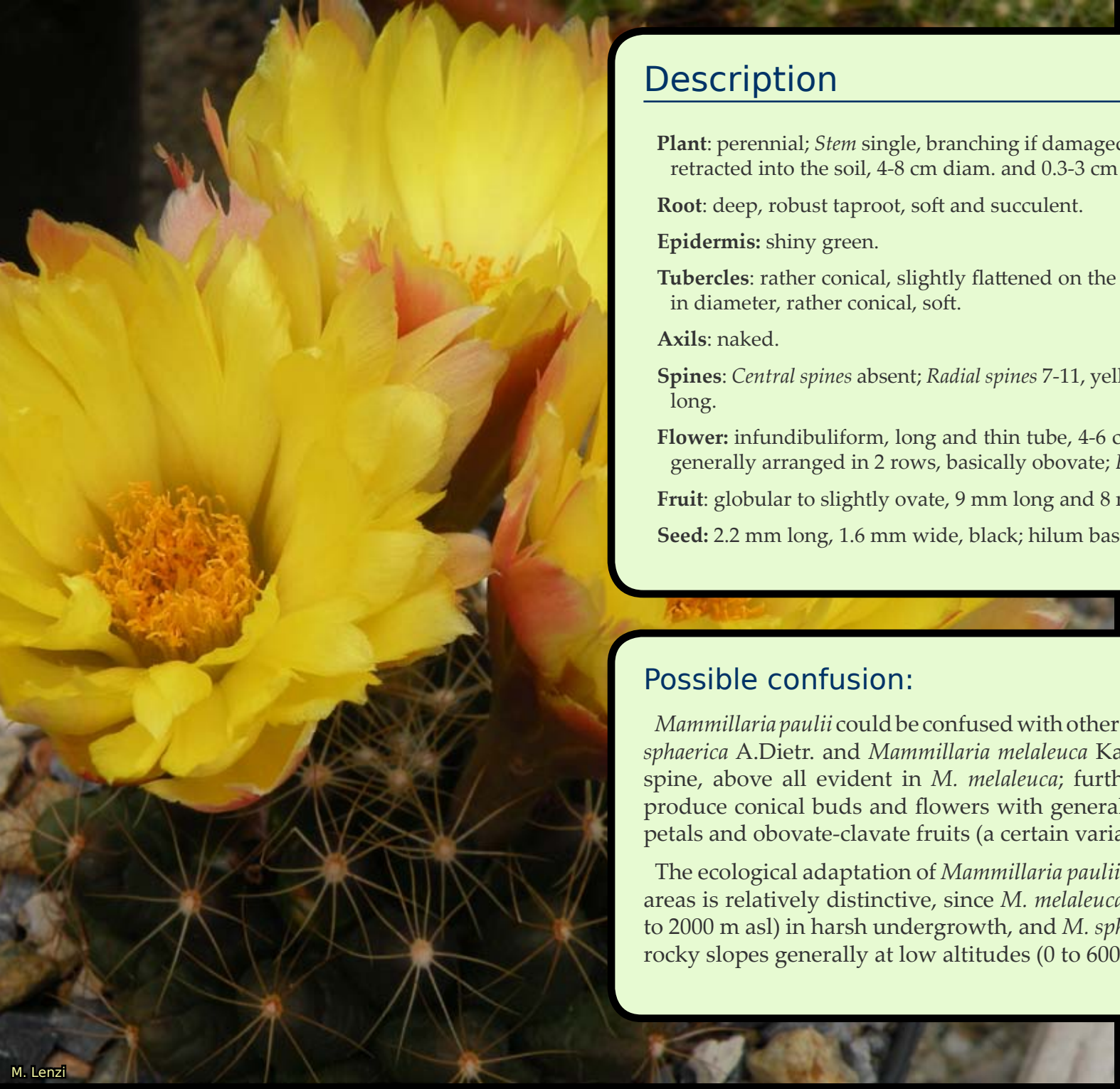
However, *Mammillaria paulii* can also grow in prairies, in gravelly areas or among the grasses: in these conditions, plants are generally rather retracted into the soil and the stem emerges from the ground for few millimetres, so most of plants are often shaded by grasses, whilst some specimens are growing in full sun, generally in places covered by a thick biological crust. Plants which grow in the middle of the grass are very hard to see.

For these reasons, *Mammillaria paulii* shows a broader ecology compared to the rest of *Dolicothele*, which mainly grow under the shade of bushes in areas with relatively dry and milder climates as those mentioned above.

Mammillaria paulii, growing here among mosses and lichens, is a very shy plant when it is not flowering.

Habitat of *Mammillaria paulii*

S. Baglioni



M. Lenzi

Description

Plant: perennial; *Stem* single, branching if damaged, depressed to globose-depressed, often well retracted into the soil, 4-8 cm diam. and 0.3-3 cm high, soft.

Root: deep, robust taproot, soft and succulent.

Epidermis: shiny green.

Tubercles: rather conical, slightly flattened on the upper side, soft, 1 to 2 cm long, 0.5 to 1.6 cm in diameter, rather conical, soft.

Axils: naked.

Spines: *Central spines* absent; *Radial spines* 7-11, yellowish, acicular, flexible, very thin, 0.5-1.3 cm long.

Flower: infundibuliform, long and thin tube, 4-6 cm in diameter; *Petals* bright, sulphur yellow, generally arranged in 2 rows, basically obovate; *Bud* roundish, reddish.

Fruit: globular to slightly ovate, 9 mm long and 8 mm diam., green yellowish once ripe.

Seed: 2.2 mm long, 1.6 mm wide, black; hilum basal.

Possible confusion:

Mammillaria paulii could be confused with other *Dolichothele*, especially with *Mammillaria sphaerica* A.Dietr. and *Mammillaria melaleuca* Karw., but these plants produce a central spine, above all evident in *M. melaleuca*; furthermore, *M. sphaerica* and *M. melaleuca* produce conical buds and flowers with generally a single row of narrower, lanceolate petals and obovate-clavate fruits (a certain variability is present, though).

The ecological adaptation of *Mammillaria paulii* to grow also in alpine prairies in humid areas is relatively distinctive, since *M. melaleuca* grows at medium-high altitudes (1000 to 2000 m asl) in harsh undergrowth, and *M. sphaerica* prefers undergrowth and shaded rocky slopes generally at low altitudes (0 to 600 m asl).

Distribution

Mammillaria paulii is distributed in a very restricted area in the Municipality of Guadalcazar, State of San Luis Potosí, Mexico. It grows on high mountains emerging from woody areas, isolated from any other *Dolichothele*.

It generally grows in areas where the soil is calcareous, with limestone outcrops in which are also commonly found *Turbinicarpus knuthianus* (Boed.) V.John & Říha, *Mammillaria candida* Scheidw., *Echinocereus pentalophus* Lem., etc.

Stenocactus aff. dichroacanthus, another usual companion of *Mammillaria paulii* in habitat.

Nomenclature

Mammillaria paulii Linzen, in *Mitteilungsbl. Arbeitskreises Mammillarienfr*. 29(3): 139-143, fig. (2005)

Typus: Herb. Jard. Bot. Univ. Bermejillo, Durango
Syn.: ≡ *Mammillaria sphaerica* subsp. *paulii* (Linzen) Lodé
Family: *Cactaceae*.

M. Lenzi

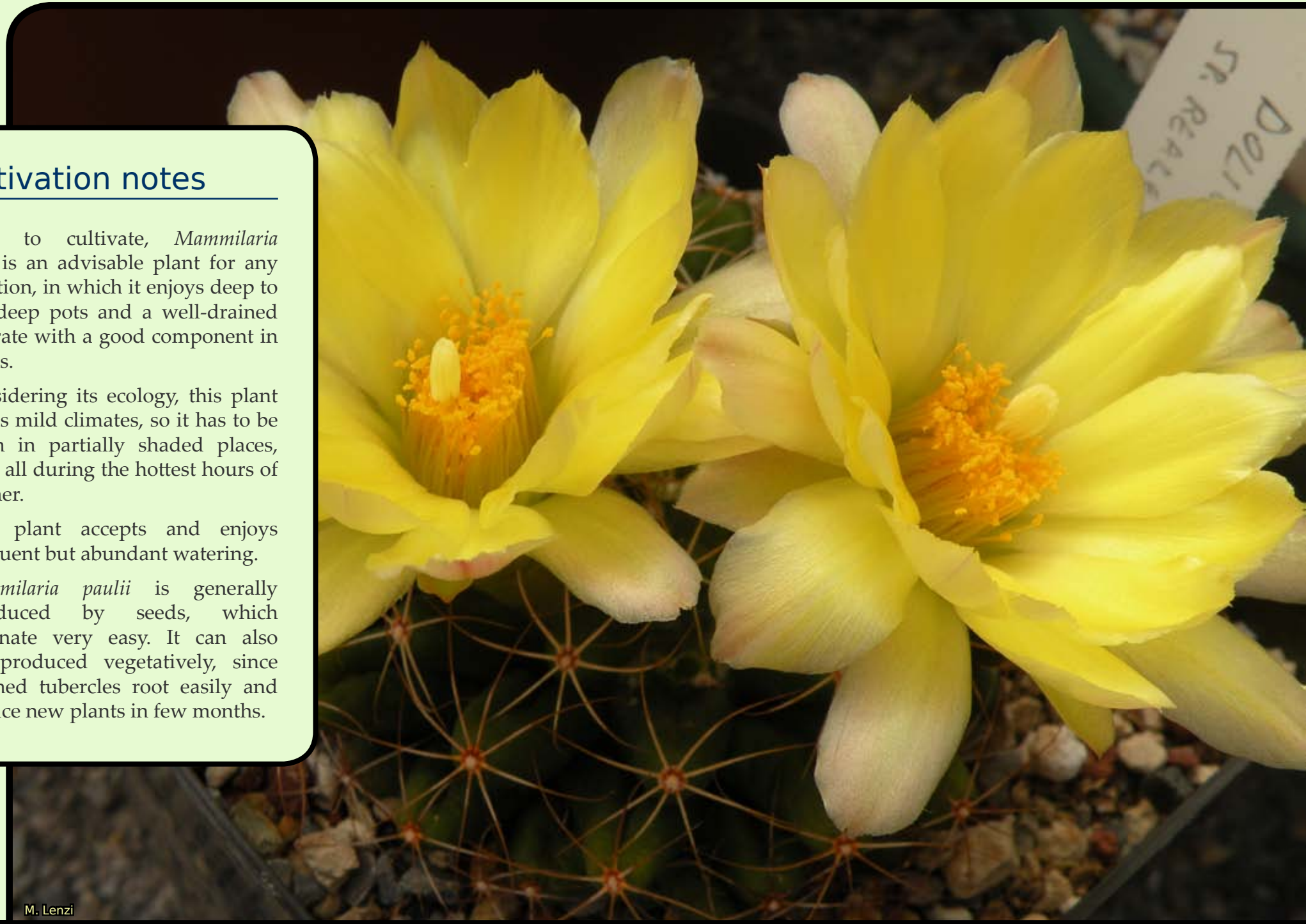
Cultivation notes

Easy to cultivate, *Mammilaria paulii* is an advisable plant for any collection, in which it enjoys deep to very deep pots and a well-drained substrate with a good component in humus.

Considering its ecology, this plant prefers mild climates, so it has to be grown in partially shaded places, above all during the hottest hours of summer.

This plant accepts and enjoys infrequent but abundant watering.

Mammilaria paulii is generally reproduced by seeds, which germinate very easy. It can also be reproduced vegetatively, since detached tubercles root easily and produce new plants in few months.



M. Lenzi

Conclusion

Mammilaria paulii is an interesting small cactus which is worthy of attention for its characteristics and its ecology. Furthermore, this plant is also very attractive in cultivation, where it makes any collection rather precious thanks to its big, showy and scented flowers. ■

Saxifraga longifolia, the queen of the saxifrages

by Jean-Louis Guihard

Well known by all lovers of alpine plants, *Saxifraga longifolia* Lapeyr. is much less known by succulent plant lovers although it is undeniably succulent and xerophytic, as are many other members of this genus. Yet this is the most spectacular of the "silvery" saxifrages, a group of mountain saxifrages all more or less succulent and characterized by the presence of calcareous secretions encrusting their leaves.

The queen of the saxifrages is undoubtedly the finest and most spectacular of all European succulents particularly at the time of its sumptuous flowering with its long cascades of countless white flowers.

Let's enter into her kingdom...

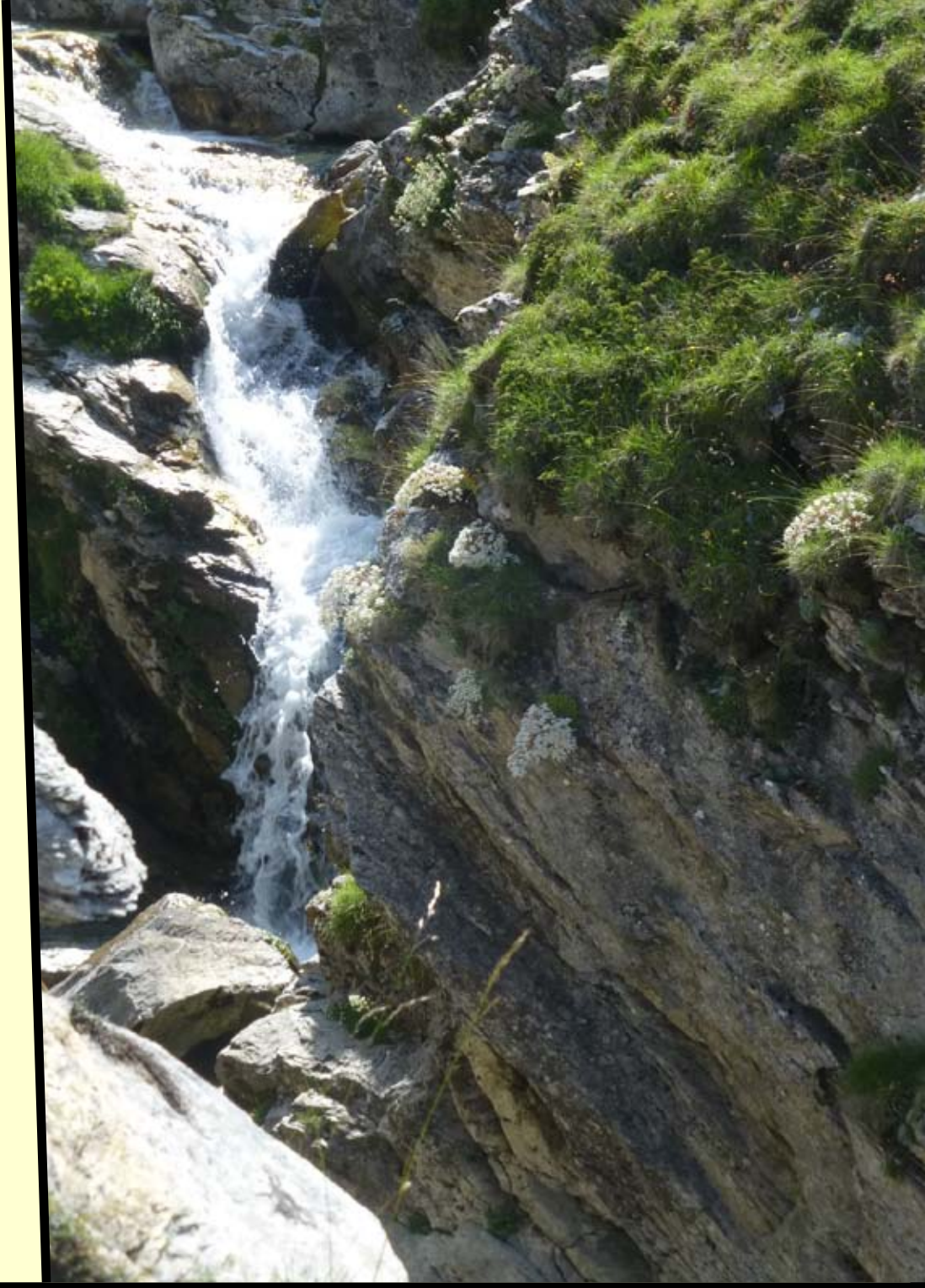
A rock wall covered with *Saxifraga longifolia* in full bloom is a breathtaking spectacle of which no photograph can really capture the emotion.

Ecology

Saxifraga longifolia is a mountain plant, like many saxifrages. It behaves as a rupicolous and calcicolous chasmophyte, that is to say, we only found it in the crevices of vertical limestone rock faces where its rosettes grow, pressed against the walls. It should be noted that when the slope of the wall deviates ever so slightly from the vertical, its rosettes grow less vigorously and become scarcer and the plant is absent from areas of gentle slopes. For optimal growth, its rosettes therefore give the impression of having to be as close as possible to the vertical.

The rosettes of *Saxifraga longifolia* generally grow relatively isolated from other plants and obviously badly withstands competition, which is naturally low on the vertical walls they colonize. The scarcity and lack of *Saxifraga longifolia* on walls gently sloping probably may be explained as much by competitive factors (the plant is supplanted by more efficient competitors) as by a purely physiological need to grow vertically.

Regarding sun exposure, the requirements of *Saxifraga longifolia* are slightly less strict since it can be found both in sun and partial shade and even in light shade. However, note that if it is found growing in full sun, it is often in a situation where the hygrometry remains if not high, at least relatively high (walls of waterway gorges, near waterfalls, etc.). The plant tolerates obviously much better a dry substrate (or at least a quick drying substrate) than dry air and it enjoys or even looks for sufficient atmospheric humidity. It grows on usually quite dry rocky substrates and seems to fear the stagnant moisture, either at root level or in its rosettes. These potential dangers of stagnant moisture may explain (in association with the phenomena of competition noted above) the difficulty for it to grow horizontally, resulting in a dangerous stagnation of rainwater in the heart of the very dense rosette.



The type of habitat of *Saxifraga longifolia* is therefore well defined and very strict: cracks of dry limestone, vertical rocky walls in hygrometric conditions not falling too low. If these criteria are not all met, the plant will be completely absent. However, if they are met, the plant can pullulate locally but, like many plants with a narrow ecology, its local abundance conceals its overall rarity because even though it is not really a rare plant (at least in the Pyrenees, the heart of its range), it is far from being a common plant.

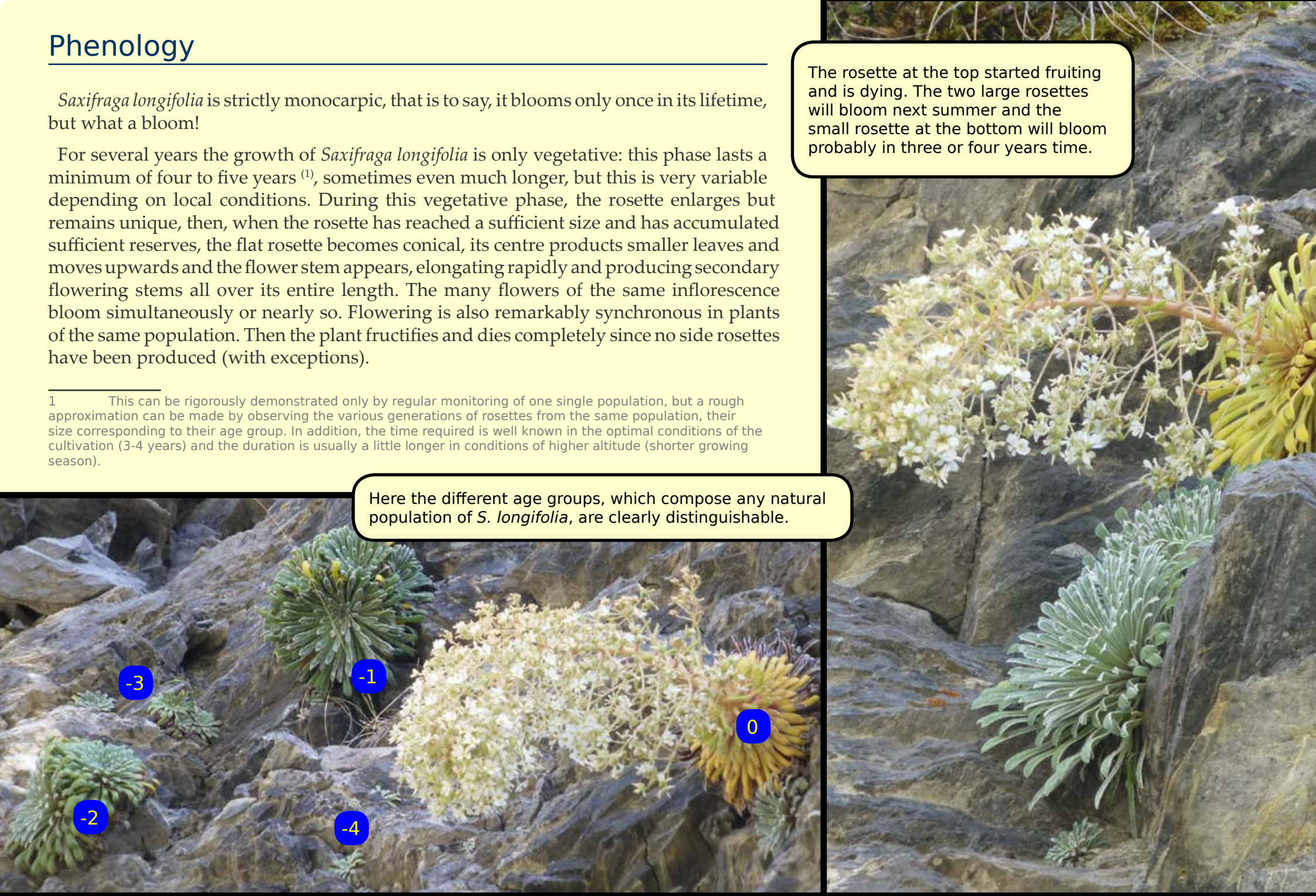
The only criterion for which *Saxifraga longifolia* shows somewhat an ecological flexibility is the elevation. Indeed, its altitudinal range is rather wide because it is found as well at moderate elevations in the mountain belt as in the subalpine belt and even in the alpine belt.

Phenology

Saxifraga longifolia is strictly monocarpic, that is to say, it blooms only once in its lifetime, but what a bloom!

For several years the growth of *Saxifraga longifolia* is only vegetative: this phase lasts a minimum of four to five years [1], sometimes even much longer, but this is very variable depending on local conditions. During this vegetative phase, the rosette enlarges but remains unique, then, when the rosette has reached a sufficient size and has accumulated sufficient reserves, the flat rosette becomes conical, its centre products smaller leaves and moves upwards and the flower stem appears, elongating rapidly and producing secondary flowering stems all over its entire length. The many flowers of the same inflorescence bloom simultaneously or nearly so. Flowering is also remarkably synchronous in plants of the same population. Then the plant fructifies and dies completely since no side rosettes have been produced (with exceptions).

1 This can be rigorously demonstrated only by regular monitoring of one single population, but a rough approximation can be made by observing the various generations of rosettes from the same population, their size corresponding to their age group. In addition, the time required is well known in the optimal conditions of the cultivation (3-4 years) and the duration is usually a little longer in conditions of higher altitude (shorter growing season).



Description

Plant: perennial, persistent, monocarpic, in stemless rosette 15-20 cm in diam. in adulthood, with many spirally arranged spreading leaves, deeply rooted in the crevices with long roots. Total lack of lateral shoots, except in case of destruction of the vegetative apex (or hybrid individuals).

Leaf: linear, discreetly spatulate, with acute or blunt apex, convex on both sides, succulent; *margins*: entire, with spaced hydathodes[2] covered by calcareous secretions simulating a toothed margin and giving a silver-grey to whitish colour to the plant.

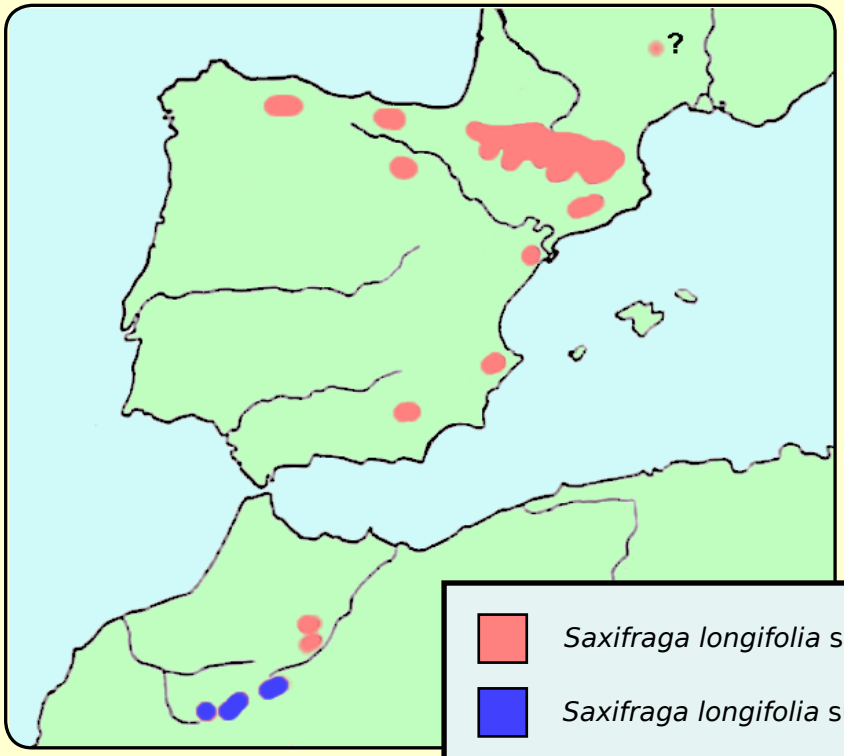
Inflorescence: terminal, very long (30-80 cm) and wide conical panicle with rounded end, slightly curved downward, densely flowered (can bear hundreds of flowers) with massive and almost simultaneous flowering throughout the inflorescence. The glandular-hairy flower stem bears flowers almost from its base. Flowering from June to early August according to the elevation of the location.

Flower: pentamerous, hermaphrodite, diplostemone, approx. 1 cm in diam.; hairy calix; *Petals* pure white, obovate to rounded, bearing a few discrete red dots (rare or absent in some individuals); *nectary* highly developed; insect pollination.

Possible confusion:

Saxifraga longifolia can especially be confused with *Saxifraga cotyledon* L., another tall monocarpic saxifrage, mainly present in the crystalline central Alps but also in the Pyrenees, where it is much rarer than *S. longifolia*. At flowering time, confusion is possible, but *S. cotyledon* has much broader and spatulate leaves and the part without flowers at the base of the flower stem is much larger, its inflorescence is a little looser than *S. longifolia* and its flowers have significantly narrower petals; in addition *S. cotyledon* is silicicolous while *S. longifolia* is calcicolous.

2 Aquiferous stomata secreting water containing mineral salts, in this case especially calcium salts. The water evaporates leaving a salt deposit encrusting the periphery of each hydathode. Once crystallized, calcium salts are hardly diluted by rain and then give their characteristic appearance to the “silver” saxifrages, including *S. longifolia* as a good example.



Distribution

Saxifraga longifolia is present from the Pyrenees to Morocco but is relatively common only in limestone areas of the Pyrenees; it is much more sporadic in the Cantabrian Mountains, in the Iberian Mounts (*Sistema Iberico*) and in the Catalan Sierras. In Morocco, it is present in the Middle and High Atlas.

Outside the Pyrenees, *Saxifraga longifolia* is present as small and scattered populations localised here and there with a very patchy and discontinuous distribution. However, neglecting these gaps and large variations in density, the area of this plant makes a regular croissant shape from Asturias to the Moroccan Atlas through the Pyrenees and the Catalan Sierras.

It should be noted that *Saxifraga longifolia* has also been reported locally in the Causses (limestone massif at the south of the French Massif Central), but its spontaneous nature can be questioned because this highly cultivated plant by rock garden lovers sometimes escapes. To be confirmed.

Uses

The uses of *Saxifraga longifolia* in traditional herbal medicine are restricted because this plant is very toxic... Its abortifacient properties are deemed to have been formerly used by Spanish and Catalan shepherds to abort goats whose pregnancies went wrong, hence its Spanish vernacular name of *Abortacabras*.

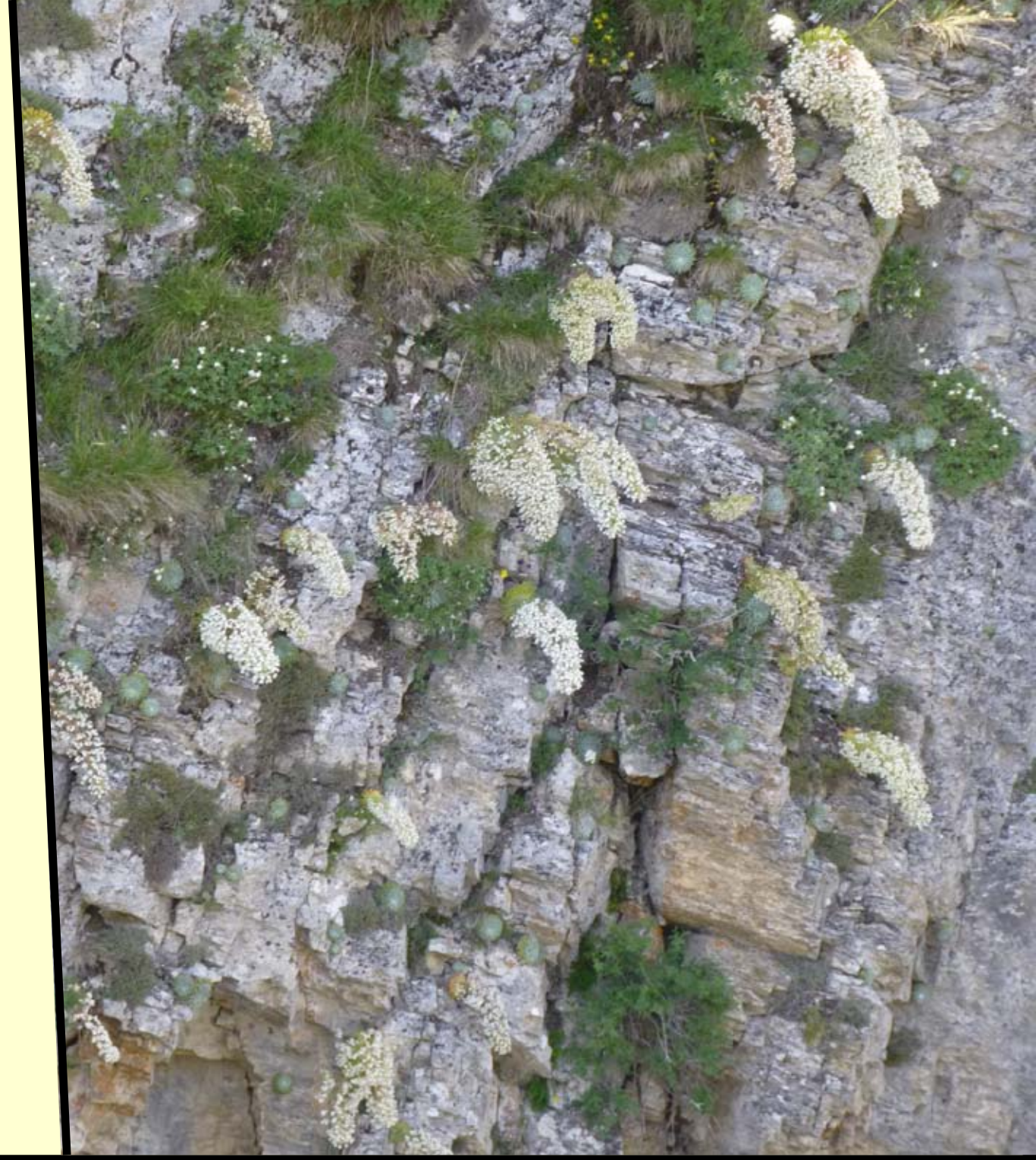
Current use of this plant is mainly horticultural: *Saxifraga longifolia* is a well known and very popular plant in rock gardens, where it is widely cultivated.

Protection

In France, *Saxifraga longifolia* is not protected by law.

In Spain, *Saxifraga longifolia* is protected in the *Comunitat Valenciana* by the Decreto 70/2009 of 22/05/2009 revised in April 2013, and in *Junta de Castilla y León* by the Decreto 63/2007 of 14/06/2007.

In Morroco, *Saxifraga longifolia* seems not to be protected by law, but that needs to be confirmed.



Saxifraga paniculata (right) the most common of the silver saxifrages, here with *Sempervivum montanum* (a plant covered in the previous issue of *Acta Succulenta*).

Natural hybrids

Saxifraga longifolia can cross with most of the saxifrages of the *Ligulatae* section (the "silvery saxifrages"), in particular with the very common *Saxifraga paniculata* Mill. that products *Saxifraga ×lhommei* H.J.Coste & Soulié[3]. Note also the existence of *Saxifraga ×superba* Rouy & E.G.Camus[4] which is the beautiful hybrid between *S. longifolia* and *S. cotyledon* but this plant is extremely rare in nature because of the different ecological requirements of its parents (*S. cotyledon* is silicicolous, *S. longifolia* is calcicolous) and it is best known in horticulture.

Hybrid individuals are much rarer than their parents and have an intermediate appearance between them but they are often morphologically closer to *S. longifolia* (large rosette with long leaves) than to the other parent and they look most often as a kind of "*Saxifraga longifolia*" of moderate size, often with multiple rosettes, which can cause confusion with *S. longifolia* s.s.

3 *Saxifraga ×lhommei* H.J.Coste & Soulié, in *Bull. Soc. Bot. France*, 59 : 404 (1912).
4 *Saxifraga ×superba* Rouy & E.G.Camus, *Fl. Fr.*, 7: 81 (1901)

Nomenclature

Saxifraga longifolia Lapeyr., *Fig. Fl. Pyr.* : 26, tab. 11 (1801)

Typus: ic. ex protologo

Sectio *Ligulatae* Haw.

Family: *Saxifragaceae*.

Synonymy:

≡ *Chondrosea longifolia* (Lapeyr.) Haw., *Saxifr. Enum. Revis. Pl. Succul.*: 11 (1821)
≡ *Saxifraga longifolia* var. *pyrenaica* Emb., *Mat. Fl. Maroc*, n° 552 (1936)
= *Saxifraga catalaunica* var. *aitanica* Pau, in *Bol. Soc. Aragonesa Ci. Nat*. 3: 283 (1904)
≡ *Saxifraga longifolia* var. *aitanica* (Pau) Pau, in *Cavanillesia* 8: 113 (1936)
≡ *Saxifraga lingulata* subvar. *aitanica* (Pau) Mas-Guindal, in *Anales Real Acad. Farm*. 8: 63 (1942)
≡ Saxifraga lingulata var. aitanica (Pau) Cámara, in Bol. Real Soc. Esp. Hist. Nat., Biol. 40: 330 (1942)
= *Saxifraga longifolia* var. *ilergabona* Pau, in *Cavanillesia* 8: 113 (1936)
= *Saxifraga longifolia* [var.] β *minor* Rouy & E.G.Camus, 1901, *Fl. Fr.*, 7: 78 (1901)
= *Saxifraga longifolia* [var.] γ *subacaulis* Rouy & E.G.Camus, 1901, *Fl. Fr.*, 7: 78 (1901)

The author of this taxon having designated no type specimen nor mentioned any original material in his protologue (that is valid because of the early date of publication) and without subsequent designation of a lectotype (?), this illustration from the protologue must be considered as the holotype.

Etymology

Saxifraga means "stone breaker" (*sax-* stone *frag-*: to break). This is a very old term used since at least the Renaissance. As the Latin word *saxum* means both "stone" and "rock", one sees intuitively in the word *Saxifraga* an allusion to the habitat of these plants in the cracks of rocks. In fact, it is more a reference to one of the therapeutic properties traditionally attributed to these plants that treats the "stone disease", that is to say, breaks kidney stones. That said, it is not impossible that this belief has had its origin in the habitat of these plants, following the old principle that stated that the antidote to an evil or poison always grows in immediate vicinity of it: so a plant that grows on stone heals stone!

longifolia means "with long leaf" (*long-*: long, *foli-*: leaf).

Common names

France: Saxifrage des Pyrénées, Saxifrage à longues feuilles, Couronne de roi (by translation of the Spanish name).

Spain: Corona de rey, Altamira, Abortacabras.

Morocco: ???

Infraspecific taxa

- ***Saxifraga longifolia* subsp. *longifolia***

(autonym)

Synonymy:

≡ *Saxifraga longifo1ia* subsp. *eulongifolia* ex Quézel, in *Collecteana Botanica* vol. 5, 1(10): 174 (1956)
= *Saxifraga longifolia* var. *ghatica* Quézel, in *Bull. Soc. Sci. Nat. Maroc* 31: 257 (1951)
= *Saxifraga longifolia* var. *orientalis* Quézel, in *Bull. Soc. Sci. Nat. Maroc* 31: (1951)

Type-subspecies species accounting for most populations of this plant, particularly all the Pyrenean populations.

The consideration of this autonym taxon is based on the rather questionable consideration of the following taxon:

• *Saxifraga longifolia* subsp. *gaussenii* Emb.

Saxifraga longifolia subsp. *gaussenii* Emb., in *Bull. Soc. Sci. Nat. Maroc* 15: 188-226 (1936)

Typus: leg. L. Emberger, 1934-7-14, s.n. ; "Maroc). Zaouia ahnesal : Falaises de l'Aïoni, calc., alt. 3000 m" ; Université Mohammed V-Agdal (RAB), HT RAB077796.

Synonymy:

≡ *Saxifraga longifolia* var. *gaussenii* (Emb.) Maire *Fl. Afrique N*. 15: 46 (1980)
= *Saxifraga longifolia* subsp. *gaussenii* var. *mesatlantica* ex Quézel, in Collecteana Botanica vol. 5, 1(10): 182 (1956)
= *Saxifraga longifolia* subsp. *gaussenii* var. *occidentalis* ex Quézel, in Collecteana Botanica vol. 5, 1(10): 182 (1956)
= *Saxifraga longifolia* subsp. *gaussenii* var. *typica* ex Quézel, in Collecteana Botanica vol. 5, 1(10): 182 (1956)
= *Saxifraga longifolia* subsp. *gaussenii* var. *rhatica* ex Quézel, in Collecteana Botanica vol. 5, 1(10): 182 (1956) (sic, non sphalm. pro *ghatica*)

Endemic to the High Atlas in Morocco.

It differs from the type by some morphological minutiae: little more spatulate and therefore wider leaves and more succulent sepals.

NB: the Moroccan plants from Middle Atlas match the type of the species, according to Maire[(5)].

This taxon is kept here for two reasons: on the one hand because it is the infraspecific taxon most often retained in the literature, and often the only one being so among those who have been published, on the other hand because a lack of personal knowledge of the plant *in situ* or *ex situ*, it would be difficult to reliably reverse it as a synonym of the type, although it seems possible to do so because its definition is based more on geography than on morphological and ecological data.

5 Maire R., *Flore de l'Afrique du Nord*. 15: 46 (1980)

Cultivars

There are primarily two cultivars of *Saxifraga longifolia* in cultivation:

***Saxifraga longifolia* 'Tumbling Waters'**:

The most common among the cultivars of *S. longifolia* in cultivation. It differs from the type by producing side-rosettes and more seldom flowering, with a smaller and looser inflorescence than those of the type. It can be vegetatively propagated, that is its main interest. Perhaps it is a hybrid?

***Saxifraga longifolia* 'Imperialis'**:

Syn.: *Saxifraga* 'Monarch'

It vaguely resembles *Saxifraga longifolia* (smaller and clustering), but it is probably a hybrid of obscure origin, the presence of *Saxifraga longifolia* among its parents is even even unsure...

Be careful not to confuse *Saxifraga longifolia* 'Imperialis' with *Saxifraga* ×*imperialis* Engl. & Irmscher[6] [syn: *Saxifraga* ×*superba* Rouy & E.G.Camus[7]] which is a hybrid between *Saxifraga longifolia* and *Saxifraga cotyledon* (the latter is the equivalent in the of *Saxifraga longifolia* in the crystalline Alps).

6 *Saxifraga* ×*imperialis* Engl, & Irmscher in Engler, *Pflanzenr*. 4, Fam. 117, 2: 523 (1919)
7 *Saxifraga* ×*superba* Rouy & E.G.Camus, *Fl. Fr.*, 7: 81 (1901)

Cultivation notes

The culture of *Saxifraga longifolia* is considered relatively easy compared to some other alpine plants. Its main requirements are a very well-draining mineral substrate and outdoor cultivation. If the pot is laid on its side, the plant will have its natural position and will grow at its best. It can also grow into a crack in an old wall or in rock garden though take care to prevent excessive winter rain in this case.

As with many mountain plants, *Saxifraga longifolia* does not like excessive heat and you will have to protect it from the sun during the hottest hours in the southern regions and focus on exposure to the east. It is not advisable to try to grow it in a greenhouse during the summer because it is too much hot for it.

Multiplying *Saxifraga longifolia* is by seeds. The seeds *must* have undergone a period of cold and even freezing for several weeks to destroy their inhibition and be able to germinate. You can try vegetative propagation by destroying the growing point to try to force the rosette to produce side rosettes but the result is not sure and the risk of killing the plant is high.

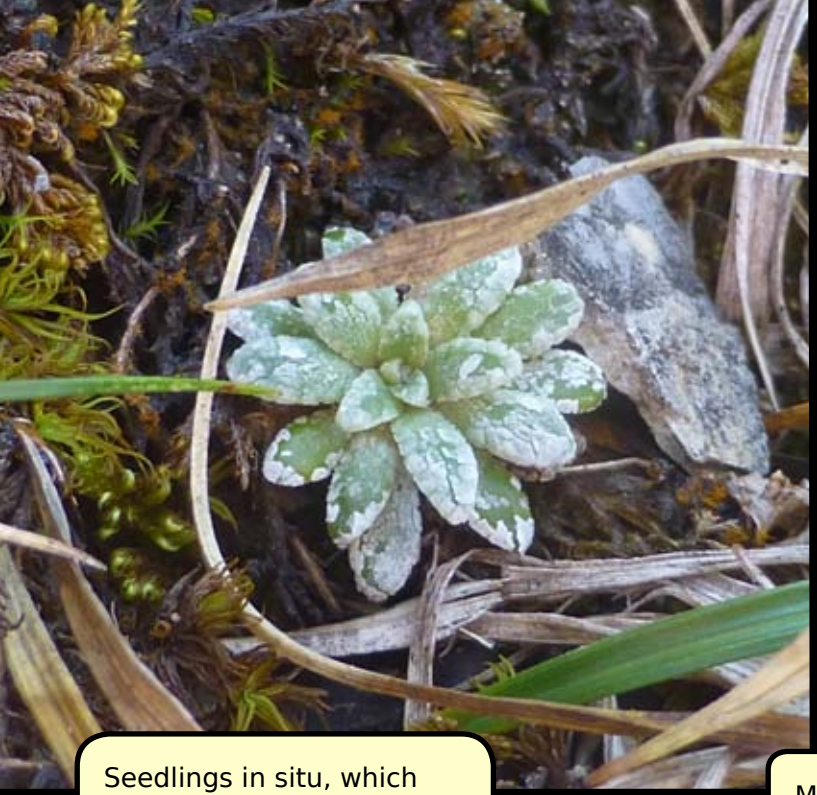
In cultivation, you can hope to get to the flowering stage in three to four years after sowing. This plant is strictly monocarpic, so it is best to spread the sowing in successive years in order to always have a few rosettes in bloom.


The most beautiful rock garden and the only jewel-case that is truly worthy of *Saxifraga longifolia*: Nature!

Where to get the plant?

Saxifraga longifolia seeds are commercially available on the Internet and most of the specialized alpine plant nurseries offer seedlings in their catalog. You can also easily obtain seeds from rock garden society seed lists (be careful however of involuntary crosses).

Although *Saxifraga longifolia* is not protected by law in most of its natural area, the removal of immature plants in nature is a practice to be avoided because this plant produces no side rosettes; it is therefore not simple cuttings that are removed but complete individuals. In addition, the local abundance of this plant in some places is only a reflection of its specialization and its close adaptation to a specific type of environment and this apparent abundance masks its overall rarity across a whole region. Therefore the collection *in situ* of *Saxifraga longifolia* must be limited to the collection of seeds or individuals spontaneously fallen at the foot of a cliff (this is not uncommon and their chance of survival is zero in this case, so feel free to collect them but thank you to not "help" them to fall down...).

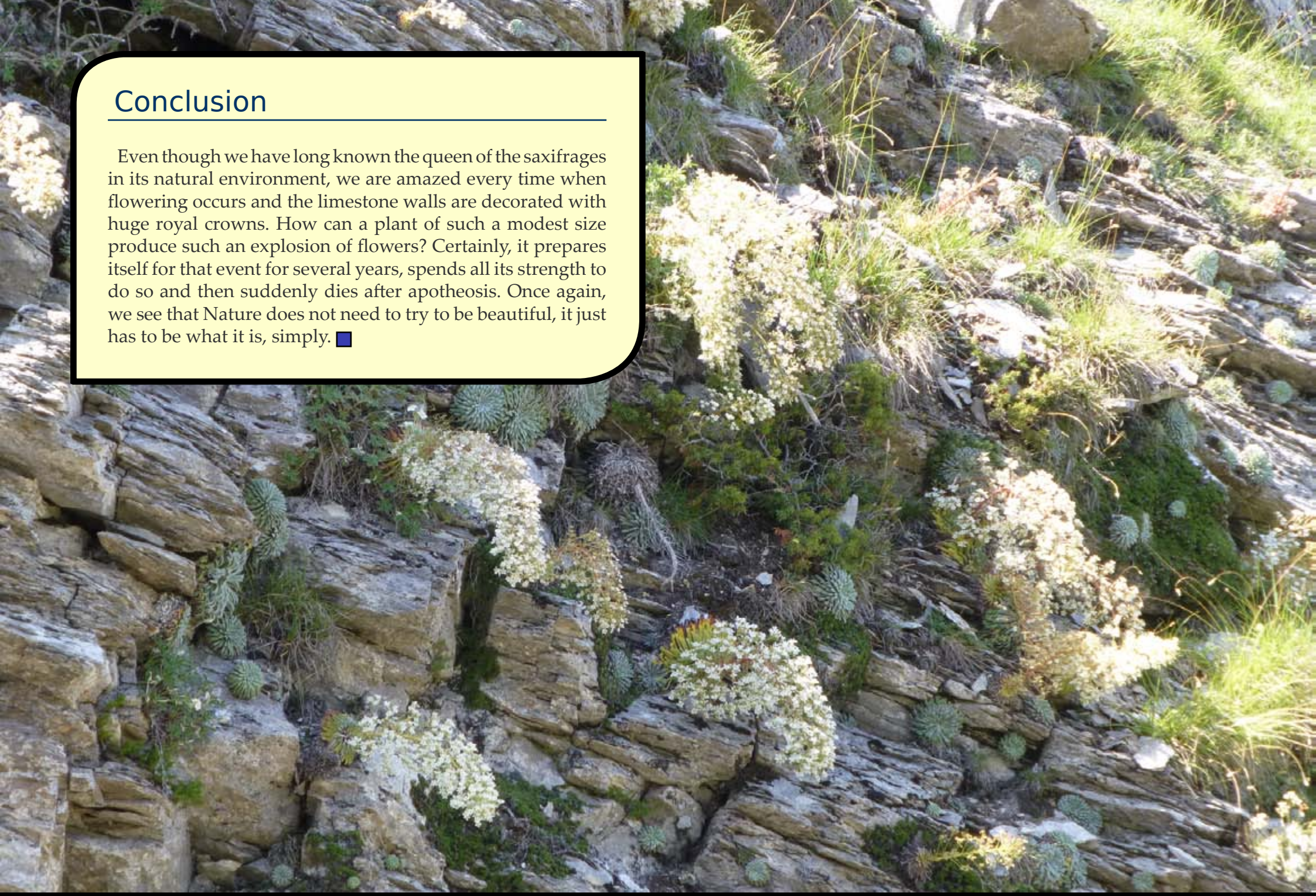


Seedlings in situ, which must be strictly respected!

Most individuals live on inaccessible vertical walls, which protect them from abusive collection.

Conclusion

Even though we have long known the queen of the saxifrages in its natural environment, we are amazed every time when flowering occurs and the limestone walls are decorated with huge royal crowns. How can a plant of such a modest size produce such an explosion of flowers? Certainly, it prepares itself for that event for several years, spends all its strength to do so and then suddenly dies after apotheosis. Once again, we see that Nature does not need to try to be beautiful, it just has to be what it is, simply. ■



Sedum sediforme subsp. *dianium*, an endemic Mediterranean succulent with a restricted distribution

by Daniel Guillot Ortiz and Emilio Laguna Lumbreras

Sedum sediforme subsp. *dianium*

Daniel Guillot Ortiz — Jardín Botánico. Universidad de Valencia. C/. Quart 82. 46008. Valencia.

Emilio Laguna Lumbreras — Generalitat Valenciana, Conselleria de Infraestructuras, Territorio y Medio Ambiente. Servicio de Vida Silvestre - CIEF (Centro para la Investigación y Experimentación Forestal). Avda. Comarques del País Valencià, 114. 46930 Quart de Poblet, Valencia. laguna_emi@gva.es

The Mediterranean flora is home to over 25,000 species and it is estimated that 60% of the plants in the Mediterranean basin are endemic, unique to this area. However, the amount of species exclusive to each country and administrative regions or provinces is much smaller. The main centres of speciation in the Mediterranean area are located in the Iberian, Italic, Greek and Turkish-Balkan peninsulas, where the percentage of endemic flora is often estimated at around 10%-15%.

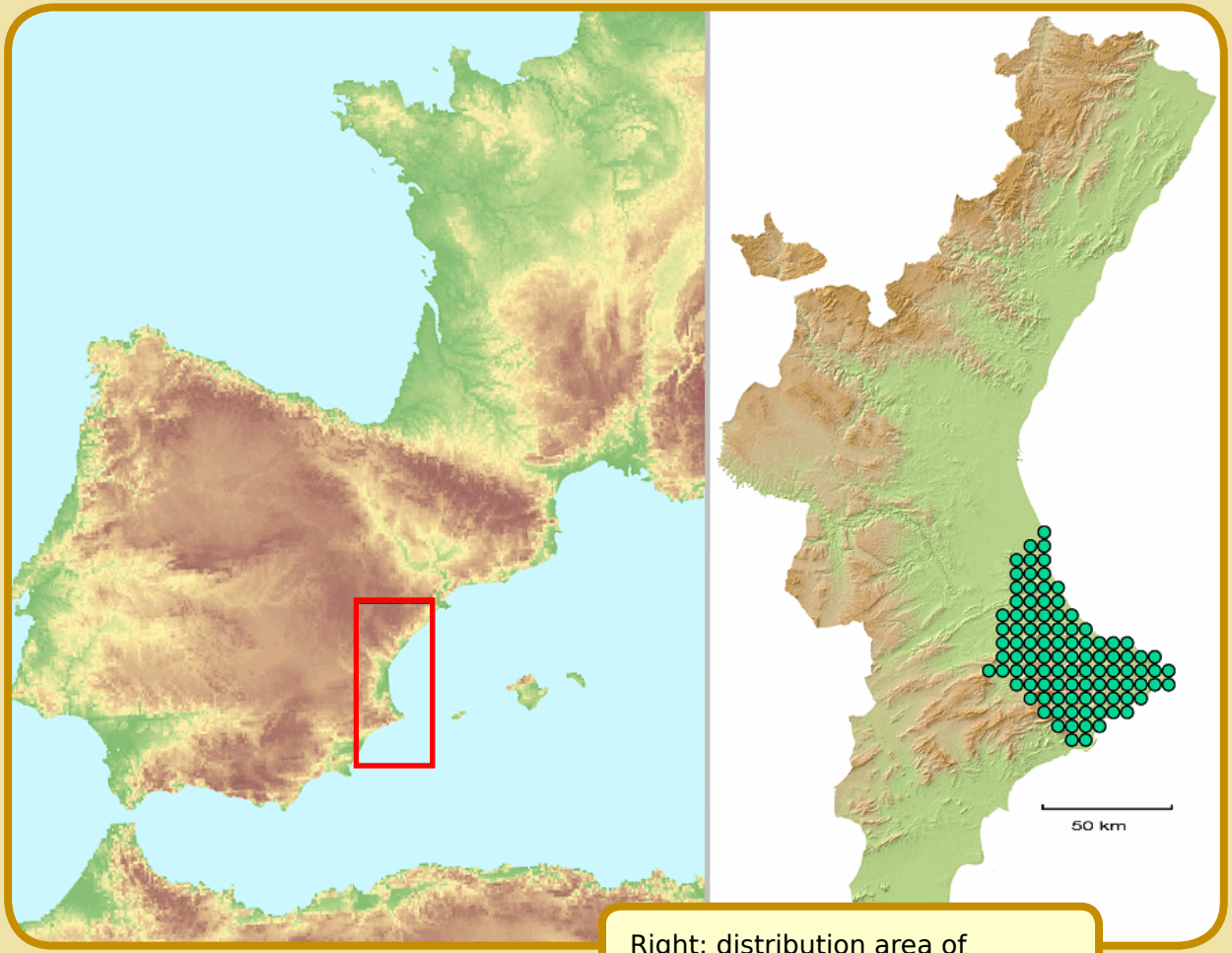
The Mediterranean climatic conditions favour the presence of succulent plants, but these species are proportionately rare and little diversified in the Mediterranean basin, when compared to other areas with similar climates such as the Cape region of South Africa. Among the most notable genera of succulents, *Sedum* L. has more than 40 species native to the European Mediterranean countries (Webb, 1964), some of them being microendemic – so living exclusively in very small areas.

Endemism in the Valencian community (Spain)

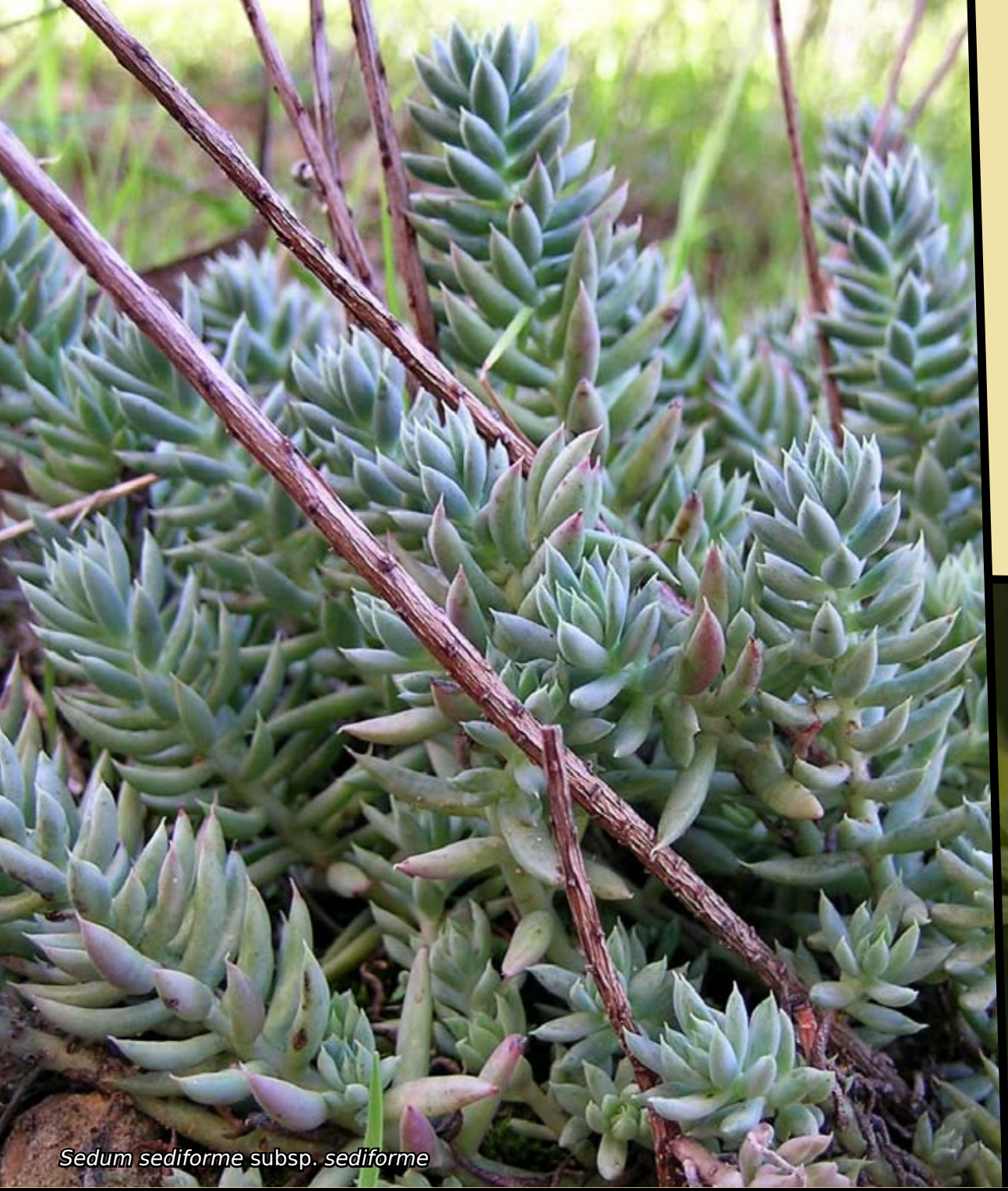
The Valencian Community covers a central strip of the Spanish Mediterranean coast, encompassing the ancient region of Valencia – holding the administrative provinces of Castellón, Valencia and Alicante – which is one of the main areas of plant speciation in the Western Mediterranean (Davis & al., 1994; Médail & Quézel, 1997).

The most remarkable succulent endemic plant of the Valencian territory is definitely *Sedum sediforme* (Jacq.) Pau subsp. *dianium* (O.Bolòs) O.Bolòs. This 'perfect' plant – i.e. fully matching the type description – lives only in the South-eastern municipalities of Valencia province and Northeast Alicante, and is therefore fully endemic to the Valencian area. However, plants showing similar traits have been also found in the Pityusic Islands (Ibiza and Formentera), which are the nearest of the Balearic islands to the Valencian region, sharing a long list of micro-endemic species (*Carduncellus dianius, Diplotaxis ibicensis*, etc.). Other outstanding succulent species — i.e. *Caralluma munbyana* subsp. *hispanica*, *Aizoon hispanicum*, etc. – are also found in other Spanish regions.

Although being a regional endemic, *S. sediforme* subsp. *dianium* is relatively abundant in its distributional range, so it doesn't need legal protection in our opinion.



Right: distribution area of *Sedum sediforme* subsp. *dianium*



Sedum sediforme subsp. *sediforme*

Sedum sediforme in the Valencian community

Sedum sediforme [≡ *Petrosedum sediforme* (Jacq.) Grulich] 'sensu lato' is distributed over much of the Mediterranean basin. Several taxa corresponding to local populations or varieties of *S. sediforme* have been described in the past, and their names are now considered synonyms – i.e. *S. altissimum* Poir., *S. jacquinii* Haw. or *S. nicaeense* All.

In the Valencian area most populations of this species are ascribed to subsp. *sediforme*. This subspecies has leaves with a round, cylindrical section, and creamy white flowers.

Sedum sediforme subsp. *sediforme*

However, within this subspecies, different geographical populations are located through the three Valencian provinces:

A The usual forms for low and medium altitudes are plants with vegetative stems up to 10 cm; their flowering stems are much taller, reaching up to 50-60 cm. The inflorescence of this common form has 4-7 branches, each one bearing 5-10 flowers.

B However, in the high mountain areas – some parts of Western Castellón and Northwestern Valencia provinces – above 1300 or 1400 m, dwarf forms of the same subspecies are often found. These little forms maintain their small size in culture even when translocated to lower altitudes, and cultivated together with the bigger forms. In these dwarf plants the sterile stems are up to 3-4 cm and the flower stems reach 25-30 cm. The inflorescences bear only 2-4 floral branches, each one of them holding 3-5 flowers.

About *Sedum sediforme* subsp. *dianium*

Sedum sediforme subsp. ***dianium*** (O.Bolòs) O.Bolòs, in *Mem. Real Acad. Ci. Barcelona*, ser. 3, 38(1): 73 (1967)

Typus: [*Sedum sediforme* var. *dianium*] leg. anonymus, s.n., s.d. ; "Dénia" ; Holotypus BC

Synonymy:

≡ [basion.] *Sedum sediforme* var. *dianium* O.Bolòs, in *Collect. Bot.* (Barcelona) 5(2): 535, in adnot. (1957)
≡ *Sedum nicaeense* subsp. *dianium* (O.Bolòs) Rivas Mart., in *Opusc. Bot. Pharm. Complut.* 3: 88 (1986)
≡ *Sedum dianium* auct. iberic.

Description

Sedum sediforme subsp. *dianium* is similar to the higher forms of subsp. *sediforme*, but its leaves have an elliptical flat section, and the flowers are a bright, intense yellow. Since the leaves are applanate, the vegetative stems have a cone or pineapple-like shape in summer – when folded to avoid excessive transpiration. At that stage the branches are like some *Sempervivum* rosettes. An accurate description of this subspecies has been made by Laguna (1994, 1998).

The examples have two bud types: 1) vegetative buds, which result in no flower stalks and 2) flower buds, which emit a floral stem. The vegetative stems convert into flowering stems and bloom from the 2nd-3rd year of life. Most of the leaves on the flower stems are gathered at the base, but they also have other minor ones above, acting as separated bracts. Those bracts can lead to propagules forming on their axils, consisting of small new buds covered by a few diminutive leaves.

Natural propagation is done by seeds or vegetatively, either as fragments of leaves and plant propagules, or stem fragments.

Sedum sediforme subsp. *dianium*

Taxonomical status

S. sediforme subsp. *dianium* is often considered as a good species by botanists working in Eastern Spain (Catalonia, Valencian Community, Murcia, Balearic Island), since following their point of view this plant shows some exclusive characteristics which aren't shared by any other local taxa: extremely flat leaves (particularly on the flowering stem) and intense yellow flowers. This second character is also typical of some Spanish populations of subsp. *sediforme*. These two characters are produced by every specimen belonging to subsp. *dianium*, both in wild and cultivated plants (the latter obtained from cuttings of wild plants).

Sedum sediforme subsp. *dianium*: left, a green individual growing near a glaucous individual; right, a flowering plant.

Sedum sediforme subsp. *dianium*

The recombination as a subspecies of this taxon was proposed by one of the most lumper botanists in Spain, Dr. Oriol de Bolòs (University of Barcelona) who often considered as mere varieties or sub-varieties many taxa now recognised as good species by the majority of Spanish botanists.

Paradoxically, the main revision of the genus *Sedum* in Spain – in *Flora iberica*, vol. 5 – avoided the recognition of infraspecific taxa for *S. sediforme*, which is treated on the book as a "*sensu latissimo*" species, although many scholars were expecting a species rank for this taxon *dianium*. It has to be remarked that many taxonomical revisions are often prepared analysing only herbarium sheets: many remarkable characters of the subsp. *dianium* are lost or barely noticeable when the plant is dry, due to the difficulties in pressing and drying succulent plants (which, in fact, are scarcely represented even in the best herbaria). Anyway the revision of the genus *Sedum* in *Flora iberica* has been often criticized for its extreme conciseness, due to neglecting to include infraspecific taxa accepted by many botanists, such as those of *S. album* or *S. dasyphyllum*.

Sedum sediforme subsp. *sediforme*

Sedum sediforme subsp. *dianium*

Sedum sediforme subsp. *sediforme*

Sedum sediforme subsp. *dianium*

Ecology

Sedum sediforme subsp. *dianium* lives in areas of high air humidity – often above 60% – from sea level to altitudes of 1400-1500 m, but its typical characters are progressively diluted over 1000 m in altitude, mingling with those of subsp. *sediforme*. Introgression between the two subspecies occurs also at low altitudes, in border distribution areas of subsp. *dianium*.

The habitat of this subspecies is very variable, from vertical rocks to the herbaceous layer of Maquis and open pine forests of *Pinus halepensis* or *P. pinaster*. It reaches its optimal situation in the permanent grasslands of *Brachypodium retusum* and low shrubs (*Rosmarino-Ericion* communities) on undeveloped calcic soils, dominated by species such as *Rosmarinus officinalis, Thymus vulgaris, Erica multiflora, Cistus albidus*, etc. These scrubs and grasslands are very rich in endemic aromatic herbs, belonging to the genus *Thymus, Sideritis, Satureja, Teucrium*, etc. They are also rich in bulbous plants, which abound more on decalcified soils, i.e. *Gladiolus ilyricus, Iris lutescens, Asphodelus cerasiferus, Narcissus dubius, Scilla obstusifolia*, etc.

Coastal habitat of *S. sediforme* subsp. *dianium*: left, a karst plateau with low aromatic shrubs; right, a lapiaz with *Chamaerops humilis*.

The highest concentrations of *Sedum sediforme* subsp. *dianium* appear on limestone-dolomite pavements in karst areas of coastal cliffs, or mountains plateaus near the sea. The subspecies is also abundant on old urban roofs, forming peculiar plant communities with other native succulent species *(Umbilicus rupestris, Sedum album*) and exotics (*Aeonium arboreum, Graptopetalum paraguayense, Kalanchoe daigremontiana, K. delagoensis, K. ×houghtonii*, etc.).

S. sediforme subsp. *dianium*

Cultivation

The age that the plants of this species can reach is unknown, but some specimens have been maintained in culture for over 30 years.

Cultivation can be achieved easily by using cuttings. A good time to collect them is the late flowering period, because the two types of stems are then best distinguished. So, you can pick sterile stems and propagules. All of them produce roots without the need to add hormones. Cultivation can also be made from seeds, but is much slower.

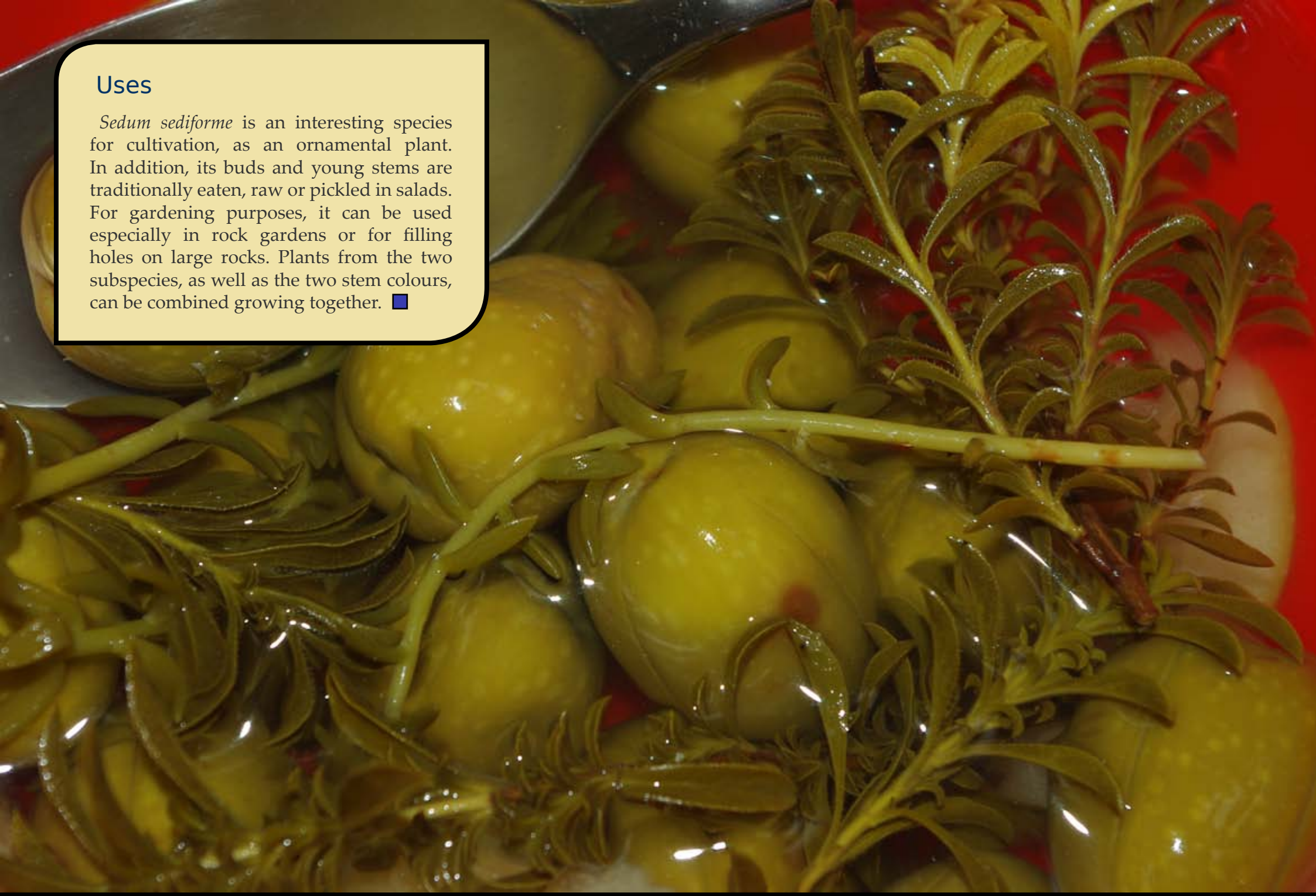
Sedum sediforme – both subsp. *dianium* and *sediforme* – often have two shades of colour, which can live together in the same places: 1) glaucous plants, showing greyish colour. 2) yellowish-green plants. Both natural varieties can be grown without difficulty at home.

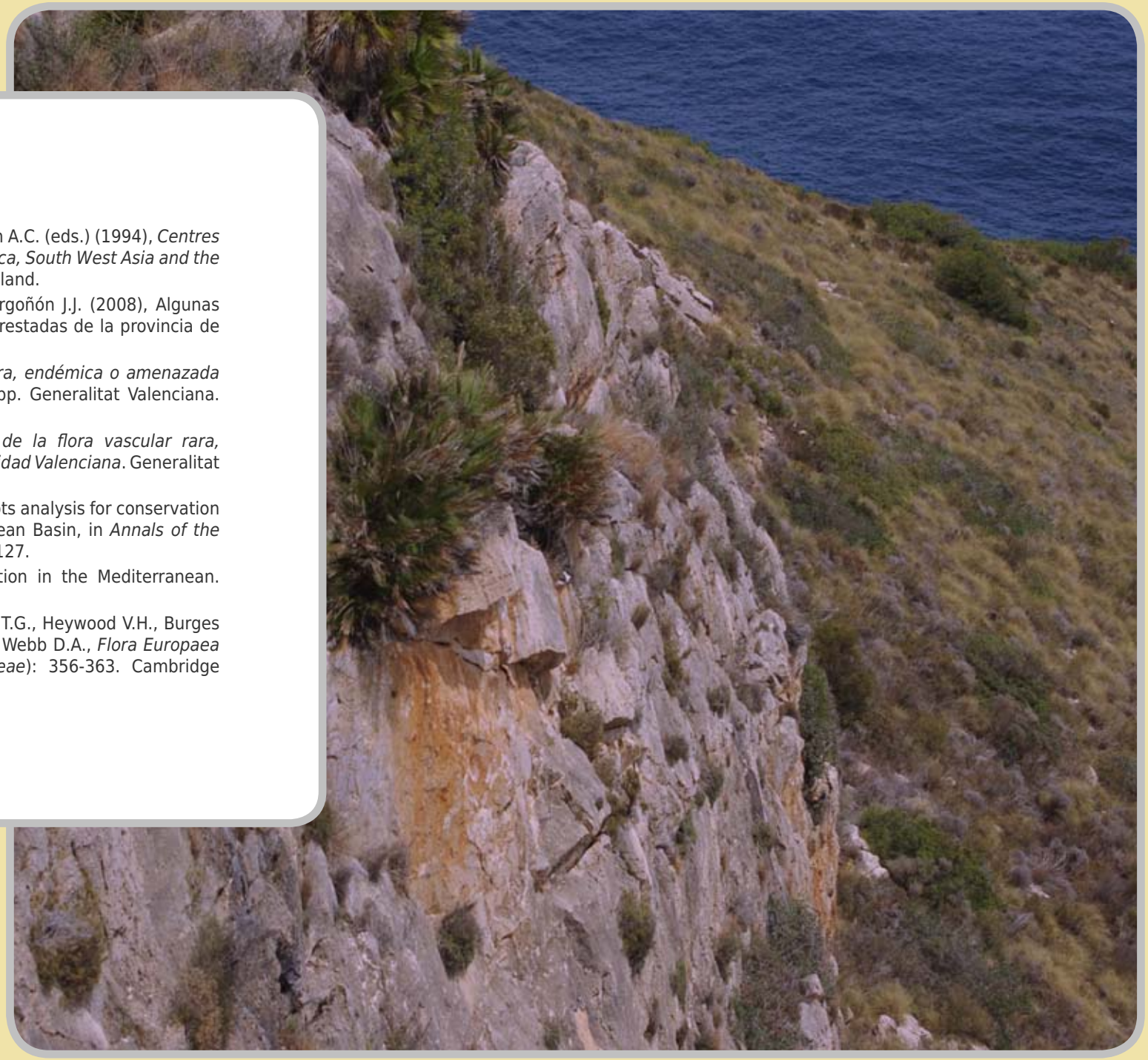
In the case of subsp. *sediforme* a monstrose variety was described by us several years ago (*Guillot* et al., 2008). This variety shows flattened or cristate stems and leaves, fused at their base.

Sedum sediforme subsp. *sediforme* 'Monstruosum'

Uses

Sedum sediforme is an interesting species for cultivation, as an ornamental plant. In addition, its buds and young stems are traditionally eaten, raw or pickled in salads. For gardening purposes, it can be used especially in rock gardens or for filling holes on large rocks. Plants from the two subspecies, as well as the two stem colours, can be combined growing together. ■





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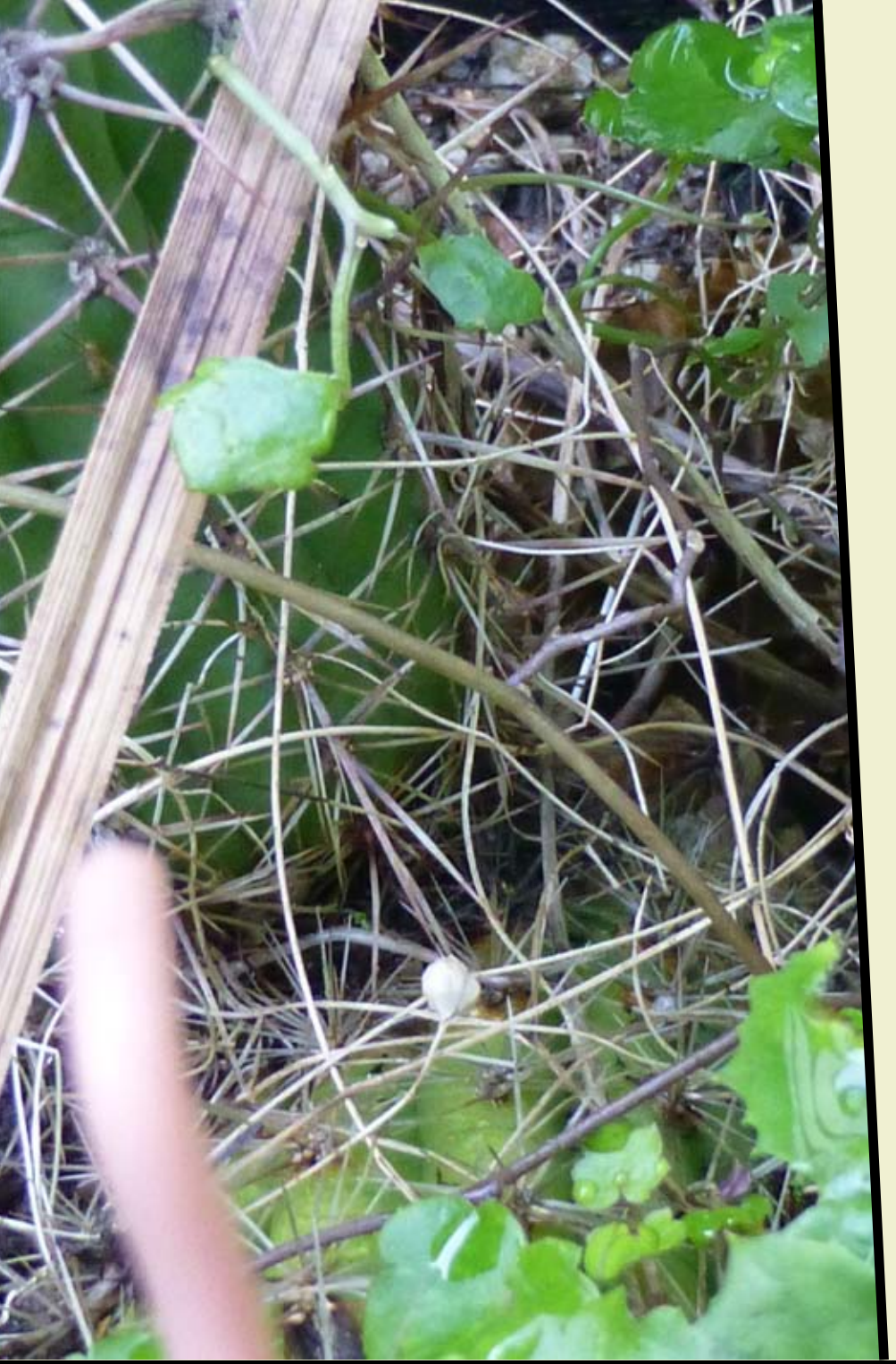
Experiments using herbicides in selective weeding on some succulent plants

by Emilio Lombardi



Emilio Lombardi — Agronomist, Università degli Studi di Parma.

Herbicides are presently widely used in agriculture, in order to eliminate unwanted weeds in extensive cultivations.

However, the impacts of these chemicals on the wild flora and fauna and on human health are well documented, as is the persistence of their residues in the ground and the environment.

For this reason, the present study has only a scientific purpose; the results reported are not to be used as advice for private gardening. The application of herbicides must be avoided as much as possible and reserved for exceptional circumstances, under the supervision of a professional agronomist.

Weeds and succulent plants

Succulent plants are often cultivated in open air conditions, often in moist climates with very cold winters, and they are even used to prepare true desert gardens. Although the soil mixture in which they are grown is generally modified by adding limestone and volcanic gravel, in order to augment drainage and to lower the richness of nitrogen and humus in the soil, the relative abundance of water and the wide plant spacing invites an infestation of multiple weed species.

Manual weeding has lesser weed control efficiency in controlling major problematic weeds: critically assessing this, the manual and mechanical methods of weed control, besides being less effective, are costly, time consuming and have to be repeated at frequent intervals. Furthermore, manual or semi-mechanical weed control methods are partially effective because most of the weeds growing below or in the middle of spiny leaves or spiny stems escape weeding, and regrow again with the next rains.

This makes manual weeding barely useful, resulting in an inefficient weed control situation. On the other hand, chemical weed control is poorly studied in succulent plants and available post-emergence herbicides are mostly non-selective and their use can cause considerable damage.

This necessitates the testing of selective post emergence herbicides for weed control in a succulent plant garden. This article approaches the problem, testing chemical selective weed control on some genera of succulent plants.

Material and methods

The research was conducted on various succulent plants during the summer season of 2013 and 2014, mainly in August-September, when weeds were at their maximum development, but also in January 2013 and 2014, during dormancy of many succulent plants. The experiment took place close to Parma, in northern Italy, Padana plain, with temperate-continental climate, average temperature 10-14°C, annual temperature excursion 16-19°C, USDA zone 8b. The trial was conducted on plants grown in open ground, fully exposed to the sun; the soil was very well-drained, consisting of lava gravel and sandy-clayish soil, with low humus content and the available nutrient status was low in nitrogen, medium in phosphorus and high in potassium.

Treatments consisted of post-emergence application of 3 distinct herbicides, as Glyphosate (36%, non selective herbicide), Quizalofop-p-etyl (5,5 %, herbicide selective against Monocotyledons), and a commercial mix of Dicamba + Mecoprob + Clopiralid (1,12 %+13,54 %+1,05 %, herbicide selective against Dicotyledons): each of them was applied on its ow Weeds and succulent plantsn dedicated portion of terrain where the same species were grown, avoiding any ovelap of distinct principles, in order to evaluate the effect of each herbicide without any interference. Ground, weeds and succulents were uniformly hand sprayed, adopting a spray volume of 500 litres/ha.

Glyphosate was applied to succulent plants during their winter dormancy, testing the efficiency of a non-selective herbicide during their inactive period, while the weeds were barely active. Quizalofop-p-etyl and Dicamba + Mecoprob + Clopiralid mix was applied in summertime, when plants were in full growth.

Results

Predominant Weed Flora of the Experimental Field

The weed flora of the experimental field predominantly consisted of three species of *Dicotyledones* (*Magnoliopsida,* the so-called "broad-leaved plants") and two species of *Monocotyledones* (*Liliopsida,* "narrow leaf plants" or grasses). *Oxalis corniculata* L., *Oxalis pes-caprae* L. and *Chamaesyce prostrata* (Aiton) Small were dominant among the broad-leaved weeds. Dominant among grassy weeds were *Elytrigia repens* (L.) Desv. ex Nevski and *Cynodon dactylon* (L.) Pers.

Oxalis pes-caprae

Species of succulents involved

Species of succulents involved in this study were those most commonly seen in xeric gardens here in northern Italy, belonging to *Monocotyledones* or *Dicotyledones*:

***Monocotyledones**:*

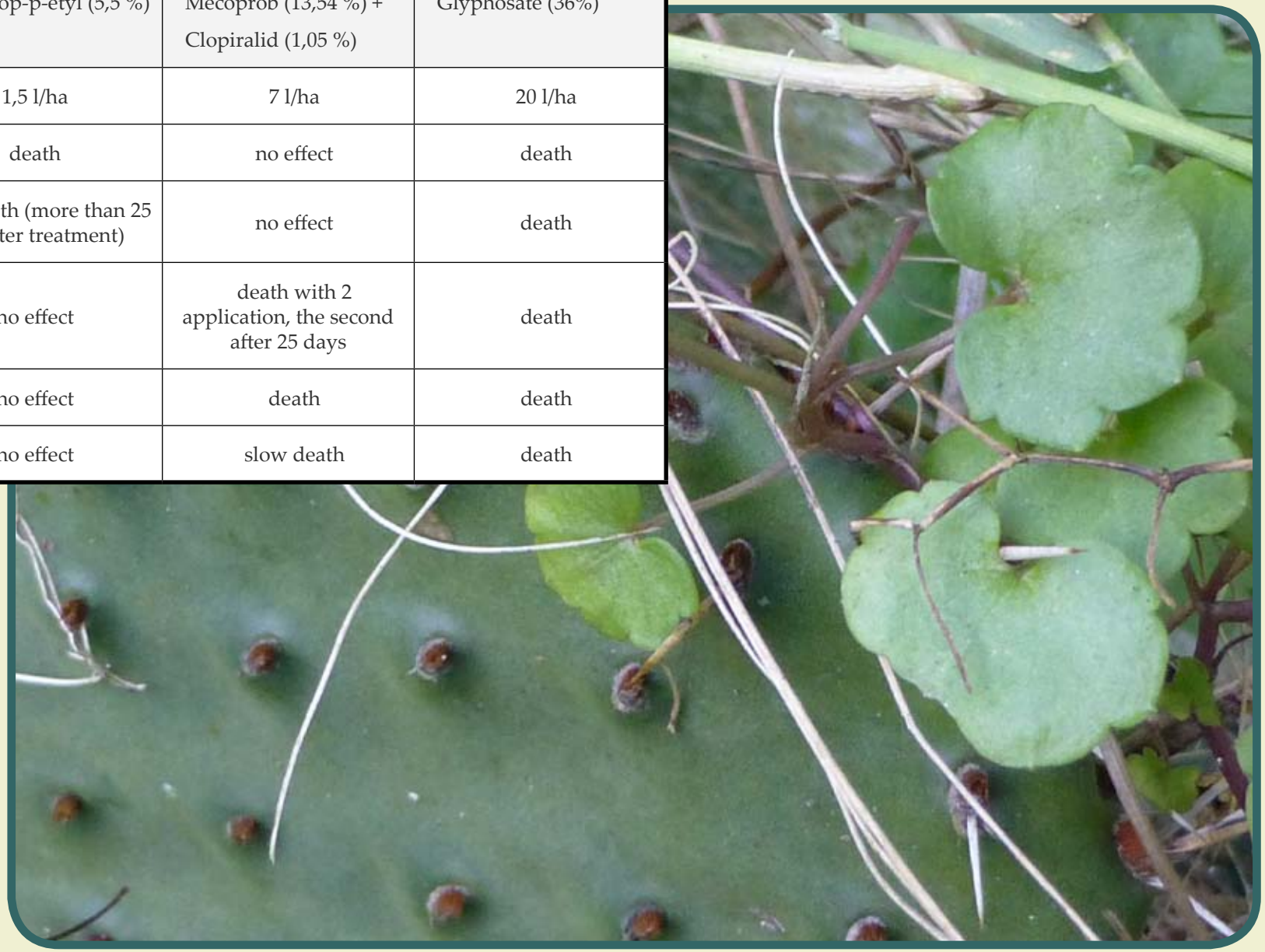
Agave americana L.
Agave bracteosa S.Watson ex Engelm.
Agave montana Villareal
Agave ovatifolia G.D.Starr & Villarreal
Agave parryi Engelm. subsp.
Agave parviflora Torr.
Agave salmiana Otto ex Salm-Dyck
Agave utahensis Engelm.
Agave victoria-reginae T.Moore
Aloe aristata Haw.
Aloe polyphylla Schönland ex Pillans
Dasylirion miquihuanense Bogler
Dasylirion quadrangulatum S.Watson
Dasylirion serratifolium Zucc.
Dasylirion texanum Scheele
Dasylirion wheeleri S.Watson
Yucca aloifolia L.
Yucca baccata Torr.
Yucca carnerosana (Trel.) McKelvey
Yucca faxoniana Sarg.
Yucca flaccida Haw.
Yucca glauca Nutt.
Yucca linearifolia Clary
Yucca rigida (Engelm.) Trel.
Yucca rostrata Engelm. ex Trel..

***Dicotyledones**:*

Corynopuntia clavata (Engelm.) F.M.Knuth
Cylindropuntia imbricata (Haw.) F.M.Knuth
Cylindropuntia kleiniae (DC.) F.M.Knuth
Cylindropuntia spinosior (Engelm.) F.M.Knuth
Echinocereus dasyacanthus Engelm.
Echinocereus nivosus Glass & R.A.Foster
Echinocereus pectinatus Engelm. subsp.
Echinocereus reichenbachii (Terscheck) Britton & Rose
Echinocereus rigidissimus Rose
Echinocereus triglochidiatus Engelm.
Echinocereus viridiflorus Engelm.
Ferocactus pilosus (Galeotti) Werderm.
Opuntia engelmannii Salm-Dyck
Opuntia humifusa Raf.
Opuntia hystricina Engelm. & J.M.Bigelow
Opuntia macrorhiza Engelm.
Opuntia polyacantha Haw.

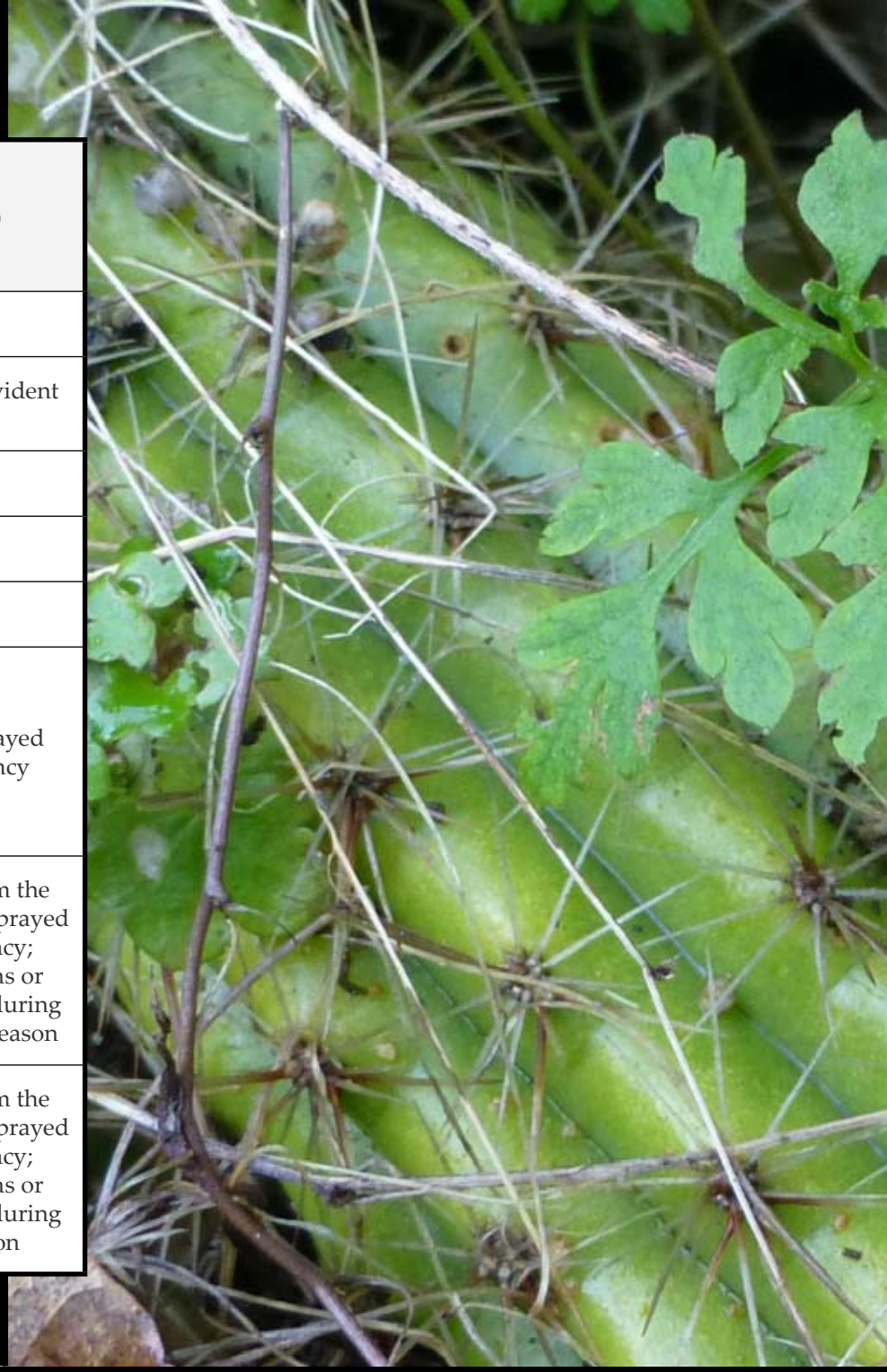
The following table, **Table 1**, reports on the efficiency of the herbicides against weeds:

Herbicide:	Quizalofop-p-etyl (5,5 %)	Dicamba (1,12 %) + Mecoprob (13,54 %) + Clopiralid (1,05 %)	Glyphosate (36%)
Quantity distributed:	1,5 l/ha	7 l/ha	20 l/ha
Elytrigia repens	death	no effect	death
Cynodon dactylon	slow death (more than 25 days after treatment)	no effect	death
Oxalis corniculata	no effect	death with 2 application, the second after 25 days	death
Oxalis pes-caprae	no effect	death	death
Chamaesyce prostrata	no effect	slow death	death



The following table, **Table 2**, reports the effect of the herbicides on the various succulents:

Herbicide:	Quizalofop-p-etyl (5,5 %)	Dicamba (1,12 %) + Mecoprob (13,54 %) + Clopiralid (1,05 %)	Glyphosate (36%)
quantity distributed	1,5 l/ha	7 l/ha	20 l/ha
Agave sp.	growth ceases, loss of leaves, death	no effect	slow death or evident damage
Aloe sp.	slow death	no effect	death
Dasylirion sp.	death	no effect	death
Yucca sp.	growth ceases, death	no effect	death
Corynopuntia sp. *Cylindropuntia* sp. *Opuntia* sp.	no effect	no effect if sprayed on old vegetation or during dormancy; growth problem and evident damage if sprayed on growing segments	no effect if sprayed during dormancy
Echinocereus sp.	no effect	growth problem, death for young plants if sprayed during vegetation, no effect if sprayed during dormancy	growth problem the following year if sprayed during dormancy; evident problems or death if sprayed during growing season season
Ferocactus sp.	no effect	no effect spraying only the base of the plants or during dormancy	growth problem the following year if sprayed during dormancy; evident problems or death if sprayed during growing season



Discussion

The results of this study are quite interesting from a gardening point of view, since they demonstrate that different selective herbicides commonly used in Europe are selective against weeds but they don't produce any damage on various groups of succulents plants, if properly used:

Quizalofop-p-etyl

Quizalofop-p-etyl is a selective herbicide commonly used to eliminate grasses from ornamental and vegetable garden. It can be applied without any damage to succulent Dicotyledons as *Cactaceae* and *Crassulaceae*, and it's very useful to eliminate grasses which grow at the base of big cacti such as *Ferocactus*, which are entangled with spines and so very difficult to eliminate with hand weeding.

The distribution of this herbicide onto xerophytic Monocotyledons generally involves evident damage or the death of the plant, so one must avoid spraying it onto *Agave*, *Yucca*, *Dasylirion*, *Aloe*, etc.

Dicamba + Mecoprob + Clopiralid

Dicamba (1,12 %) + Mecoprob (13,54 %) + Clopiralid (1,05 %) is a commercial mix of selective herbicide commonly used on lawns to eliminate broad-leaved weeds like *Taraxacum*, *Oxalis*, *Cichorium*, etc. It has been sprayed without any damage onto many succulent and xerophyte *Monotyledones* belonging to the genera *Agave*, *Dasylirion*, *Yucca*, *Aloe*. For this reason it can be used to eliminate unsightly Dicotyledons weeds like *Oxalis* when they grow in rock gardens at the base of big plants of *Agave*, *Yucca*, etc, among leaves and spines, where they are very difficult to eliminate by hand weeding.

The distribution of this mix of herbicides on *Cactaceae* generally involves damage or the death of the plant (except for *Opuntia* and related genera during the winter season), so one must avoid spraying it on *Cactaceae*.

Glyphosate

Surprisingly, the application of a non-selective herbicide like Glyphosate on plants belonging to the genera *Opuntia*, *Cylindropuntia* and *Corynopuntia* during their winter dormancy didn't involve any damage for these plants, but did eliminate any weeds growing among them. This is probably due to the ability of *Opuntia* to avoid any water exchange with the surrounding environment during winter dormancy, with extremely low transpiration and absorption, as well as its very low winter metabolism.

However, the application of Glyphosate involved many problems or death on the rest of the plants tested in this study, as well as on opuntioids and other cacti during the growing season.

Conclusion

From the results of these field experiments, it could be concluded that post emergence spraying of selective herbicides can be done for complete control of the commonest weeds that grow in xeric gardens, but it's very important to distinguish if the xerophytes we are growing are Mono or Dicotyledons, and then it's important to distinguish the season of the application, in order to use the proper herbicide on them. The wrong application can ultimately result in the death of the plant.

However the results of the present study were obtained under the environmental conditions reported, on plants growing in the open air and in full sun, with roots in open ground. Before any extensive use of herbicides, some repeated tests should be done in order to check their effect on the plants, because different environmental conditions can evoke a different response by a plant. ■

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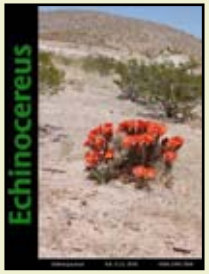

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ACTA SUCCULENTA

ISSN 2257-6606

Free magazine published only on the Internet.

Volume 3 n° 1 - online published on 05 February 2015.

English edition

http:\\acta-succulenta.eu

CONTACT: contact@acta-succulenta.eu

EDITOR: Davide Donati.
via Caduti di Cefalonia 25/4 — (I) 40054 Budrio - BO

CONTRIBUTORS (alphabetic order) : Stefano Baglioni, Gérard Dumont, Jean-Louis Guihard, Daniel Guillot Ortiz, Emilio Lombardi, Emilio Laguna Lumbreras, Al Laius, Maurizio Lenzi, Antoine Mazzacurati. Great thanks to Chris Davies, Philippe Gontier.

PUBLISHER: Collegium Europaeum pro Plantis Succulentis (CEPS)
4, place de l'Eglise — (F) 29100 Pouldergat