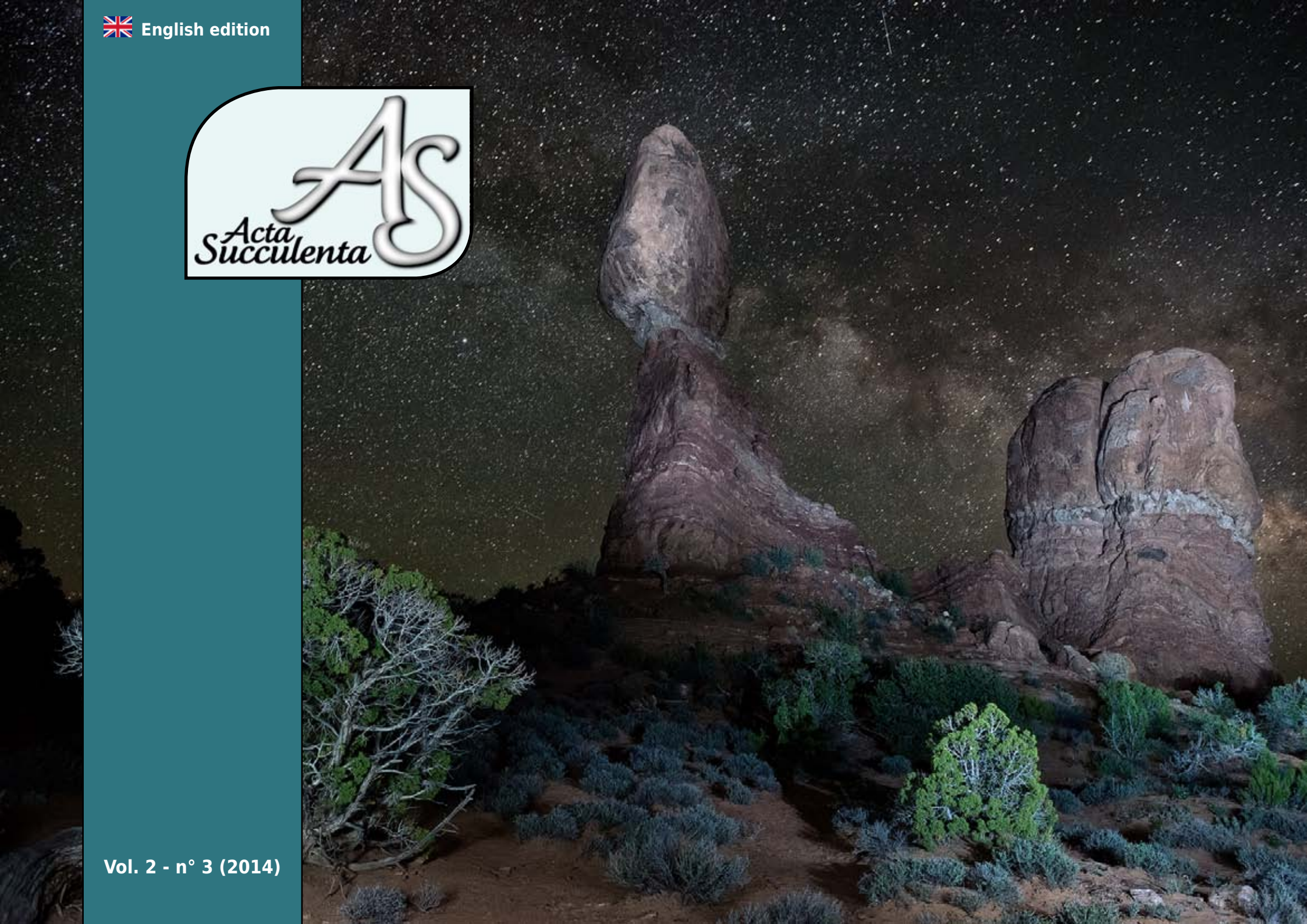
English edition

Acta Succulenta



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Acta Succulenta

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Cover photo: Stefano Baglioni

EDITORIAL

Believe or not, fog is important for many succulent plants.

In Europe, the fog is sometimes so dense that you feel you can cut it with a knife, but even this enveloping mist is very important for many maritime succulents, as well as for the native succulents which grow at the tops of high mountains, as an important water supply during the dry, summer months.

On the other side of the globe, the coastal deserts of the western side of Southern Africa and South America are so arid that rain can be absent for many years. In these harsh lands, a kind of magic happens: every night a dense but delicate fog comes from the Ocean inland, so that many succulents can survive all year long without a single drop of rain, thanks to this moisture. They sometimes do better than many plants which grow in normal desert, such as in some parts of the USA, for example.

But it's at the base of these plants that another sort of magic occurs.

In the Namib desert, the surface of the soil is often covered for kilometres by thick, dry formations, a sort of compact layer of contracted filaments, attached to the soil. When the fog comes from the Atlantic Ocean, it supplies enough water to revive this living crust, which in a matter of minutes transforms and shows its nature: amazing lichens with various and often colourful forms.

Crusts with a biological origin covers soil and rocks all over the world, and October is the best month to visit a plain in Mexico, since it's possible to see dozens of colourful flowers of Ariocarpus *emerging from the encrusted soil.*

Ok, it's time to read more about this...

Davide Donati

Travelogue of a photographer and a naturalist

(Part 3)

by Stefano Baglioni

It was almost time to come back to Italy…

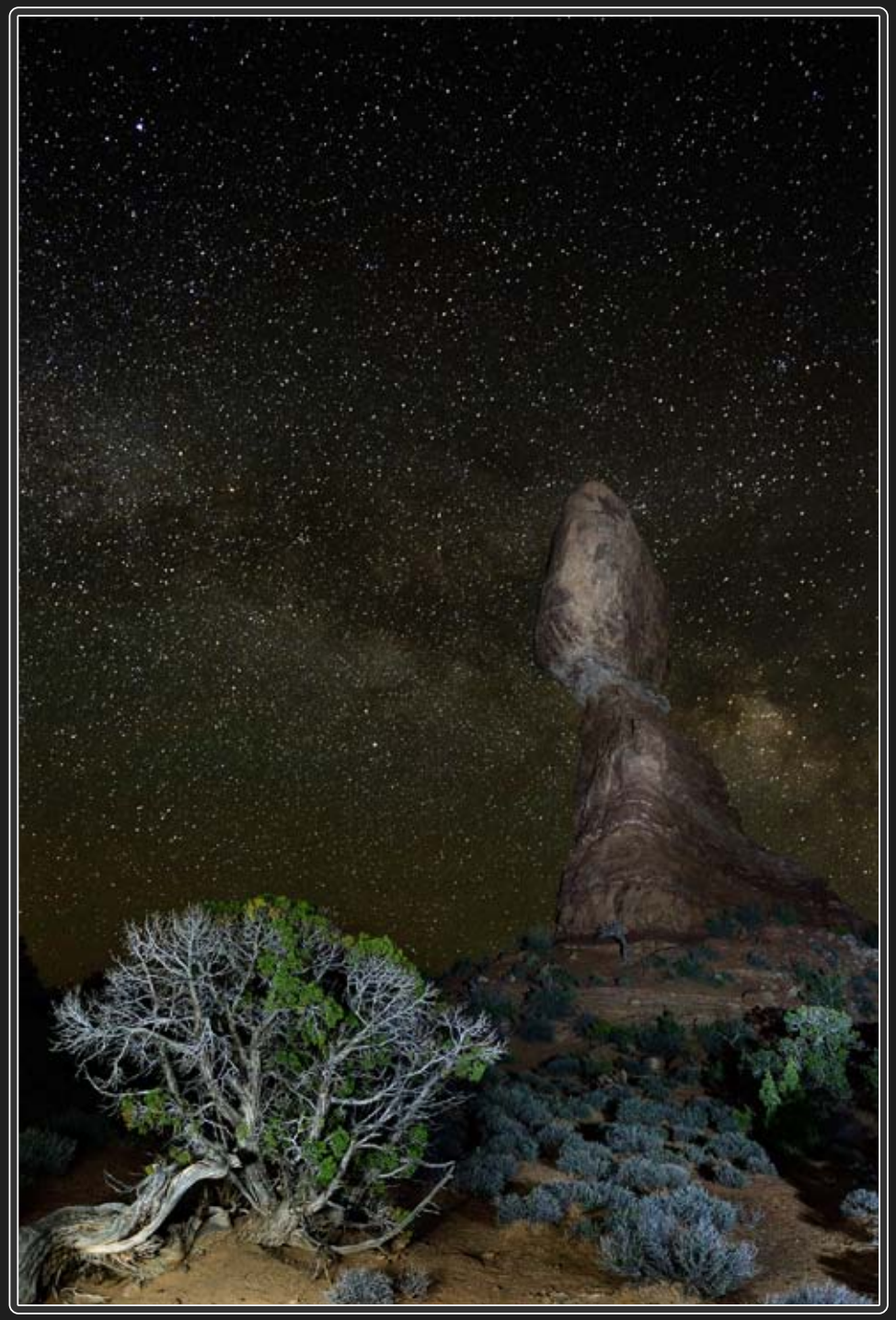
During my American journey, I saw endless deserts, impressive mountains, unforgettable landscapes…

But if deserts were vast there, by night they were overhung by immense black skies, and the feeble light of countless stars was so bright to gently illuminate cactus and succulent plants, which seemed to take on abstract vibration, at least to my eyes.

In that corner of Death Valley I tried to capture in a picture the emotions I felt during those sleepless night, looking at the Milky Way while a coyote howled, breaking the silence in the endless search for the perfect composition of the photo.

I think there are no adequate words to describe what I saw there every time I took a look at the sky on those nights, so I will leave the photos to speak for me.

This is the end… the end of a journey I will never forget. ■



Peru: land of deserts, ice, cacti and oxygen deprivation

by Håkan Sönnermo

***Haageocereus* sp. [N of Patavilca]**

After a 15 hour flight from Sweden (and its winter), it was wonderful to reach Lima in full summer.

I was very happy to meet again fantastic people, to eat delicious food and just being in beautiful surroundings, but for me, an ardent botanist, it was a real pleasure to find my friends again: the cacti.

Back in Peru at last!

Last time I visited Peru, some years ago, I hiked on my own for a week, with my backpack and tent, on Cordilliera Raura, a mountain range where nighttime temperatures drop to 15°C below zero, in order to study *Austrocylindropuntia floccosa* (Salm-Dyck) F.Ritter. After that, I travelled on an incredibly bad road for 200 km by bus to Macusani, in order to examine *Punotia* (*Austrocylindropuntia*) *lagopus* (K.Schum.) D.R.Hunt. That trip was great, since I was 100% successful, I was able to realize what I planned to do. Honestly speaking, during that trip I nearly drowned in a river near Raura, then, on the walk back, whilst I nearly died because of dehydration, I was chased by angry dogs so I had to run a lot, losing my last corporal fluids; last but not least, on the bus from Lima to Cajatambo, on the edge of the Raura Mountains, I could find only salty and spicy things… Nothing able to keep a true Cactus Enthusiast away from his mission!

That trip was fantastic, it whetted my appetite and I was able to go to Peru again in December 2013.

***Punotia lagopus* [Macusani, 4500 m]**

***Haageocereus* sp. [N of Patavilca]**

About Peru

Travelling in Peru is not easy, but exciting. The traffic in Lima is chaotic and there are dangers in every corner, and in the countryside as well. Everyone seems to drive as that day is the last day on Earth. People are always kind and helpful, sometimes too helpful: they are happy to explain how to get a place, even if they don't actually know the right direction… This is one of the reasons why it's essential to have new and reliable maps there, especially if you are planning to drive far from the beaten track.

Many people who go to Peru are worried about their stomach, but I think that with ordinary precautions you'll enjoy your trip without any problem.

I learnt two things from my previous trip: first, keep in touch with a local friend who can pick you up at the airport and take care of you during the first, few hectic days; second: you should hire a car, budget permitting. It is very important to stop freely wherever you want and as long as you wish: I remember that during my last journey, on the bus from Lima, I saw marvelous place for cacti through the windows, but I couldn't stop, obviously.

This time, my good friend Carlos Alberto Jimenez Lopez collected me at the airport and generously let me stay for one week with him and his family, in their house, where we planned our Peruvian cacti expedition: I wanted to visit the deserts north of Lima, to search for *Haageocerus* Backeb. and other cacti, as well as the cacti of Puno Mountains.

Patavilca

I needed few days for acclimatizing in Lima, then, with Carlos and his family, we prepared the supplies and we drove north, in the lively Lima traffic. We wanted to look for *Haageocerus lanugispinus* F.Ritter in the vicinity of Patavilca, about 200 km north of Lima.

We drove through immense coastal deserts, with only few houses here and there. The weather was warm and sunny. At Reserva Natural de Lachay we stopped the car: east of the Panamerican Highway, desert and mountains were very inviting, so with plenty of water in our backpacks we hiked up sand hills and mountains until we (happily) found a (probably newly discovered) colony of *Haageocerus tenuis* F.Ritter.

Cleaning session of cacti *in situ*... *Haageocerus tenuis* [Chancay]

Haageocerus tenuis is a very unusual species and has only been observed in few places around the area. We enjoyed that find and we spent some hours taking photographs and studying the spiny plants. In the meantime, we tried to clean the place from plastic waste and rubbish coming from the chicken farms working there, which unfortunately threaten the future of this species in this locality.

***Haageocereus* sp. [Patavilca]**

***Haageocereus tenuis* [Chancay]**

Once we had satisfied our need of images of *Haageocerus tenuis*, we trekked further up to the mountains and we found a lot of *Haageocereus* and *Loxanthocereus* Backeb., in an extremely arid place: they can survive almost without any rain, since these plants can survive thanks to the ocean mist, which provide little water from May to August.

We left the place and we drove toward Barranca, where we could swim in the Pacific Ocean, wonderful pleasure after the desert.

Loxanthocereus sp. **[Chancay]**

Then Patavilca, a small town not far from Barranca, is placed on the border of the Departemento Ancash: the road to Cajatambo, the little village on the Andes that I visited the last time I was in Peru, began not far from there, but we didn't have much time, so Cajatambo had to wait. So we drove northward and we hiked the mountains near Patavilca. We were hoping to see some *Haageocereus lanugispinus*, which has never been observed after Ritter discovery in 1957.

***Haageocereus* sp. [Patavilca]**

We walked up and down the mountains, finding several other very beautiful *Haageocerus* and also lovely specimens of *Mila caespitosa* Britt. & Rose, but unfortunately we didn't find *Haageocerus lanugispinus*.

***Haageocereus* sp. [Chancay]**

Puno

After some resting days in Lima, I decided to visit the Puno area, Lake Titicaca, near the Bolivian border. Arrived in Juliaca, where your whole body feels the altitude, I took a bus to Puno. Puno is ubicated at almost 4000 meters a.s.l., on the lake Titicaca. You need a couple of days to acclimatize, but you easily forget any altitude problems there when you meet kind people and you are surrounded by magnificent landscapes.

Some sleepless nights later, my first trip from Puno, with a Peruvian friend, went to Lago Umayo, a pretty lake near Silustani. I wanted to find some *Lobivia maximiliana* (Heyder ex A.Dietr.) Rausch, which is one of my favorite plants, not far from the enormous tombs, the Chullpas, where old Peruvian people buried their dead in the 14th century. We found there several *Cumulopuntia pentlandii* (Salm-Dyck) F.Ritter and *Lobivia maximiliana*, very easy to find because of the red flowers, very visible among the green grass. What a fantastic place, where you can combine history with cacti!

***Lobivia maximiliana* [Puno]**

***Austrocylindropuntia floccosa* [Macusani, 4200 m]**

Macusani

After few days in Puno, I decided to visit again Macusani, so high in the Andes.

This time the road was much better, so I persuaded my friend in Puno and we left the town early in the morning. We drove through Juliaca, then we took the 34B highway, towards Macusani. Just after Azanguro, though, we decided to stop for some explorations: we found some *Lobivia* and very little else.

Very high on the Andes, we saw many peaks mountains covered by the snow. Close to Rosario we found the first clumps of *Austrocylindropuntia floccosa*: the silky, white hairs gave it the same colour of the surrounding snow. Close to Ajoyani we found a fantastic cushions of *Punotia lagopus*: no word can describe the magnificence of this plant, I consider it as one of the most peculiar cacti of the world.

When we reached Macusani after a mountain pass at 5000 m altitude, we were hungry and tired. After a while we found a small hotel where we could eat and sleep, the place was nice but we hoped to be lucky: often a good sleeping bag is a must, since the room temperatures seldom rise above 5°C there. Before sunset we wanted to explore the hills around Macusani, where we took many pictures of *Austrocylindropunta floccosa* and *Punotia lagopus*. Here and there, the red flowers of *Lobivia maximiliana* were impossible to neglect.

Thunder, lightning and heavy rain obliged us to get back in our icy rooms. There was nothing to do, darkness fell quickly and we were exhausted from the altitude, so we fell soon asleep in our sleeping bags.

Macusani is placed between the jungle and the mountains. This city grows continuously, despite it's exposed to the injuring weather. I noticed this in many Peruvian cities. More and more people try to find a new life far from the largest cities, with a pioneering spirit which is already a threat for plant life and vegetation.

End of the trip

We took our way back to Puno, then I visited the Lago Umayo again, a place which I love, with glorious landscape, history and stunning cacti together.

I spent few resting days in Lima, enjoying the ocean, before my return to Sweden (and its winter).

Punotia lagopus **[Macusani, 4500 m]**

Austrocylindropuntia floccosa and ***Punotia lagopus***
[Macusani, 4500 m]

***Punotia lagopus* [Ajoyani]**


In conclusion, I thoroughly enjoyed this trip. Everything was good and I'll never forget my visits to the deserts north of Lima, the Puno area with Lago Umayo and the trip to Macusani on the Andes.

Cochlearia officinalis, the Cape Horners' succulent

by Gérard Dumont and Antoine Mazzacurati

In the time of sailing ships, all sailors knew this maritime succulent plant. Not because botany was one of their primary concerns, but because this plant prevented them from losing their teeth and sometimes their life, among conditions related to scurvy, the scourge of long sea travels in the past[1].

The prevention of scurvy being now ensured by other means, sailors stopped to pick this little plant and it found again the tranquility of its native rocks, a very relative tranquility given the difficult conditions of the places it has chosen as its living quarters...

1 Scurvy is the result of a severe and prolonged deficiency in vitamin C. It is expressed by vascular fragility resulting in bleeding, muscle weakness, loss of teeth and leads to death if the deficiency is not corrected in time. The frequency of scurvy during long sea voyages was related to the difficulty of storing on board fresh food.

Ecology

Cochlearia officinalis L. is a chasmophyte rupicolous plant that is characteristic of the steep sea rocks and especially the cliffs of the rocky headlands jutting into the sea, therefore in very exposed situations.

At these steep rocky sites, its more typical habitat consists of the cracks and crevices remaining damp in winter and strongly drying in summer. This type of habitat has already been mentioned for *Inula crithmoides* L.[2] and indeed, these two plants often live together. Nevertheless *Cochlearia officinalis* is less strictly heliophilous than the latter and can colonize deep crevices under overhangs that *I. crithmoides* cannot. *Cochlearia officinalis* therefore enjoys moderate shade, partially sheltered by a rocky ledge, but it tolerates direct sunlight striking vertical walls as well. Its latitude to sun exposure is particularly wide as it is a facultative heliophilous plant.

The resistance of *Cochlearia officinalis* to summer drought is high because of the succulence of its leaves covered with a thick cuticle in summer time during which it clearly behaves as a xerophyte and enters into semi-vegetative rest. Its succulence fades in late winter when it forms its flower buds and during flowering, which is very early, from the end of February and lasts until early spring, being indifferent to periods of cold which may occur at this time. The fragrant flowers attract insects, but given their rarity at this time of year, it is likely that self-fertilization also holds a place.

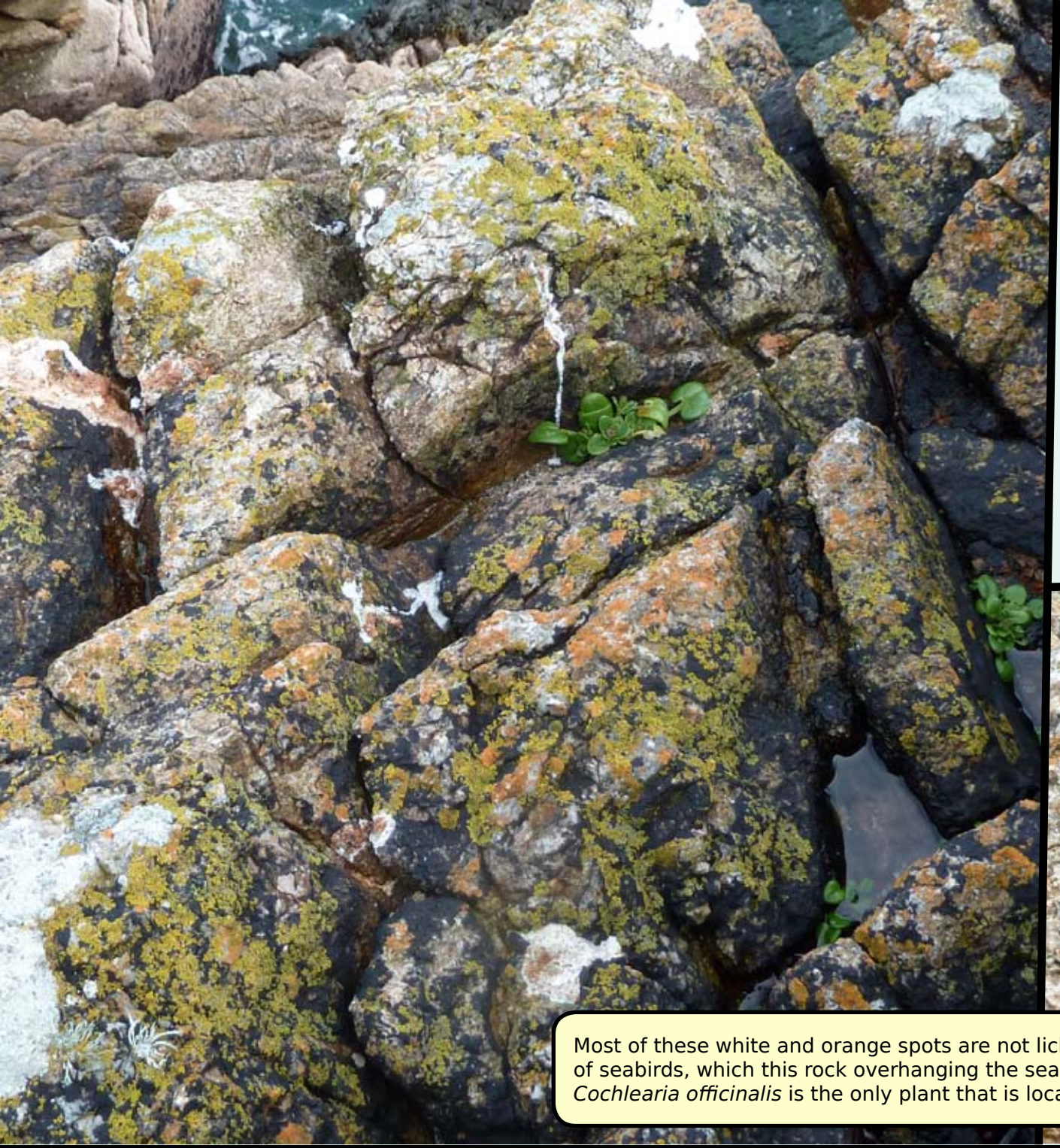
2 Dumont G. & Mazzacurati A. (2013), Inula crithmoides, The false Crithmum who dreamed of being a true one, in Acta Succulenta 2(2) : 142-171.

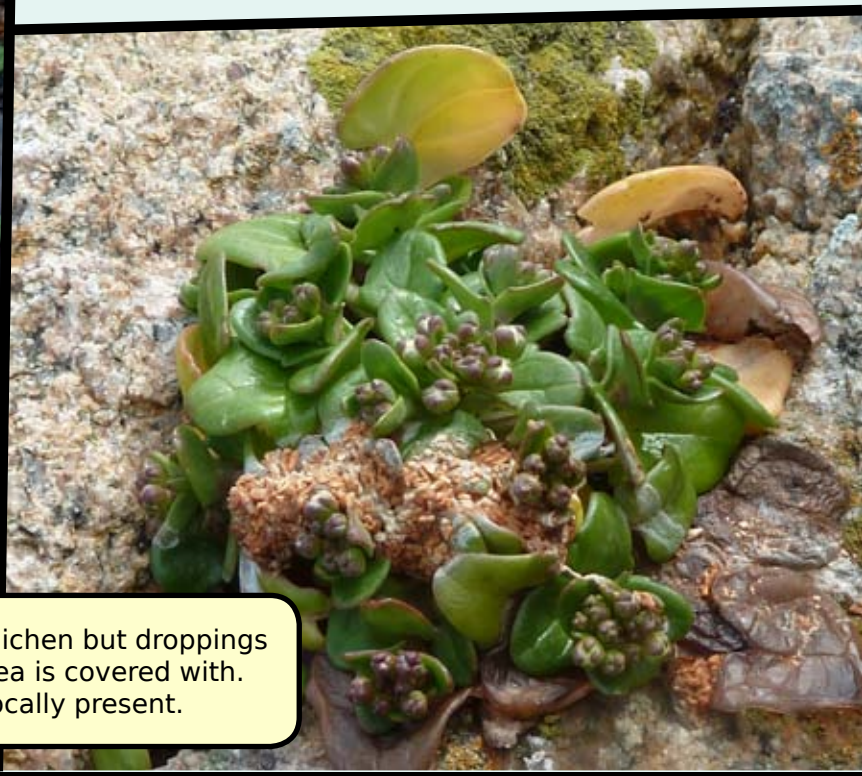
Just as with *Crithmum maritimum* that we presented here[3], *Cochlearia officinalis* is a resident of the "spray zone". It is found most often in association with *Crithmum maritimum* but, altough its withstands sprays very well, its maximum frequency is slightly higher than that of *Crithmum*, that means *C. officinalis* doesn't grow down as low to the waves as the latter. However, this last statement is untrue for many places, especially on high rocks facing north, where it often grows even lower than *Crithmum maritimum*, but this is probably the consequence of a much more pronounced heliophily in the latter, that is to say, it is not *Cochlearia officinalis* which grows lower in such sites but *Crithmum maritimum* which grows less low because of the shadow of the slope.

3 Dumont G. & A. Mazzacurati A. (2013), Crihmum maritimum, The succulent of storms, in Acta Succulenta 1(1): 21-44.

As with many maritime rock plants, *Cochlearia officinalis* is halonitrophilous. It supports salt remarkably well and benefits from trapping minerals and organic matter in cracks brought by the wind and sprays. Its high nitrophily is also highlighted by its frequency on rocks covered by seabird droppings (ornithocoprophily). In these seabird repositories, it often grows alone and abundantly[4].

4 Droppings of seabirds are rich in ammonia. The ammonium ion (NH_4^+) at high concentrations is very aggressive against plant tissues (roots and leaves) that burns quickly if the plant is not adapted; in return, it is immediately and directly absorbed by the plant as nitrogen supply.





Most of these white and orange spots are not lichen but droppings of seabirds, which this rock overhanging the sea is covered with. *Cochlearia officinalis* is the only plant that is locally present.

In winter, its habit, a rosette lying on the substrate allows it to easily withstand the strongest storms.

Although sea crags are its most common habitat by far, it is sometimes possible (but rare) to find *Cochlearia officinalis* in the higher part of the salt marshes, but be careful to not confuse it with his cousin *Cochlearia anglica* L., which is much more frequent in this type of biotope!

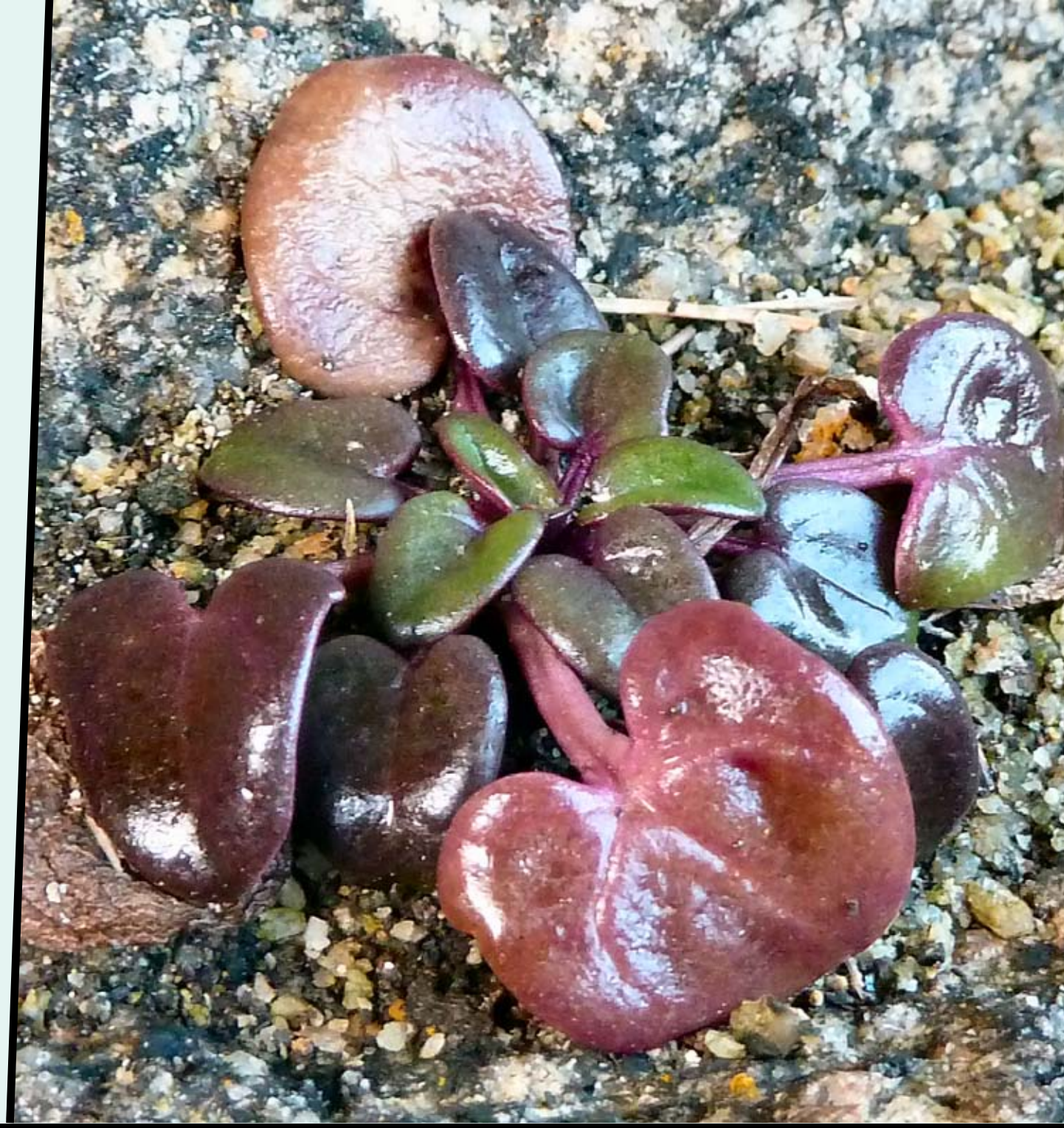
Cochlearia officinalis does not seem to show clear preference about the reaction of the substrate. If it seems to be more common on siliceous acid rocks, it is mainly because they predominate in the whole of its distribution area!

A northern plant with a pseudo-mediterranean pace of growth

Cochlearia officinalis has a pace of growth adapted to very strong alternating hydric regime on the Atlantic coastline, with very wet winters and rather dry summers. Its growth remains active throughout the winter and accelerates very early in late winter and early spring, the time of flowering.

Cochlearia officinalis begins to develop its flowering stems very early – they are already visible in the heart of the rosettes in January-February – then it blooms from March (or late February) to June and fruits. The rosette having bloomed dies but produces a new rosette at its base that will spend the summer in slower growth and then will resume active growth during the following winter. This pace is accompanied by a relative dimorphy between summer rosettes (very succulent, waxy and very tough rounded leaves) and winter and spring rosettes (less succulent with tender leaves more or less shield-shaped)

This winter growth is probably one of the reasons for its clear preference for headlands rather than rocks further back because it hardly ever freezes on headlands and rare frosts are minimal and very short.



Description

Plant: biennial or, more often, short-lived perennial; habit as a rosette lengthening and branching during flowering. Some older individuals develop a short trunk and a few vegetative branches. The morphology is very variable depending on the population, individuals from the same population, the time of year and especially this aspect is highly responsive to environmental conditions.

Roots : long taproot plunging deep into cracks in the bedrock.

Leaves: – *Rosette leaves*: evergreen, glabrous or slightly papillose, fleshy, leathery, long-stalked ; heart or kidney shaped, shiny, dark green, mottled brown and purple in summer, blade – S*tem leaves*: much smaller, in auriculate shield somewhat reminiscent of the ivy leaf, basal ones short-stalked, apical ones with more or less clasping sessile base.

Inflorescence : a simple raceme ; terminal inflorescence surrounded by multiple inflorescences radiating from the axils of the upper leaves of the rosette. Flowering starts close to the rosette before the elongation of the inflorescence, this lengthening is progressive, internodes and flower stalks stretching a lot after the withering of each flower. The elongation of the inflorescence which is reached at the end of flowering is highly dependent on environmental conditions (5 to 50 cm).

Flowers: small (4-5 mm), white, rarely slightly pink, fragrant; typical crucifer hermaphrodite flower with 4 sepals, 4 petals (two times longer than sepals) and 6 stamens with subequal filaments (2 just slightly shorter than the 4 others).

Fruits: rounded globular siliqua, slightly flattened transversely, about 5 mm in diameter, containing few seeds.

Possible confusion:

In practice, *Cochlearia officinalis* can be confused only with the other maritime *Cochlearia* (*Cochlearia anglica*, already mentioned, *Cochlearia danica* L., a very common and opportunistic plant, expanding and largely escaping the coast, and *Cochlearia aestuaria* (J.Lloyd) Heywood, much rarer and very localized), but these latter are more slender (and much smaller in the case of *C. danica*), much less succulent and are all either annual (*C. danica* germinates in the fall and passes the summer as seeds) or biennial, not true perennial. In addition, their habitats are different, the other maritime *Cochlearia* prefer, depending on the species, sea meadows and sandy-muddy environments and when they are found on rocks (this is sometimes the case for *Cochlearia danica*) it's rather on sandy-humic grassy flats in sheltered positions while *Cochlearia officinalis* is typically a rupicolous chasmophyte of exposed maritime rocks. This is the only *Cochlearia* in this case and its ecological preferences are usually sufficient to avoid confusion.

In fact, the main risk of confusion arises with hybrids between *Cochlearia officinalis* and other maritime *Cochlearia*. They do not seem very common but their perfectly intermediate aspect, as their ecology, leads to serious identification problems.

Confusion can sometimes occur in late winter with some small individuals with very fleshy leaves of *Beta vulgatis* subsp. *maritima* (L.) Thell. (sea beet) growing in exposed rocky site (which is not the main ecology of this plant), but the messy and jagged aspect of the beet leaves, coming out a big cespitose root stock, allows an easy distinction.

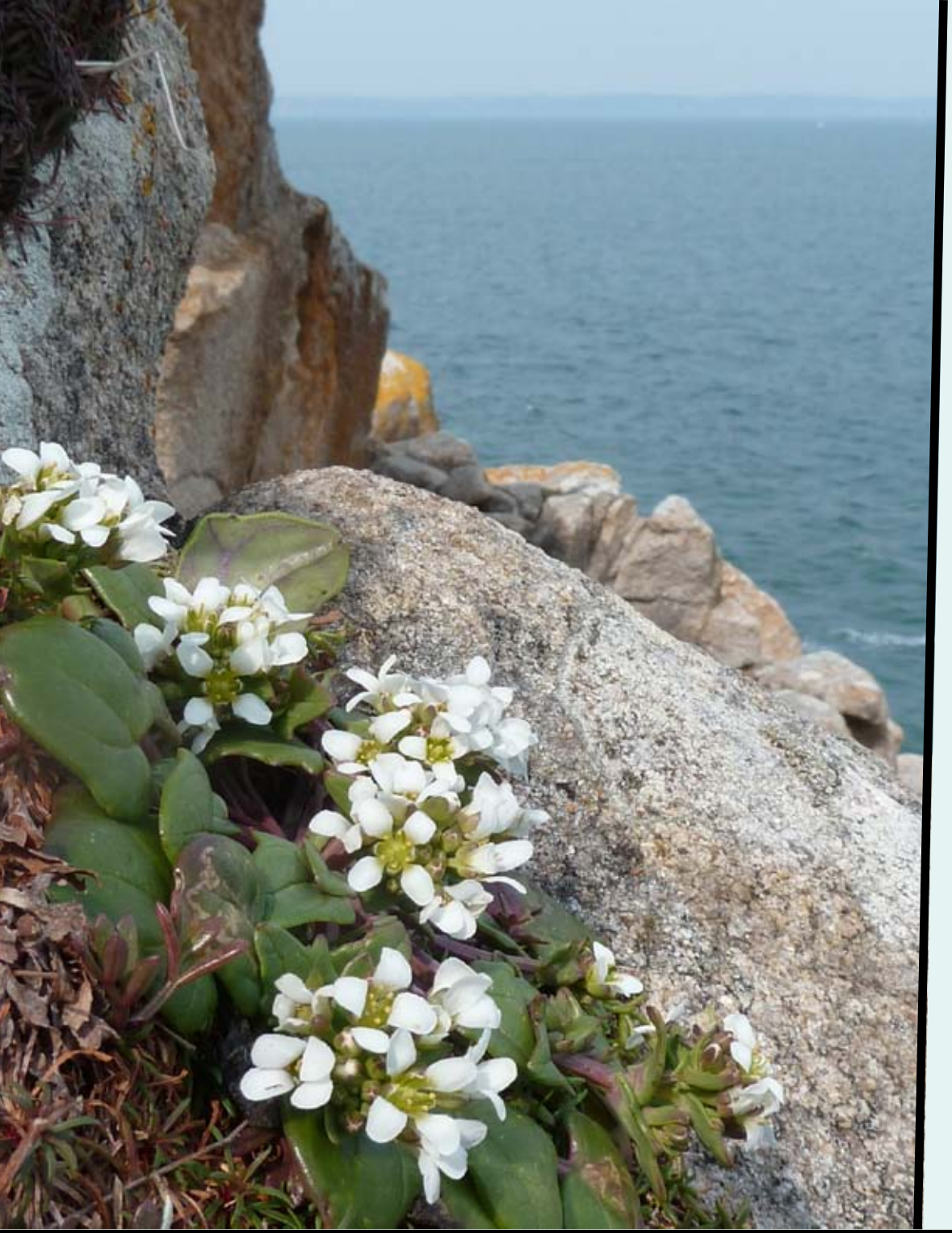

Cochlearia anglica


Cochlearia danica


Beta vulgaris subsp. maritima


Cochlearia danica × officinalis ?


Cochlearia aestuaria



Uses

Because of its richness in vitamin C (ascorbic acid), *Cochlearia officinalis* was in the past a major antiscorbutic recognized as such since the Renaissance[5] and was widely used by sailors who harvested it for consumption before leaving and took it with them. Because of their succulence and their cuticle preserving them from a too rapid drying, cut leaves kept fresh for long. Dried leaves were also used, although less rich in vitamin C (very sensitive to oxidation) and therefore less effective. *C. officinalis* was also used as a decoction in alcohol that was taken on board, the prevention of scurvy was then probably not the only purpose of this preparation...

Apart from this real antiscorbutic property *Cochlearia officinalis* was also used for various properties assumed (respiratory diseases, oral antiseptic, etc.), its name *officinalis* keeps the memory of that.

Apart from the context of prevention of scurvy, *Cochlearia officinalis* is an edible plant for food purposes but it is very bitter and acidic in summer. Its taste is somewhat reminiscent of that of horseradish (*Armoracia rusticana* G.Gaertn., B.Mey. & Scherb.) and mustard, which are botanically close. In winter, its taste is much milder, but still pleasantly tangy and salty, the initial impression is very pleasant in the mouth but is then altered by a rather bitter metallic aftertaste. Mixed with other plants, however, *Cochlearia officinalis* can pleasantly flavour salads.

5 Its empirical recognition as an antiscorbutic of course preceded by several centuries the recognition of its high levels of vitamin C.

Distribution

Cochlearia officinalis occurs spontaneously in all the coastal areas of Western Europe, including the British Isles, and is relatively common on the rocky coasts of the Atlantic, the Western English Channel and the British North Sea. It does not penetrate the Mediterranean.

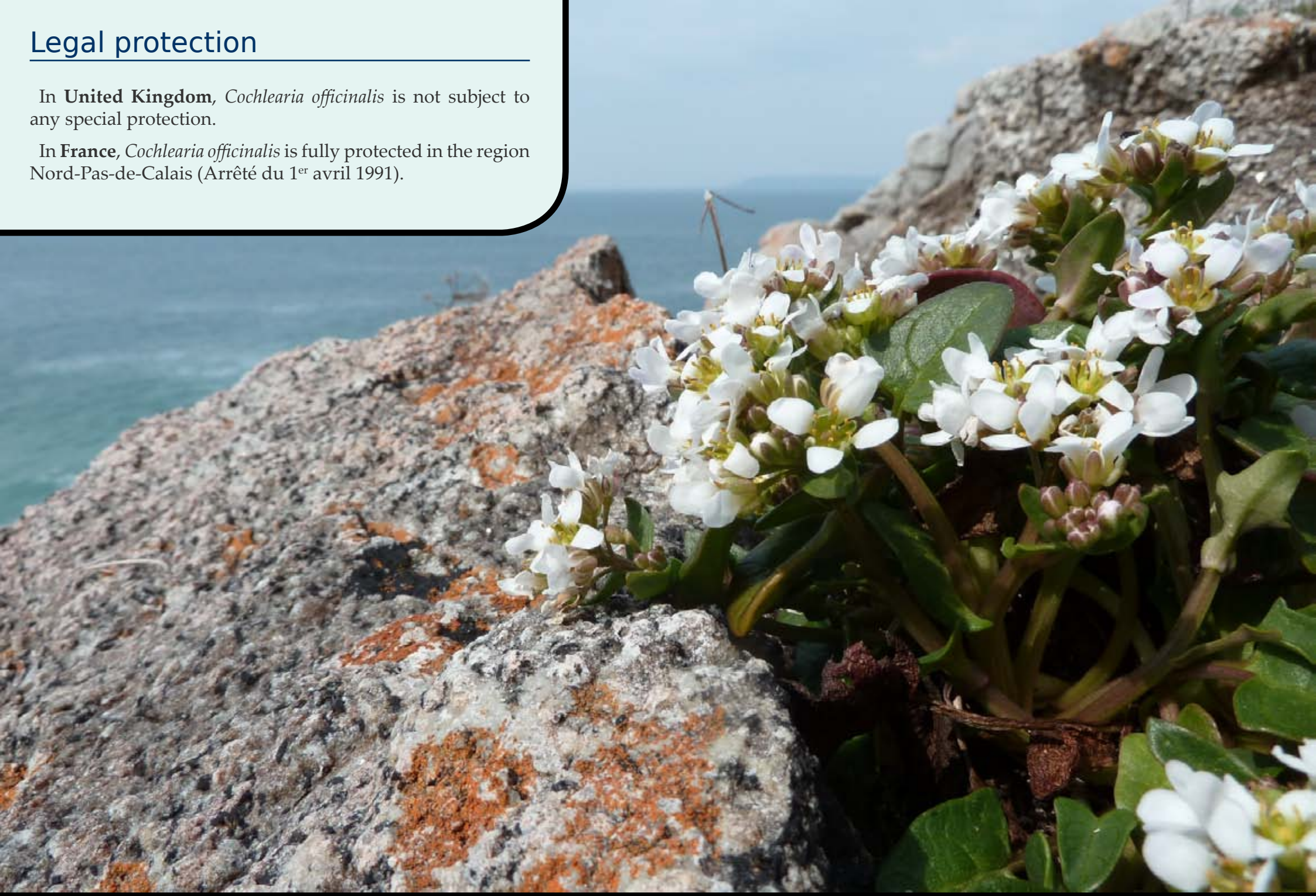
NB: inside the European distribution of this species some mountainous areas are mentioned here and there; it's a broad interpretation of the species including the mountain species close to *Cochlearia officinalis* (often treated as a subspecies of it: *Cochlearia pyrenaica* DC., *Cochlearia alpina* Watson, *Cochlearia micacea* E.S.Marshall rshall) and not *Cochlearia officinalis* in the strict sense. Morphological differentiation is relatively low but there are genomic differences (coastal populations are tetraploid and mountain ones are diploid)

The actual distribution of *Cochlearia officinalis* seems much larger, since it is also mentioned on the North American Pacific coast, very locally here and there from northwest U.S. to Alaska, but its spontaneity can be questioned because its presence could be the result of old introductions followed by naturalization. The very ancient use of this plant by sailors has certainly led to a relative voluntary or involuntary dissemination of this plant (by cultivation of the plant near the overwinter boat sites). In fact, it appears that genomic differences with *Cochlearia officinalis* (2n = 24, tetraploid) connect these North Pacific populations to *Cochlearia groenlandica* L. (2n = 14, diploid) from Greenland, Iceland and Spitzbergen (Svalbard).

Legal protection

In **United Kingdom**, *Cochlearia officinalis* is not subject to any special protection.

In **France**, *Cochlearia officinalis* is fully protected in the region Nord-Pas-de-Calais (Arrêté du 1er avril 1991).



A bit of nomenclature...

Cochlearia officinalis L., *Sp. Pl.* : 647 (1753)

Famille : *Brassicaeae* (nom. altern. *Cruciferae*)

Type: (Lectotypus) LINN 826-3 // design. Elven & Nordal, in *Nord. J. Bot*. 22: 69 (2002)

Chromosome number: 2n = 24 (tetraploid) (Gill E. 2007)

The generic name *Cochlearia* refers to the spoon shape (*cochlea* = spoon in Latin) of the leaves of most species of this genus. The specific epithet *officinalis* refers to the old medicinal use of this plant.

NB: *Cochlearia pyrenaica* DC., a plant close to *Cochlearia officinalis*, growing in the Pyrenees and the Massif Central, is sometimes subsumed with it (*Cochlearia officinalis* subsp. *pyrenaica* (DC.) Rouy & Foucaud.). *Cochlearia pyrenaica* differs morphologically from *Cochlearia officinalis* sensu stricto by its less succulent leaves and its pods whose base is not rounded but cuneiform, and its chromosome number of 2n = 12 (diploid).

The great mess...

The nomenclature of the genus *Cochlearia* L. is somewhat blurred because of the morphological variability of most of the species, the extent of their natural area (for some) and the wide range of habitats occupied, as well as rather a continuum between some of them.

All species of *Cochlearia* being more or less interfertile, the existence of natural hybrids further makes things more complex...

The result of this is that the differences *in situ* between individuals and populations of one same species are often more important than the differences between two "species". The genus *Cochlearia* is clearly inhomogeneous and multispecific but the precise limits between many of its taxa are difficult to define[6].

The ultimate confusion is achieved in the group of *Cochlearia officinalis* sensu lato. The interpretation of this complex species has varied a lot over time and according to the authors, many taxa of uncertain value or confused definition have been described and are referable to this group. Giving a reliable list of nomenclatural (heterotypic) synonyms of *Cochlearia officinalis* is hence a difficult task without a thorough review of the herbarium types associated with an extensive tour of the corresponding populations *in situ*, which we did not do. Those who went a little deeper into the subject than we did (Gill 2007) came to the conclusion that everything can be put in synonymy with *Cochlearia officinalis* except *C. anglica*, *danica* and perhaps *pyrenaica*, and that it is even difficult to give a real infraspecific status to all these taxa put in synonymy of *C. officinalis*.

So we won't dwell on this micro-nomenclature with little practical significance.

6 This is strongly reminiscent of a genus that has been discussed many times in Acta Succulenta: the genus *Sempervivum* (*Crassulaceae*).

Vernacular names

(GB) Scurvygrass, Spoonwort.

(FR) Cranson officinal, Cochléaire maritime, Herbe aux cuillères, Herbe au Scorbut.

(IT) Coclearia medicinale.

Infraspecific taxa

The infraspecific taxa most often retained for *Cochlearia officinalis* are the following:

- ***Cochlearia officinalis*** subsp. ***officinalis***

Synonymy:

≡ *Cochlearia officinalis* var. *typica* G.Andersson & H.Hesselman, *Bih. Kongl. Svenska Vetensk.-Akad. Handl*. 26, 3(1): 36 (1900)

2n = 24 (tetraploid).

Matches the populations of the European Atlantic coast, those which are the subject of this paper, and, in our opinion, the only ones that deserve to be attached to *Cochlearia officinalis* (as well as many coastal micro-taxa mentioned above).

• *Cochlearia officinalis* subsp. *aestuaria* (J.Lloyd) Nordal & Laane

Cochlearia officinalis subsp. *aestuaria* (J.Lloyd) Nordal & Laane, in *Symb. Bot. Upsal*. 31(3): 56 (1996)

Type [*Cochlearia officinalis* var. *aestuaria*]: typus non designatus ?

Synonymy:

≡ [basionyme] *Cochlearia officinalis* [var.] *aestuaria* J.Lloyd, *Fl. Ouest France*, ed. 4: 36 (1886)
≡ *Cochlearia aestuaria* (J.Lloyd) Heywood, in *Feddes Repert*. 70: 6 (1965) ***
≡ *Cochlearia pyrenaica* subsp.*aestuaria* (J.Lloyd) Fern.Casas & M.Laínz, in *An. Inst. Bot. Cav*. 32(2): 301 (1975)

2n = 14 (diploid).

Biennial plant. Highly polymorphic leaves on the same individual, they are ovate-elliptic, medium green (darker than in the type *anglica*, clearer than in the type *officinalis*), with margins more or less sinuate or toothed-serrated, not succulent, blade sometimes a little corrugated and undulated. Higher stem than that of the type *officinalis*. Flower variable in size but often smaller than that of the type *officinalis*. Frequently incurved petals (inconstant in rich environments). Globular fruit.

Southwest coast of the Armorican Massif and northern coast of the Iberian Peninsula (Asturias, Basque Country, Galicia). Rare plant known from a small number of locations but can proliferate very locally therein.

The habitat of this plant is precise and very strict: only the upstream part of some estuaries and maritime rivers, in areas still submitted to the tide but relatively desalted by freshwater (areas with significantly lower average salinity than in the more downstream parts of estuaries where subsp. *anglica* grows). This plant grows in natural sites (mudflats banks) or, more often, in anthropized sites (docks and walls of raw rocks), where it stands in the intertidal zone, because in the past the natural biotopes of this plant were all suitable sites for installation of harbours at the upper reaches of estuaries.


Cochlearia aestuaria

Cochlearia aestuaria

This taxon is well individualized from the type *officinalis* ecologically, genomically and morphologically. However, it is much less compared to the subsp. *anglica*, whose aspect is often fairly close, with which it can be confused (and often is, cf. the blur about this plant in the literature). **Nevertheless, its ecological and genomic individualisation fully justifies the species status and it should therefore no longer be regarded as a subspecies of *Cochlearia officinalis*.**

In France, *Cochlearia aestuaria* (J.Lloyd) Heywood is a fully protected species at the national level (Décret du 13 mai 1982).

Its rarity, its limitation to a few scattered small locations, which may be considered as shelter stations, its narrow ecology with less salt tolerance and its diploid genome (note that the close mountain species *Cochlearia pyrenaica*, cited above, is also diploid while the other maritime *Cochlearia* are polyploid, and a polyploid always derives from a diploid and not the reverse), all that makes it logical to see in this case, not simply an ecotype or a variant of the current maritime populations of *Cochlearia*, but more likely a vestigial form (see below) if not ancestral at least remaining close to the ancestral forms from which were previously differentiated the populations of maritime mudflats (*C. anglica*) and those of maritime rocks (*C. officinalis* sensu stricto). This impression of a vestigial plant is further enhanced by the fact that *Cochlearia aestuaria* shares the same chromosome number as *Cochlearia groenlandica* L. from Arctic areas.

- ***Cochlearia officinalis*** subsp. ***anglica*** (L.) Bonnier & Layens

Cochlearia officinalis subsp. *anglica* (L.) Bonnier & Layens, *Fl. Fr.* : 30 (1894)

Type [*Cochlearia anglica*]: (Lectotypus) LINN-826.4 // design. Jonsell & Jarvis, in *Nordic J. Bot*. 22: 68 (2002)

Synonymy:

≡ [basionyme] *Cochlearia anglica* L., *Syst. Nat*., ed. 10, 2: 1128 (1759) ***

≡ *Cochlearia officinalis* var. *anglica* Kurtz, in *Bot. Jahrb. Syst*. 19(4): 364 (1894)

2n = 48 (octaploid).

Biennial plant, sometimes more or less perennial. Leaves ovate with truncate or cuneate base, much clearer pale green that the type *officinalis*, sometimes a little fleshy but not really succulent. Oblong stem leaves. Slightly larger flowers than the type, larger and elliptical fruits. Petals with truncated apex.

Common plant on North Atlantic European muddy coasts as well as in the English Channel, in the upper parts of the salt marshes.

Just like the previous one, this taxon, ecologically and morphologically well individualized from the type *officinalis*, **justifies fully the status of species and should therefore, in our opinion, no longer be regarded as a subspecies of *Cochlearia officinalis***.

In France, this species is protected in the region Pays de la Loire (Arrêté du 25 janvier 1993) and in the region Poitou-Charentes (Arrêté du 19 avril 1988).

Cochlearia anglica

• *Cochlearia officinalis* subsp. *arctica* (Schltdl.) Hultén

Cochlearia officinalis subsp. *arctica* (Schltdl.) Hultén, *Fl. Kamtchatka* 2, in *Kongl. Svenska Vetensk. Acad. Handl*., n.s. 5(2): 147 (1928)

Type [*Cochlearia arctica*]: leg. Pallas, s.n., 1768-74 ; « in arctitis littoralis ad Obum Sibiria, Pallas » ; HAL-0026702

Synonymy:

≡ [basionyme] *Cochlearia arctica* Schltdl. ex DC., *Syst. Nat*.: 2: 367 (1821) ***
≡ *Cochlearia officinalis* [var.] *arctica* (Schltdl.) Gelert, in G.Andersson & H.Hesselman, *Bih. Kongl. Svenska Vetensk.-Akad. Handl*. 26, afd. 3, 1: 40 (1901)
≡ *Cochleariopsis groenlandica* subsp. *arctica* (Schltdl.) Á. Löve and D. Löve, in *Bot. Not*. 128(4): 514 (1976 pro 1975)

Matches the populations of the North American Pacific coast, which could be suspect from a former naturalization (planted there by sailors during wintering stopover) unless, more likely, it relates to *Cochlearia groenlandica* rather than *Cochlearia officinalis* sensu stricto (see above).

• *Cochlearia officinalis* subsp. *scotica* (Druce) P.S.Wyse Jacks.

Cochlearia officinalis subsp. *scotica* (Druce) P.S.Wyse Jacks., in *Bot. J. Linn. Soc*. 106(2): 119 (1991)

Type [*Cochlearia scotica*]: leg., E.S.Marshall, s.n., 1890-07-16 ; K-000484382

Synonymy:

≡ [basionyme] *Cochlearia scotica* Druce, in *Rep. Bot. Exch. Cl. Brit. Isles 1928*, 8: 867 (1929)
≡ *Cochlearia groenlandica* subsp. *scotica* (Druce) Á.Löve & D.Löve

Coasts of Scotland, Faroe Islands and Northern Ireland; maybe also western Ireland.

Smaller and more compact than the type in all its parts and more cespitose. Very small inflorescence, with generally lilac but also whitish flowers. This taxon is often versed, we think with good reason, in the type as being at most one of its multiple ecotypes. Note that this dwarf and compact habit is not a simple phenotypic accommodation since it maintains itself in experimental cultivation from seeds (Gill 2007). However, the type (subsp. *officinalis*) may also present this morphotype *scotica* when it grows in very exposed situation, but in this case this morphology is not maintained in cultivation.

We mention this coastal micro-taxon not for its taxonomical value, which is low, but because, from a horticultural point of view, it is very pretty!

Cochlearia officinalis subsp. ***artica***
[ex Andersson & Hesselman]

When plants hesitate between sea and mountain...

We have just mentioned that *Cochlearia officinalis* has a close mountain cousin. This is much more than anecdotal and poses an interesting problem of interpretation.

The facts

This case of convergence between the mountain and the coastal flora is not exceptional: many other maritime plants also have close mountain cousins (in the genera *Armeria*, *Silene*, *Sedum*, *Plantago*, *Geranium*, some *Poaceae*, etc..).

In each case, the level of differentiation between sea and mountain forms is rather low (mostly at varietal or subspecific level, taxonomically speaking, at most affine species), therefore a distance (morphologically and genomically) compliant with monophyletic branches having diverged relatively recently.

Conversely, many maritime plants have no close relatives in the mountain flora (and vice versa) and this is the most frequent case. In this case, morphological and physiological adaptations to the maritime environment (or to the mountain environment) are generally more obvious than in the group of plants common to both floras.

For plants with sea populations and mountain populations, the areas of these two populations are generally well separated, without connection uniting their respective areas.

How to explain that?

The former hypothesis of plants coming down from the mountains, pushed by ice during the Quaternary glaciations, which would have implanted themselves on the coast as shelter areas, then would have gone up to the heights during the climatic warming while leaving a few descendants on the coasts is not fully satisfactory.

Modern concepts rather see these plants, which are at the same time present in both mountain and sea environments, not as originally mountain plants, but as descendants of the flora of the plains of the last ice age[7].

At this time, the ice cap reached down to the British Isles and glaciers covered the European mountains almost entirely. The vegetation of central Western Europe was a low tundra vegetation type but more heliophilous because of the much lower latitude than the contemporary tundras.

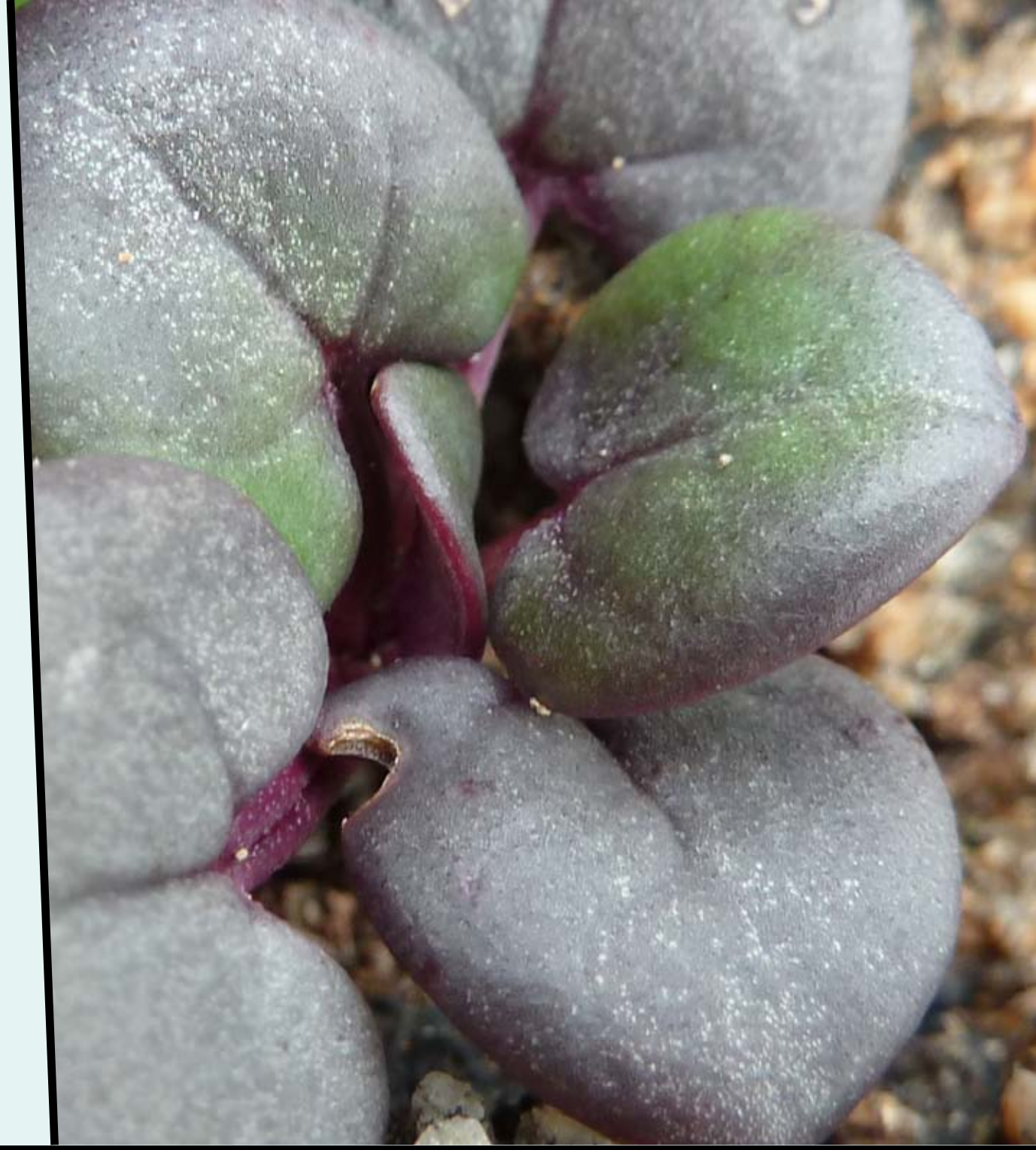
During post-glacial warming, trees reappeared (or, more exactly, spread up from the south), then the forest gradually replaced the tundra and the heliophilous flora of the latter went slowly northwards, but a part of it fled and remained in areas where the trees implantation was more difficult: the coast and the mountains. The gene flow being interrupted between these populations became maritime and mountain, some differentiation has occurred secondarily favoured by specific ecological constraints of these environments (such as salt and summer drought for maritime populations and low temperatures resulting in a short growing season for mountain populations) to which was added the polyploidization of some maritime populations (that's the case of the populations that lead to current *Cochlearia officinalis* sensu stricto) increasing the ecological plasticity and the differentiation of those.

7 Period known as the Würm period in the area concerned; it ended 10,000 to about 13,000 years ago.

The absence of any obvious adaptation of type thalassochory in *Cochlearia officinalis*, as in all plants with mountain cousins and that contrary to some maritime plants without such a kinship, reinforces the hypothesis of its late, post-glacial, arrival, knowing that evolutions in the reproductive system are still slower to appear than those affecting the vegetative system (the latter being subjected to a higher and constant selection pressure).

When, in addition, we observe that the genus *Cochlearia* is a genus with much more boreal than Mediterranean affinities, everything matches this hypothesis and we can therefore see in this maritime succulent plant a probable witness, among others, of the major floristic changes that followed glaciations.

Caution, *this explanation is that of a mechanism and not of a chronology*. In fact, the reality was certainly more complex, because the quaternary glaciations were not a single episode but a series of glacial episodes interspersed with periods of warming. This mechanism could therefore be renewed and some isolated and differentiated populations were able to regroup again and then separate, amplifying the complexity of the group each time. What we are seeing is a false static snapshot of dynamic phenomena that are measured in geological time scale!



Cultivation notes

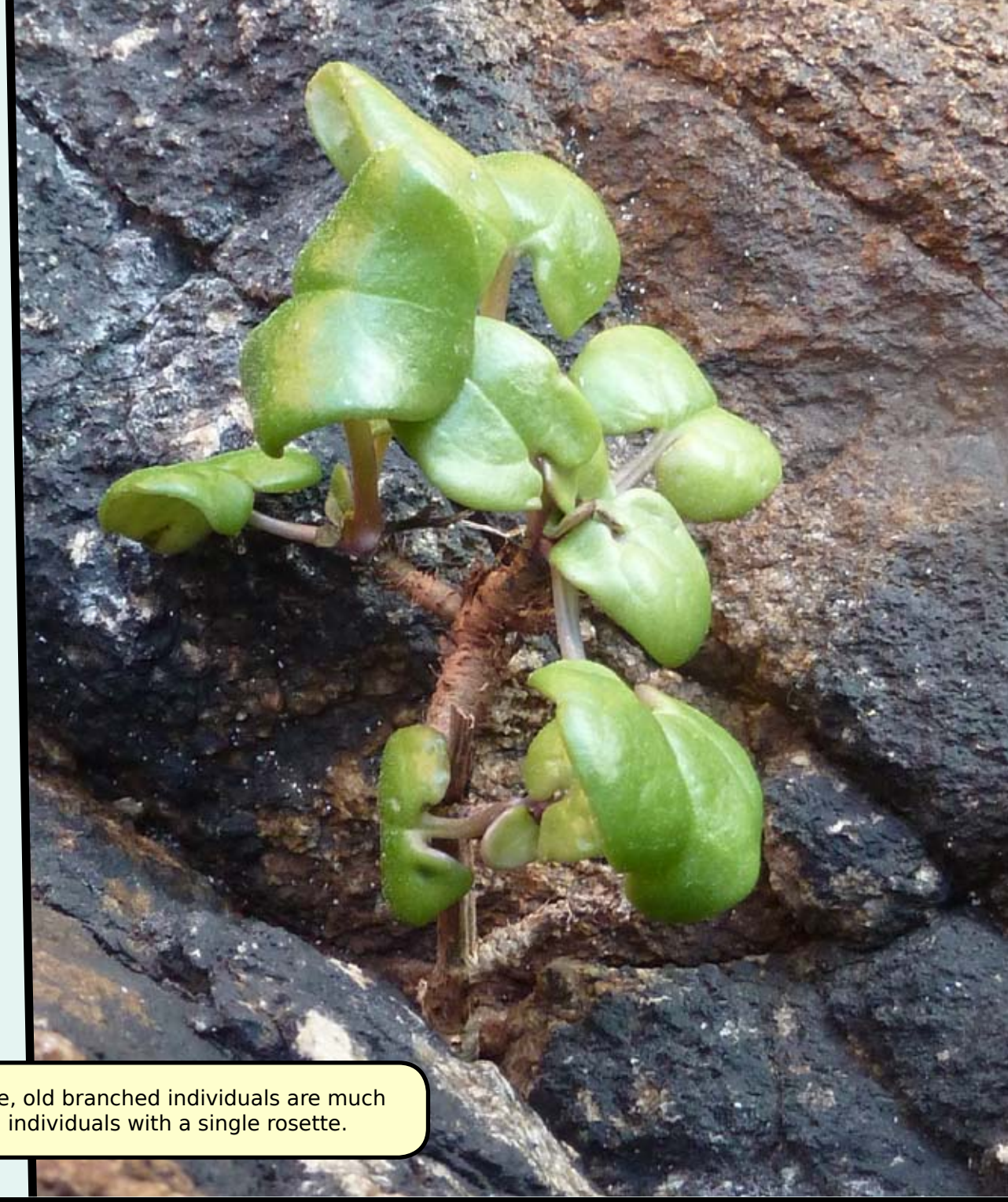
Cochlearia officinalis can be grown without problem in the ground in the garden or better still, in a rockery, where it withstands the winter moisture without problems. Although its origins are from the seaside, its frost resistance, even severe, is excellent.

In spite of its long taproot, it also adapts well to pot cultivation.

Like every other halonitrophilous plants, a rich soil and regular fertilizer supplies will make it happy. A pinch of salt from time to time, or watering with diluted seawater, will promote the succulence of its leaves. Remember that, in nature, it is ornithocoprophilous; so if you are breeding birds (chickens, pigeons, etc.) do not hesitate to watering it occasionally with diluted droppings, it will love it!

For it to get its beautiful summer colours, *Cochlearia officinalis* will have to stay a little dry in summer and in full sun, although it will tolerate some shade.

Note that *Cochlearia officinalis* subsp. *scotica* is a very nice and compact dwarf form with lilac flowers which, despite having not a great taxonomic importance, is interesting to look for in a horticultural point of view. We do not have experience of it in cultivation, but given its rather northern origins, it must fear the heavy summer heat.

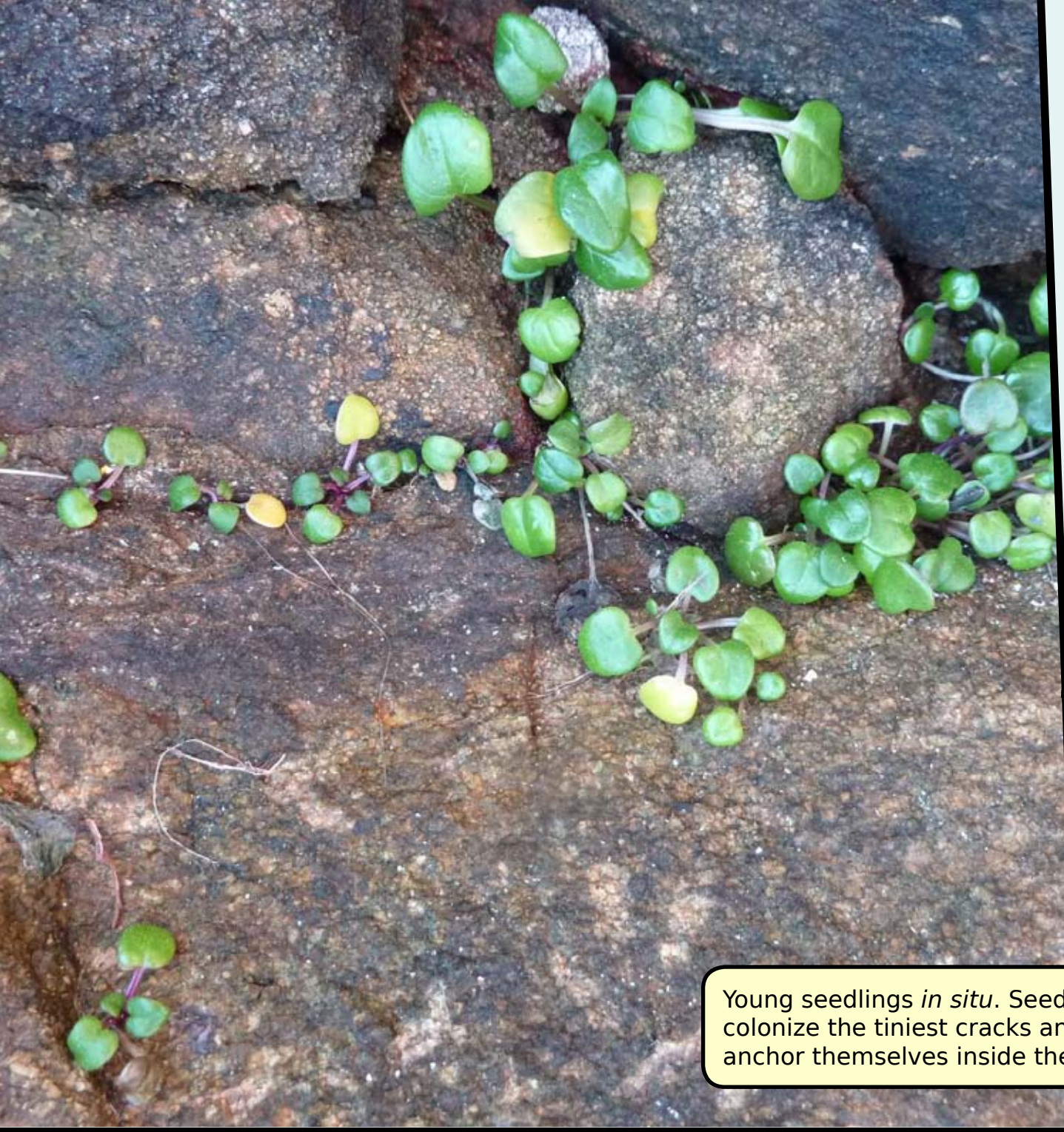


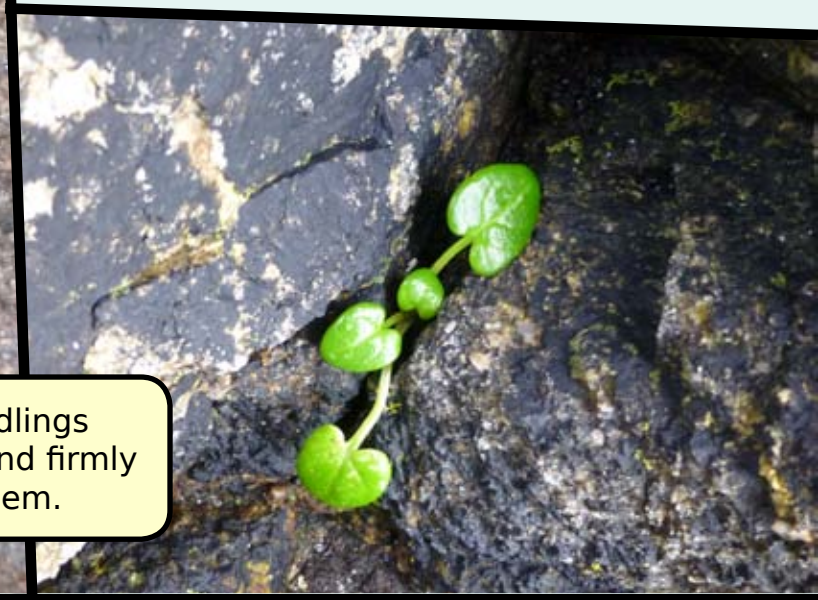
Although not rare, old branched individuals are much rarer *in situ* than individuals with a single rosette.

Propagation

It's possible to try making cuttings with side rosettes that appear after flowering but as the plant often produces only one rosette and as the mother-rosette dies after fruiting, the efficiency is not great...

In practice, the reproduction is therefore performed only by seed. The seeds are known to germinate with difficulty in hot weather. In situ, one can note that seedlings appear in winter (February) or in autumn. Therefore sowing should be undertaken early in the season and directly in place, because the long taproot of this plant does not like being transplanted. Early sowing is all the more important given that the maximum growth of this plant is in early spring and slows down sharply in summer.





Young seedlings *in situ*. Seedlings colonize the tiniest cracks and firmly anchor themselves inside them.

Where to get this plant?

Cochlearia officinalis seeds are relatively readily available commercially, at least on the Internet. But the risk is high to receive the seeds of another *Cochlearia* under the name *Cochlearia officinalis*, because the descriptions of this plant on some sites offering seeds are visibly confused and they can mix several species... that's not surprising given the complexity of the nomenclature of the genus *Cochlearia* and the confusion that reigns inside it.

Cochlearia officinalis itself is also available cheaply in some nurseries specializing in medicinal plants, condiments and herbs, some which sell online. The same reservations can be expressed about the identification of the plants sold...

Many fans of "natural medicine" cultivate *Cochlearia officinalis* and exchanges between afficionados are hence possible.

Given the uncertainty about the true identity of the plants you get through these indirect channels, it is preferable to collect seeds yourself *in situ* in an area where the plant is not protected, which is very easy as its fruiting is generous.

As for the pretty subsp. *scotica*, it seems that it's necessary to go *in situ* to obtain seeds, unless soliciting some botanical gardens.

Conclusion

No need to consider buying a sailing boat and no need to fear scurvy to enjoy this plant. Its ethnobotanical aspects, its extreme ecology and the window that it opens to every lover curious about the history of plants over time, are enough to make it exciting... but if you're really a hypochondriac and persuaded to have teeth that move, then eat it! ■

Bibliographic references:

- Gill E. (2007), *Conservation genetics of the species complex Cochlearia officinalis L. s.l. in Britain*, PhD thesis, University of Edinburgh.
- SAUNTE L.H. (1955) Cyto-genetical studies in the Cochlearia officinalis complex, in *Hereditas* 41(3-4) : 499–515.

Sempervivum thompsonianum, the Houseleek surrounded by confusion

by Josef Ježek

In many cases it is difficult to identify houseleeks (genus *Sempervivum* L. and genus *Jovibarba* Opiz) correctly. At first glance they seem to be the same, but a closer look at them reveals their variability and beauty.

For this reason, and because the exact location of the original population remained unknown, in the past different plants appeared under the epithet *Sempervivum thompsonianum*[1].

In this article I discuss *Sempervivum thompsonianum* and its habitat, since I found the probable type locality in Stogovo planina, Republic of Macedonia.

1 The exact location of the original natural habitat was probably only known by F. Lemperg, discoverer of *Sempervivum thompsonianum*, and apparently the habitat wasn't visited after 1938, when F. Lemperg found this plant.

Description

It's not easy to distinguish *Sempervivum thompsonianum* from other species of genus *Sempervivum,* as it's morphologically similar to *Sempervivum macedonicum* or *Sempervivum octopodes,* so distinctive characters are not easily noticed[(2)].

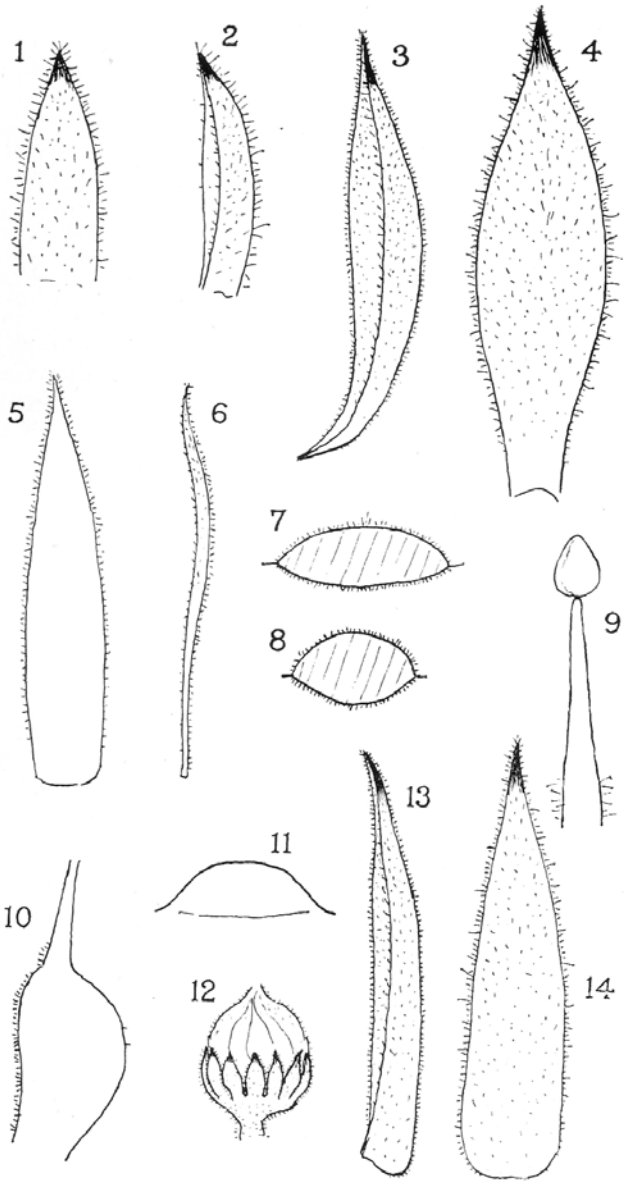
For this reason I describe the plant here:

2 It's important to bear in mind that in many cases, cultivated plants of *Sempervivum thompsonianum* are wrongly identified, since they are actually other species or they are interspecific hybrids.

Sempervivum macedonicum **[Babin Srt]**

Sempervivum thompsonianum

Sempervivum octopodes [Ilinden, Baba planina]



Sempervivum Thompsonianum.

1. Sepal, abaxial surface. 2. Sepal, lateral view. 3. Rosette leaf, lateral view. 4. Rosette leaf, abaxial surface. 5. Petal, adaxial surface. 6. Petal, lateral view. 7. Rosette leaf, transverse section. 8. Cauline leaf, transverse section. 9. Stamen. 10. Carpel. 11. Scale. 12. Bud. 13. Cauline leaf, lateral view. 14. Cauline leaf, abaxial surface.

The original drawing from the protologue of *S. thompsonianum*

Rosette: diam. 10-30(-40) mm, almost globular, centre depressed; dense with many leaves, inner ones curved inwards, outer erect.

Leaf: obovate-oblanceolate to elliptical, convex on both sides, 14 × 4 mm, 2 mm thick; pubescent on both sides with unequal marginal cilia; red to violet at the apex.

Offsets: quite long, 40-80 mm, thin, red to violet; slightly leafed, with the very small leaves often red.

Flowering stem: about 80 mm tall, but can be also quite slim and depressed. *Cauline leaves* erect, lanceolate to narrow deltoid-lanceolate; 11 × 3 mm, 1.5 mm thick, pubescent on both sides with unequal marginal cilia. Upper leaves dark violet.

Inflorescence: from 14 up to 20 flowered, compact, with often 4 simple pubescent branches. Globular acuminate buds.

Flower: from 10- up to 13- (mostly 12-) parted, diam. 19 mm. *Calyx* about 6 mm long; sepals lanceolate, acuminate, about 4 × 1.3 mm, 0,8 mm thick, pubescent on both side but less on the inner side. *Petals* lanceolate to linear-lanceolate, about 9 × 1.8 mm, light purple colored with wide white stripes, very slightly pale yellow at the apex, yellow green on the underside, with short red pinstripes on the upper portion. *Stamens* from 20 to 26, about 4 - 4.5 mm long, tapering, sparsely pubescent, dark red, lighter at the base; anthers about 1 mm long, yellow. *Carpels* green; ovaries pubescent on the inner side, bald outside, green. *Scales* 0.3 mm long, 1 mm wide, almost rounded, tight.

The above mentioned data corresponds with that reported in the original description by Royden Samuel Wale (1940), which I'm now expanding thanks to my field studies and cultivation experience. For this reason I can confirm that I most surely found the true *Sempervivum thompsonianum* in its habitat.

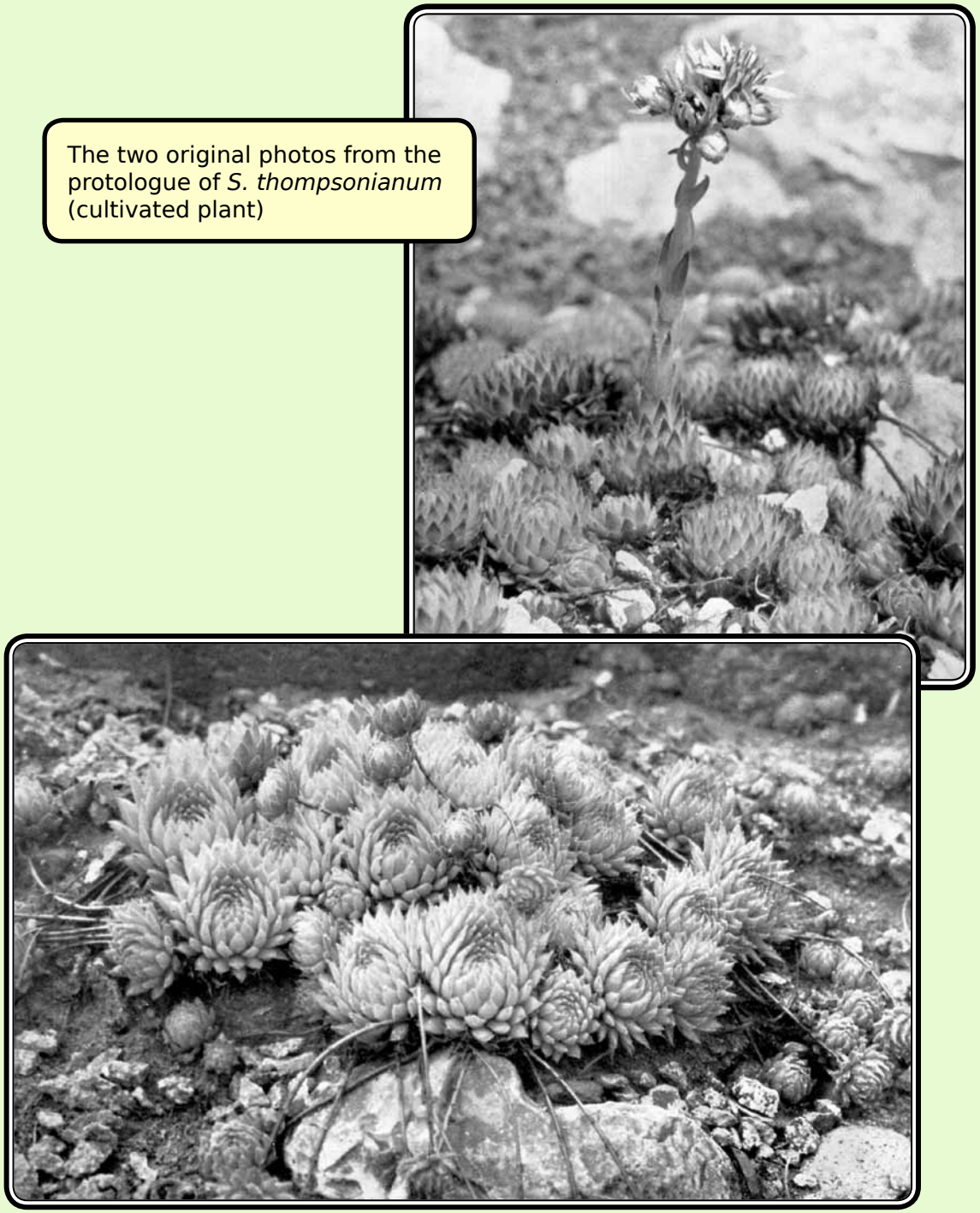
The original data

Sempervivum thompsonianum Wale, Semperviva of the Balkan Peninsula, in *Quarterly Bulletin of the Alpine Garden Society* 8(3) n°41: 210 (1940)

Typus: leg. F. Lemperg, s.n, 1938 ; "N. Macedonia: Stogovo planina, on summit in crevices of limestone rock, 2150 m." ; in herbario kewensi [typus perditus][3]

Etim.: dedicated to Mrs. H.P. Thompson, who studied the genus *Sempervivum* in Balkan Peninsula.

Two photos of *Sempervivum thompsonianum* were published in the article by R.S. Wale, where the plant is described: these photos help us to understand this plant, but some important characters aren't visible. The remaining pictures are simple drawings, which show us the distinctive characters of *Sempervivum thompsonianum*, for example rosette leaves, leaves of flowering stem, petals, sepals, etc. The author of the description of *Sempervivum thompsonianum* also gives some indications about the habitat and how to distinguish *Sempervivum thompsonianum* from other species of genus *Sempervivum*. In my opinion these notes are even more important than the actual description of the species: R.S. Wale compares here, with Horticultural Colour Chart, *Sempervivum thompsonianum*, then he states differences of new species from *Sempervivum macedonicum* (leaves, much shorter offsets, flowers), *Sempervivum octopodes*, *Sempervivum ciliosum*, *Sempervivum leucanthum* and *Sempervivum kindingeri* (flowers, size of rosettes, leaves). He gives information about the locality: "N. Macedonia: Stogovo planina, on summit in crevices of limestone rock, 2150 m, with *S. heuffelii* Schott, Dr. Lemperg 1938 (typus in Herb. Kew)." As we explain later in this paper, these notes are not only unclear, but they are erroneous.



The two original photos from the protologue of *S. thompsonianum* (cultivated plant)

3 All the original material in Kew was lost and no lectotype nor neotype was designated.

Stogovo planina

Stogovo planina is a mountain chain situated in southwestern Republic of Macedonia, delimited on the west by a dam called Debarsko ezero, in the very deep river valleys of Crni Drim and Radika, close to the town Debar; on the north by the deep river valleys of Mala reka, Garska reka and Jamska reka, with the Jama mountain pass; on the east by the valley crossed by the main road between Ohrid and Kichevo; on the south by the Karaorman massif.

Stogovo planina is named after the mountain Stogovo (2,218 m), although it is not the highest summit in this range. In the chain, this mountain is situated a bit aside from other higher mountains and it's easy recognizable due to transmitters built near the peak. The highest peak of Stogovo planina is Bijak Dorok (2,268 m). Another mountain is worthy of mention: Babin Srt (2,241 m). Other peaks in Stogovo planina have altitudes of around 2000 metres.

During my trips to Stogovo planina I was amazed by the nature of the rock which changes very often; one can find limestone, mica schist, sandstone or schist. In some places the rock can changes every two steps, and two types of rock even mingle into each other in some places. It's very interesting to observe the changes of the flora following the nature of the rock.

Stogovo planina and Mount Stogovo seen from Mount Bijak Dorok

Sempervivum on Stogovo planina

First trip

I visited Stogovo planina on the 5th of July 2010 for the first time with my friends. We began our trek in the village of Gari, on the northern slopes of Stogovo planina, following indications given by Klaus Schropp on an internet website. Although the information about plants reported by Klaus Schropp in the article were rather unclear and ambiguous, we decided to explore an area between the mountains Bijak Dorok and Babin Srt.

There we looked for *Sempervivum* on limestone rocks and other places suitable for *Sempervivum*, but we didn't find any *Sempervivum* s.s, we only observed colonies and clumps of *Jovibarba heuffelii*. I also explored the top of Kaneš mountain as well as the upper parts of the eastern and southern slopes of Bijak Dorok, without any success.

Once back in Gari, I suggested exploring some rocks on the north-western slope of Babin Srt. The nature of the rock was different there, since the limestone was substituted by schist and mica-schist. I was very lucky, because I found plants belonging to the genus *Sempervivum*, a large amount of rosettes! It was interesting that the plants were growing only on the schist and mica-schist, avoiding the limestone rocks. The populations are growing there from about 1700 m asl to 2100 m asl. Another population is growing below the top of Babin Srt[4].

4 Hornát, Milan. 2013, (pers. comm.).

A population of *S. macedonicum* on the slope of Babin Srt.

Sempervivum macedonicum **[Babin Srt]**

The plants we found were very similar to the plants showed in the article by Klaus Schropp[5], so we thought that we had found the real *Sempervivum thompsonianum*, but we were wrong, since they were actually *Sempervivum macedonicum*! I can confirm this because later we noticed that this plant has too many petals, no yellow colour on its petals; the offsets were too thick, the rosettes were violet coloured; the shape of the leaves of the rosette didn't correspond to the paintings published with the description of *Sempervivum thompsonianum*; the cilia on the margins of the leaves had an equal length.

It's worth mentioning that this *Sempervivum macedonicum* is smaller than *Sempervivum macedonicum* plants from other localities.

5 [**Editor note**].: the flowers produced by plants found by Klauss Schropp had white-yellowish petals with an extended pink-reddish base (often it's a true, evident midstripe in the limb).

Sempervivum macedonicum **[Babin Srt]**

Second trip

Many questions about *Sempervivum thompsonianum* needed an answer, so I revisited Stogovo planina on 21st July 2013, and went up to the mountains again from Gari village.

This time I wanted to look for *Sempervivum* on Stogovo mountain. During the ascent, I looked for *Sempervivum* in every likely place, but I didn't find any, and not even any *Jovibarba heuffelii*. The nature of the rocks was very variable and at Mala Megdanica it was changing at almost every step: limestone, schist, mica-schist, slate. Just below Stogovo mountain the rock changed again: sandstone and slate are there. Finally I found some *Sempervivum* on the first rocks of the south-eastern slope of Stogovo mountain. These plants were distinctive from the plants I found before on Babin Srt.

I am convinced that I found *Sempervivum thompsonianum* in its natural habitat, since the morphology of this plant is practically the same as shown on the photos and paintings in the original description by Wale.

Its stolons are red or violet, thin and slightly leaved, and they are longer than those of the *Sempervivum macedonicum* that I found during the previous trip. The leaves are pubescent (not densely hairy) on the upper and lower sides, narrow and violet on the apex. The cilia on the leaf margins are unequal in length. The morphology of the leaves fits the paintings of the original description.

I didn't find any flowering plants during that trip.

Summit of Mount Stogovo

Sempervivum thompsonianum

Last trip

On 21st of July 2014 I explored Stogovo mountain again. I found there about 25 rosettes with open blooms. The blooms corresponded to the original description written by Wale, since they were from 10-parted to 13-parted.

I explored the southeastern slopes of Stogovo from an altitude of 2000 metres to the top of Stogovo, and I found that *Sempervivum thompsonianum* grows there in abundance with thousands of rosettes, from about 2100 metres right up to the top. Plants generally consist of multiple rosettes, but solitary specimens aren't rare. There is variability in the length of marginal cilia of the rosette leaves. The colour of the rosette leaves in the upper third is also variable. Other features are more or less the same.

Plants are dispersed here and there in habitat, always on sandstone and slate, never on limestone. They grow on rocks and stones, in the gaps among stones, in crevices of rocks and beside them. *Jovibarba heuffelii* is sympatric there, as stated in the original description.

Sempervivum thompsonianum

Discussion

There has been confusion around *Sempervivum thompsonianum* in recent years, and so many people have wrongly labelled plants in their collections.

To determine *Sempervivum thompsonianum* correctly it's necessary to study the original description written by Wale by comparing the morphology of the rosettes with the drawings in the original description. Thus I can confirm that correctly labelled plants of *Sempervivum thompsonianum* are rare in collections.

It has been really difficult to rediscover the natural habitat of *Sempervivum thompsonianum*. Botanists looked for *Sempervivum thompsonianum* in the Stogovo planina mountains, but owing to an error about the type of rock on which *Sempervivum thompsonianum* grows, they weren't successful or found other plants. *Sempervivum thompsonianum* doesn't grow on limestone in habitat, *but* on sandstone and slate in the wild.

I searched for *Sempervivum thompsonianum* in the literature, but apart from the original description I didn't found any other references.

Stogovo planina isn't a protected area and *Sempervivum thompsonianum* is threatened by intensive livestock grazing.

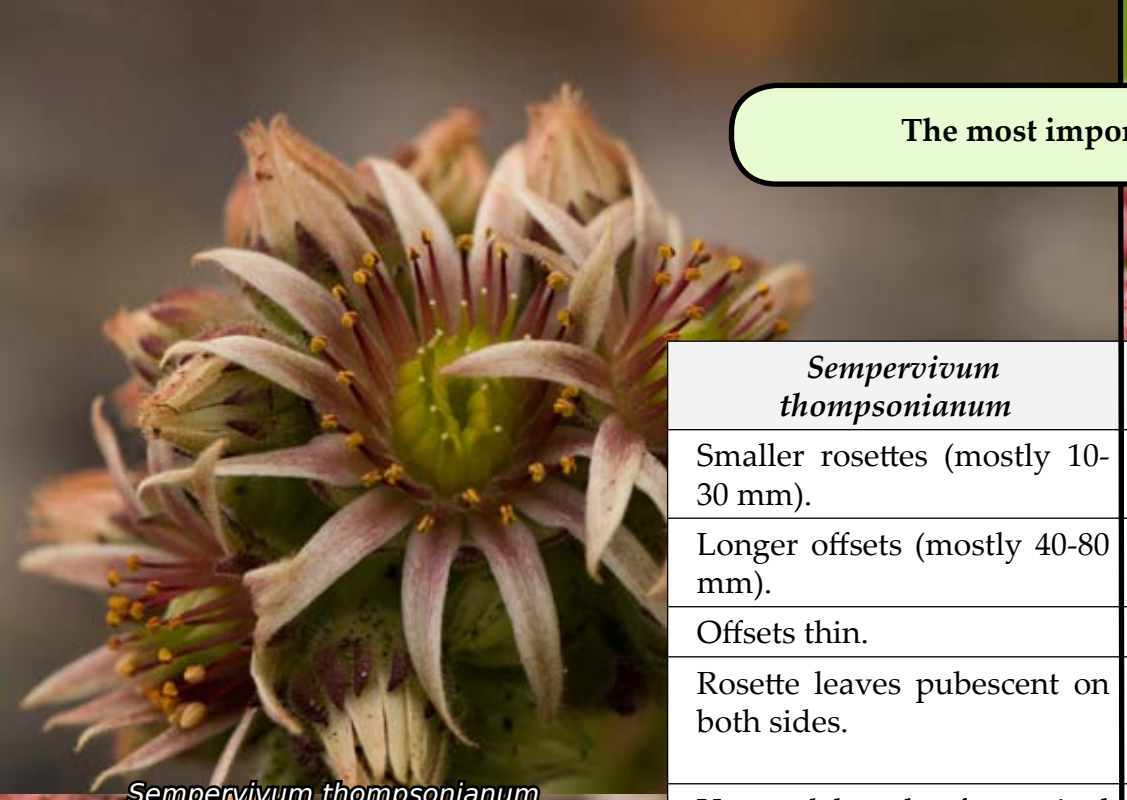
Although I presume I rediscovered the original habitat, there are still many questions and further research and observations are needed. It's necessary to explore the original natural habitat of *Sempervivum thompsonianum* in-depth, describing the true distribution range of *Sempervivum thompsonianum* in the wild. Do they grow only on sandstone and slate, or do they also grow on schist or other rocks? At what altitude do the plants start to grow? How do they grow and look in cultivation? Many questions haven't been answered yet.

Considerations on the status of this plant

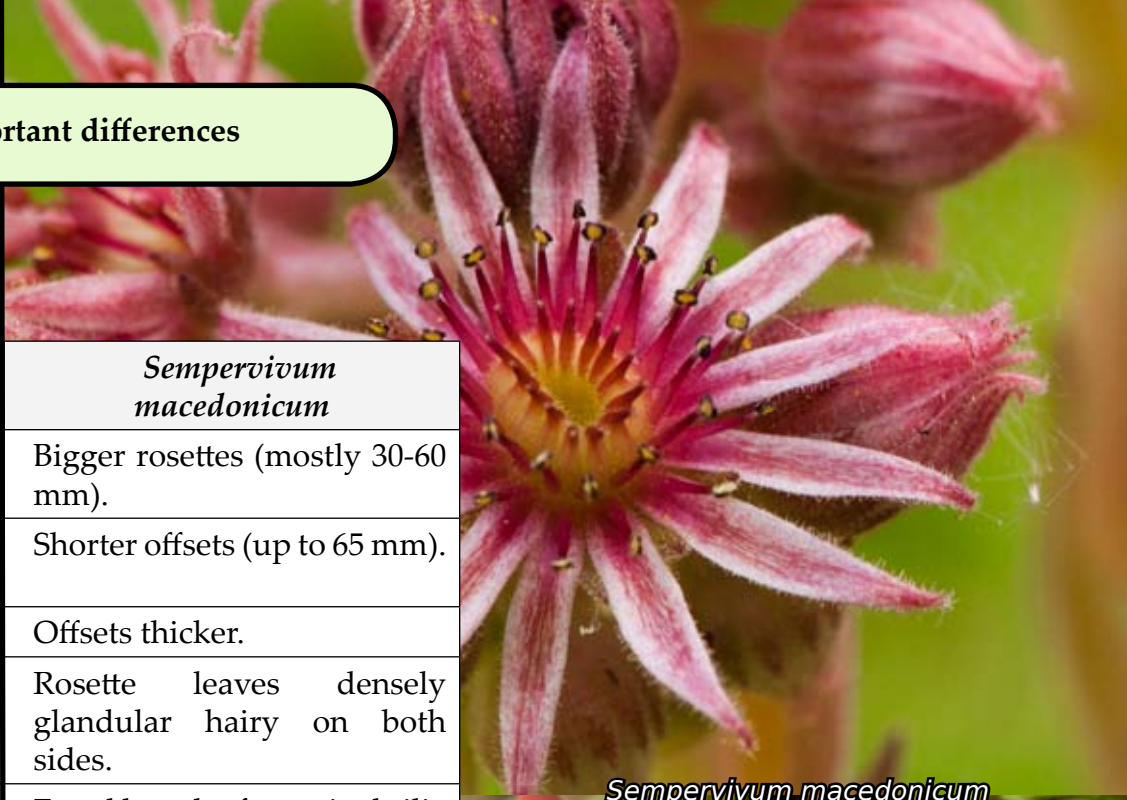
We can find in the literature many speculations about a hybridogenous origin of *Sempervivum thompsonianum*. This thesis wasn't supported by any arguments and my experiences in habitat cannot support this thesis either. For this reason and bearing in mind that we don't know enough about this plant, I suggest maintaining the specific status, according to the original description by Wale.

Sempervivum thompsonianum has apparently an interesting, very restricted distribution area, but this situation isn't so rare in the genus *Sempervivum*. Maybe the distribution of *Sempervivum thompsonianum* is a consequence of its ecology, which allow it to grow only on certain types of rock.

Sempervivum thompsonianum is similar to other two species of *Sempervivum*: *Sempervivum macedonicum* and *Sempervivum octopodes*; in particular it's very similar to *S. octopodes*, so much so that if you take a close look at them, you would probably say that *thompsonianum* appears to be a strange *S. octopodes*.



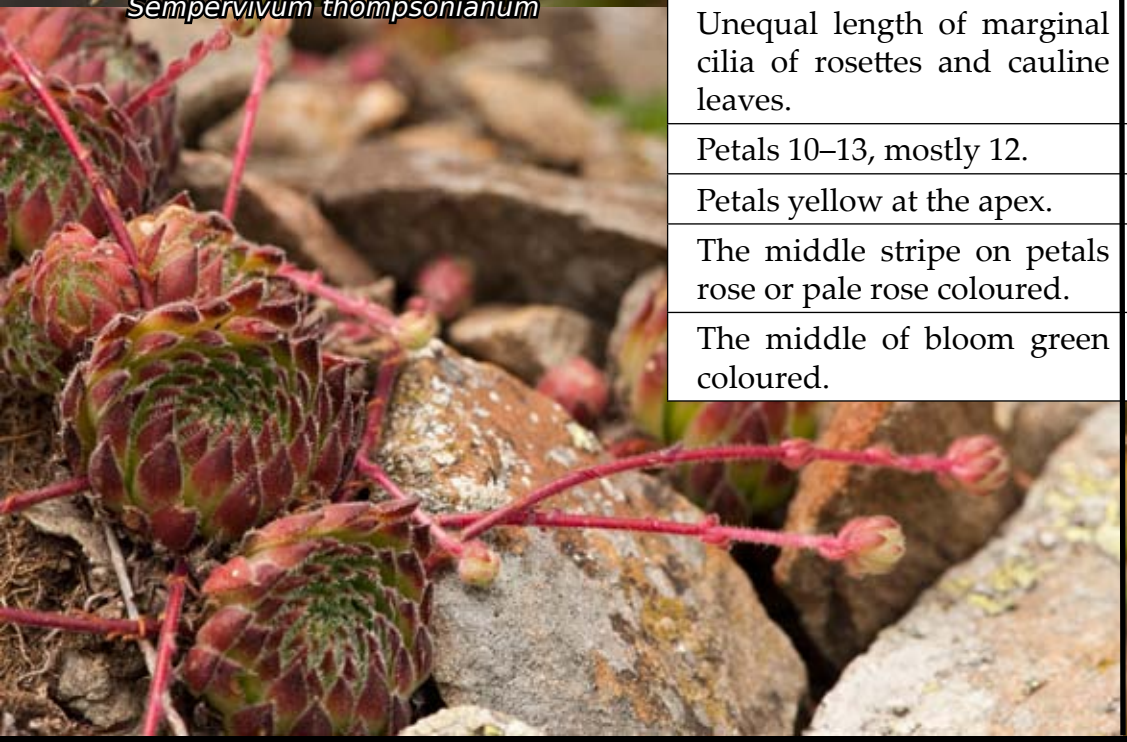
Sempervivum thompsonianum

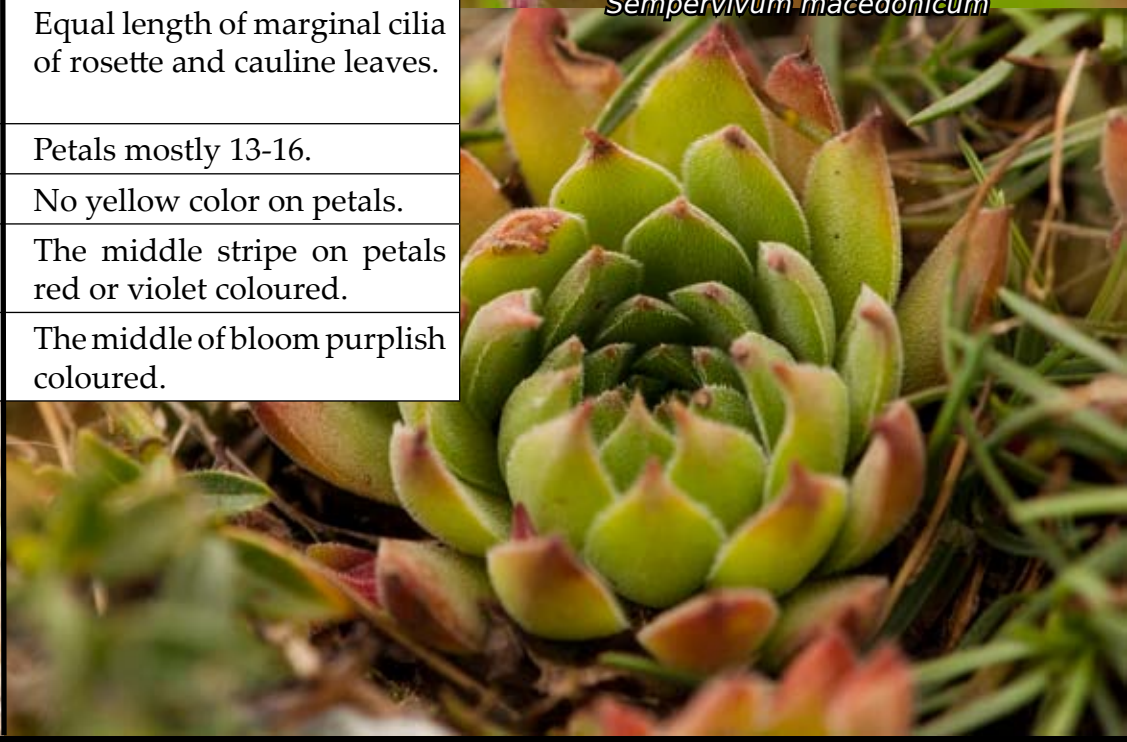


Sempervivum macedonicum

The most important differences

Sempervivum thompsonianum	*Sempervivum macedonicum*
Smaller rosettes (mostly 10-30 mm).	Bigger rosettes (mostly 30-60 mm).
Longer offsets (mostly 40-80 mm).	Shorter offsets (up to 65 mm).
Offsets thin.	Offsets thicker.
Rosette leaves pubescent on both sides.	Rosette leaves densely glandular hairy on both sides.
Unequal length of marginal cilia of rosettes and cauline leaves.	Equal length of marginal cilia of rosette and cauline leaves.
Petals 10–13, mostly 12.	Petals mostly 13-16.
Petals yellow at the apex.	No yellow color on petals.
The middle stripe on petals rose or pale rose coloured.	The middle stripe on petals red or violet coloured.
The middle of bloom green coloured.	The middle of bloom purplish coloured.

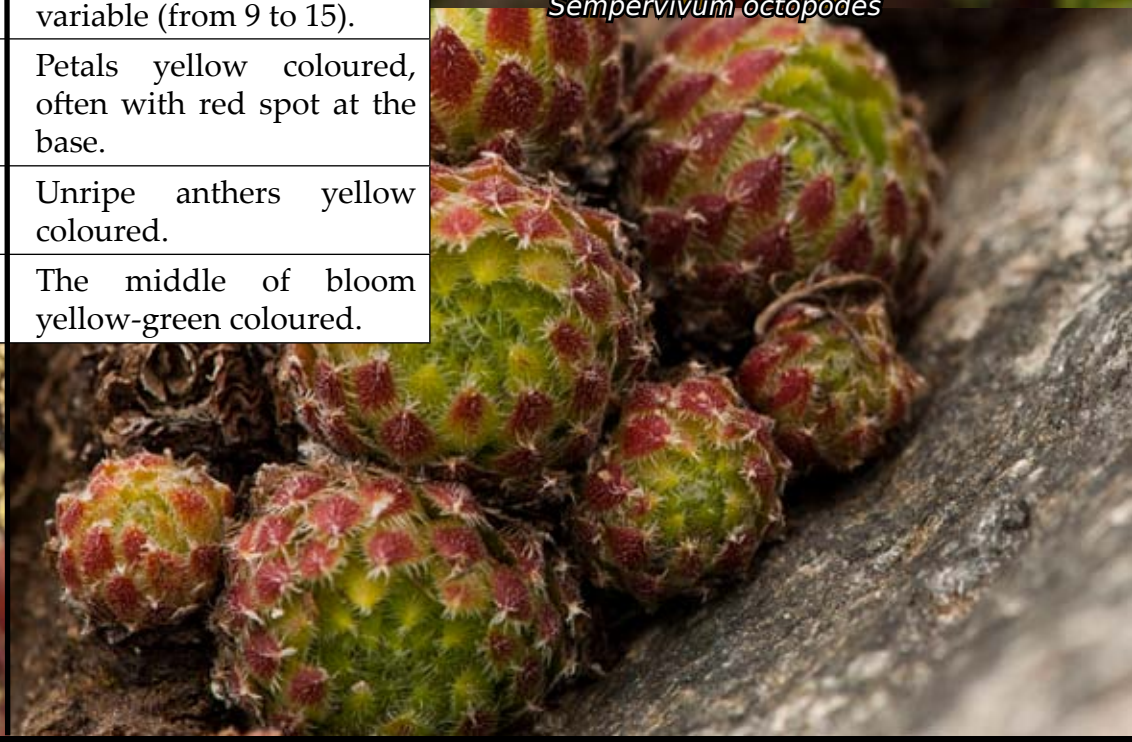




Sempervivum thompsonianum

Sempervivum octopodes

Sempervivum thompsonianum	*Sempervivum octopodes*
Long apex of rosette leaves.	Short apex of rosette leaves.
Shorter marginal cilia of rosette and cauline leaves.	Longer marginal cilia of rosette and cauline leaves.
Inflorescence from 14 to 20 flowered.	Inflorescence often to 12 flowered.
10-13 petals (mostly 12).	Number of petals very variable (from 9 to 15).
Petals rose colored with white margins, yellow only at the apex.	Petals yellow coloured, often with red spot at the base.
Unripe anthers rose coloured.	Unripe anthers yellow coloured.
The middle of bloom green coloured.	The middle of bloom yellow-green coloured.



I found the natural habitat of *Sempervivum macedonicum* in the vicinity of Stogovo mountain, but I didn't find habitats of any other species of genus *Sempervivum* close to the natural habitat of *Sempervivum thompsonianum*.

As I reported before, a large number of plants of *Sempervivum thompsonianum* grow on Stogovo. I observed variability only in the length of the cilia on the leaves and in the colour of the rosette leaves. The morphology of the flower is the same. In my opinion this testifies against the speculation of a hybridogeneous nature of this plant.

In the locations of *S. thompsonianum* on the southeastern slope of Mount Stogovo another houseleek is present: *Jovibarba heuffelii*, which is not a *Sempervivum* stricto sensu and these plants are not interfertile.

Conclusion

I hope this article, where I report my experience in habitat, will help to solve the mystery of *Sempervivum thompsonianum* and will be the incentive for new botanical trips and researches on Stogovo planina, a wonderful place seldom visited by tourists.

Last but not least, *Sempervivum thompsonianum* is a really nice plant, not so common in the collections of succulent plant growers. If you have the opportunity to grow this plant then try it, but don't forget that it doesn't like wet soil, in which it rots quickly. ■

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First observations of *Opuntia* 'Papiki' as allochtonous in Iberian Peninsula

par Daniel Guillot Ortiz, Emilio Laguna Lumbreras & Jordi López-Pujol

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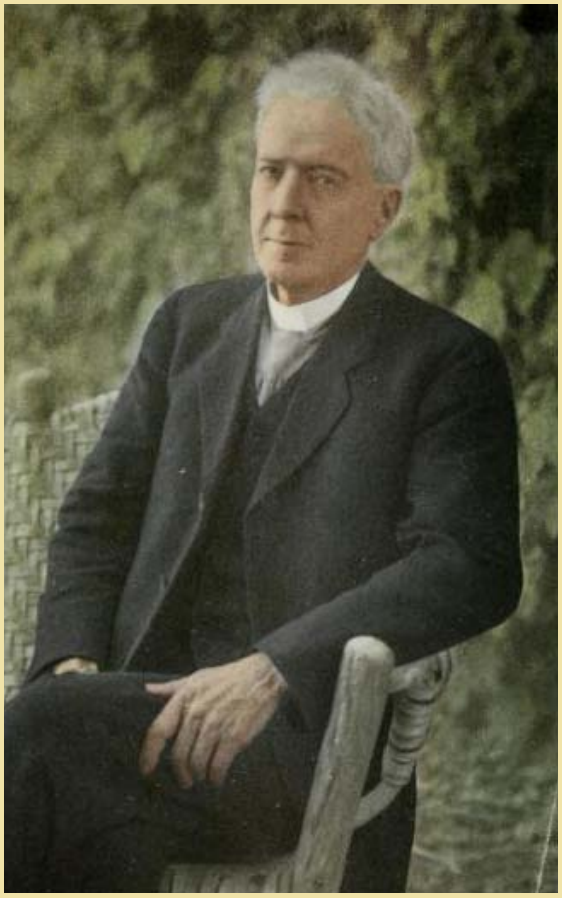
In this paper we report on an allochthonous and potentially invasive presence in Spain, one of the *Opuntia* cultivars, namely "Papiki", originally selected by Luther Burbank and marketed in the early twentieth century.

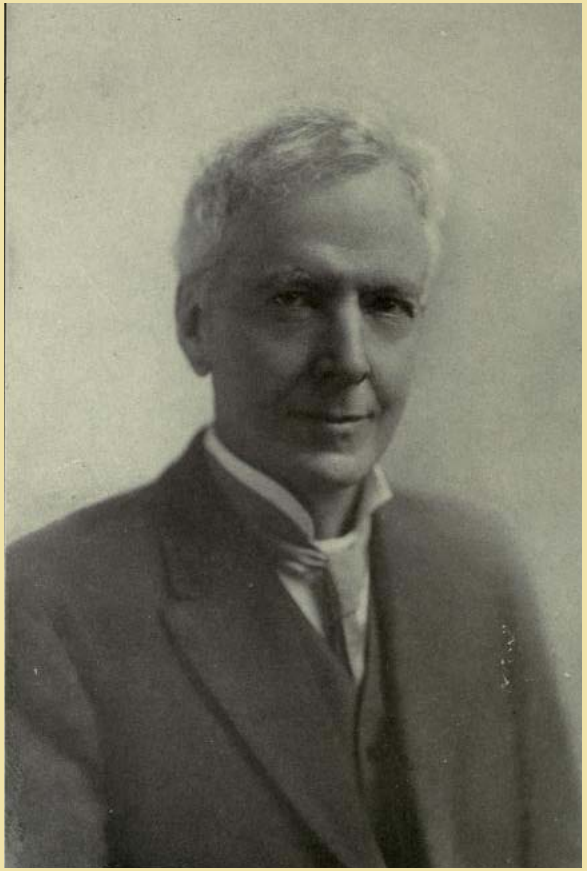
Opuntia **'Papiki'**

About Luther Burbank (1849-1926)

Probably one of the best known growers of the end of the 19th century and the first half of the 20th century (the period during which he worked on the genus *Opuntia*, the subject of this article, is unknown), Luther Burbank "*was once widely acclaimed to be America's most famous horticulturist and plant breeder*" (Stansfield, 2006), and during the second half of the 19th century and the first quarter of the 20th century "*no other name has so clearly focused public attention on the role of selection and geographical origin in the creation of new plant forms*" (N. Vavilov, tomado de Crow, 2001).

Burbank was born and raised in Massachusetts (Howard, 1945) where, at the age of 22, he began truck-gardening and selling his vegetables at a local market (Stansfield, 2006). In 1873, Burbank found a very rare pod of seeds on an 'Early Rose' variety of potato plant. He planted all 23 seeds, grew 23 seedlings, and selected two of the best. He propagated one cluster asexually and named it the Russet Burbank. Over 100 years later, it was still the most widely grown potato in the United States, albeit under different names (Stansfield, 2006). Looking for a more equitable climate than Massachusetts, he moved to Santa Rosa, California in 1875 and established a nursery there in 1877 (Stansfield, 2006). Some say that, after his arrival in Santa Rosa, Burbank found "enough new and curious plants … to set a botanist mad" (Dreyer, 1993). He brought 10 of his potatoes to Santa Rosa and continued propagating them for sale. He bought seed and plants from sources elsewhere (sometimes from nurserymen in foreign countries) and propagated the plants for sale, locally at first, but as his reputation grew, eventually nationwide and internationally (Stansfield, 2006). He claimed that in his plant-breeding programs, he often made crosses between different varieties of a species (sometimes even between closely related species) in order to disrupt in the hybrids inherited tendencies from the parents (Stansfield, 2006). First-generation hybrids tended to be intermediate for many characteristics (especially quantitative ones with complex heredity), but Burbank recognized that some traits were like those of one of the parents due to "prepotency of the life forces" (Dreyer, 1993). This was in 1893 before Mendelian dominance had been rediscovered. Rigorous selection of desired individuals (saving perhaps only one in a thousand plants) from the first generation produced parents for the second-generation hybrids, which usually had much





greater variability than the first generation (Stansfield, 2006). Sometimes backcrosses or additional hybridizations, together with continued rigorous selection in subsequent generations toward his ideal phenotypes, were often required to move the lineage in the direction he desired and to fix the traits (Stansfield 2006).

He had an uncanny ability to select, sometimes over many generations, for several traits simultaneously toward an ideal type that he envisioned at the start (Stansfield, 2006). Sometimes hundreds of grafts were made on the same tree, enabling Burbank to raise the entire progeny of a cross to maturity in only 2 years from the planting of the seed. He regularly sent out catalogs listing his newest products to potential buyers across the country (Stansfield, 2006). His ability to produce new varieties or improve old ones became legendary (Stansfield, 2006). Someone defined him as "wizard" (Dreyer, 1993). For example, it's important to report the note published under the title "*What Prominent People Say of Luther Burbank*", included in the book Luther Burbank's spineless cactus (Burbank, c. 1913a), by David Starr Jordan, president of the Leland Stanford Junior University: "Luther Burbank is the greatest originator of new and valuable forms of plant life of this or any other age". He was a popular hero, far and away the most highly publicized plant breeder of his time (Crow, 2001).

He was an appreciated horticulturalist and grower, and he generally followed scientific methods for his work, however they weren't recognized by science at that time, mainly because other authors had a lot of problems in deducting any information about his methods: Burbank never noted what he was doing (a "must" for a scientific study), since he was only interested in the results and not the actual process in obtaining them. As reported by Stansfield (2006) "*While Burbank enjoyed the company of many famous scientists and wanted to be recognized as an experimental scientist, he was not one himself*". He was a commercial nurseryman /seedsman/ horticulturist/ plant breeder who had to make a living by propagating existing varieties (sometimes importing them from foreign countries) or by creating new or improved plant varieties and offering them for sale.

He died in Santa Rosa in 1926 (Howard, 1945).

The literature by Burbank

The most important work by this author, in twelve volumes, is entitled "Luther Burbank: his methods and discoveries and their practical application". Written on the basis of his field notes on more than 100,000 experiments on numerous groups of plants and tested in more than 40 years. Under the editorial supervision of J. Whitson, R. John and H. S. Williams, these books are a mix of biography, descriptions of new varieties, colour photographs (1500, unusual at that time) and hagiography (Crow, 2001).

Other important works are:

- *New creations in fruits and flowers* (1893, ed. 2 1894)
- *Half hour experiments with plants* (c. 1922)
- *How plants are trained to work for man* (c. 1921)
- *Luther Burbank's spineless cactus* (c. 1913a, ed. 2 1914)

In his catalogues he included important information and descriptions about the new varieties obtained, in the middle between a mere catalogue (list of names) and a work belonging to the horticultural literature of that time, like many other European and North American catalogues of the 19th and the first half of the 20th centuries (e.g. the catalogue is entitled "*Twentieth century fruits*"; Burbank, 1911?).

The new varieties by Burbank

Burbank introduced over 200 varieties of fruits alone, consisting of 10 different apples, 16 blackberries, 13 raspberries, 10 strawberries, 35 fruiting cacti, 10 cherries, 2 figs, 4 grapes, 5 nectarines, 8 peaches, 4 pears, 11 plumcots, 11 quinces, 1 almond, 6 chestnuts, 3 walnuts, and 113 plums and prunes (Howard, 1945). Altogether, it is estimated that he was responsible for introducing between 800 and 1,000 plants to American horticulture and agriculture (Stansfield, 2006). He obtained his results thanks to several techniques: he selected the best plantlets obtained from an enormous number of plants, he imported interesting specimens from all over the world, made many cross-pollinations between varieties and species, grafted many plants and employed vegetative reproduction in order to maintain the genotype of particular plants obtained. Probably his major contribution to science was the discovery of true hybrids not segregated, like the crossing between strawberry and blackberry, later demonstrated as amphyploids. He can be considered a pioneer of the creation of new species with this technique.


NEW CREATIONS
IN
Fruits and Flowers,
JUNE, 1894.

PRICE: 25 CENTS.

BURBANK'S EXPERIMENT GROUNDS,
Santa Rosa, California, U. S. A.

Office and Residence:
204 Santa Rosa Avenue.

Cable Address:
"Burbank, Santa Rosa, Cal."

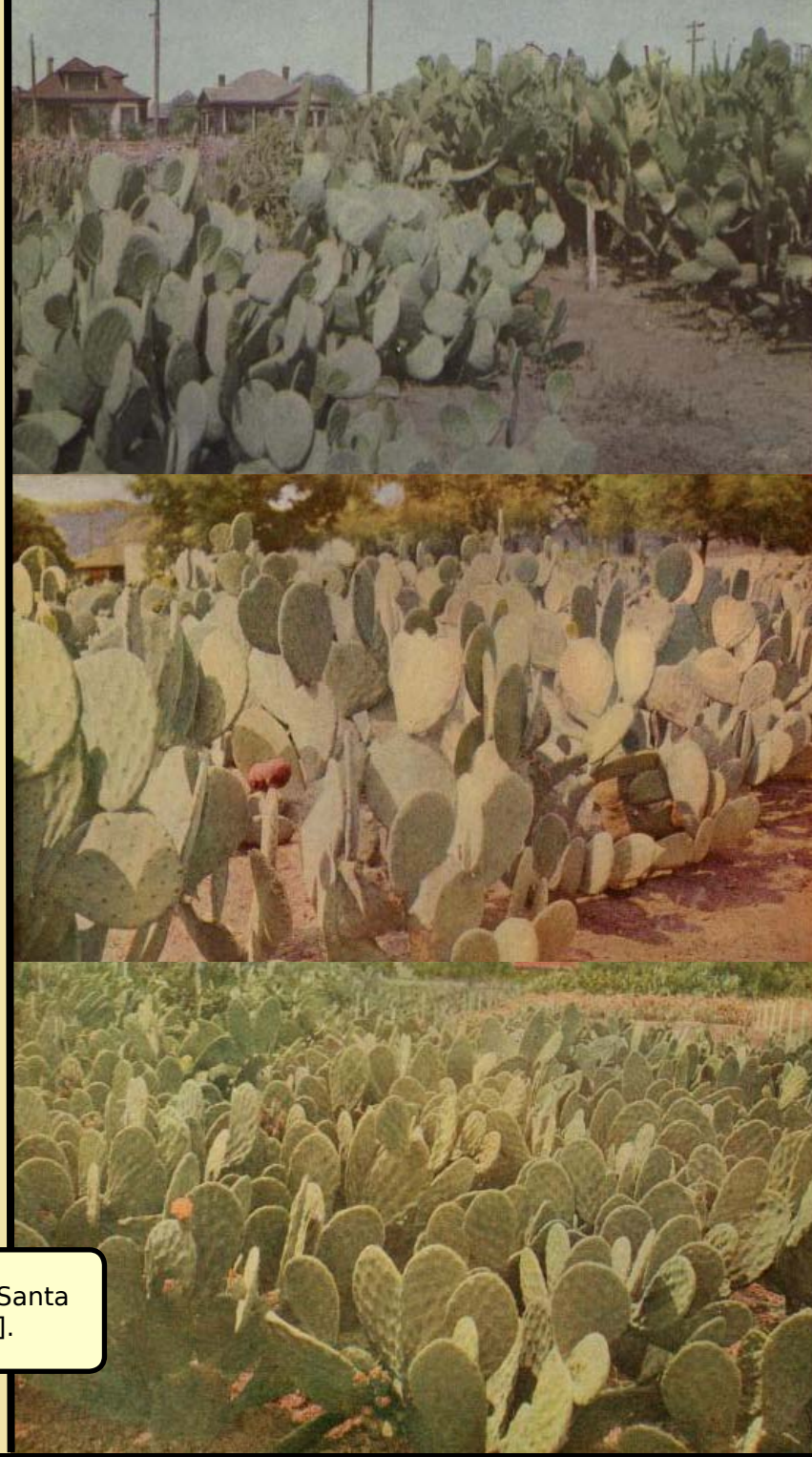
The cultivars of *Opuntia* by Burbank

Burbank obtained a lot of varieties of *Opuntia*. For several years he maintained a huge collection of cactus species, mostly belonging to the genus *Opuntia*, which he assembled from various parts of the world. Perhaps the largest number of forms came from Mexico (Howard, 1945). Over a period of twenty years, more than 60 varieties, mostly the product of selection or hybridization, were offered for sale, some being recommended for their fruit, some exclusively for forage, and still others for both purposes (Howard, 1945).

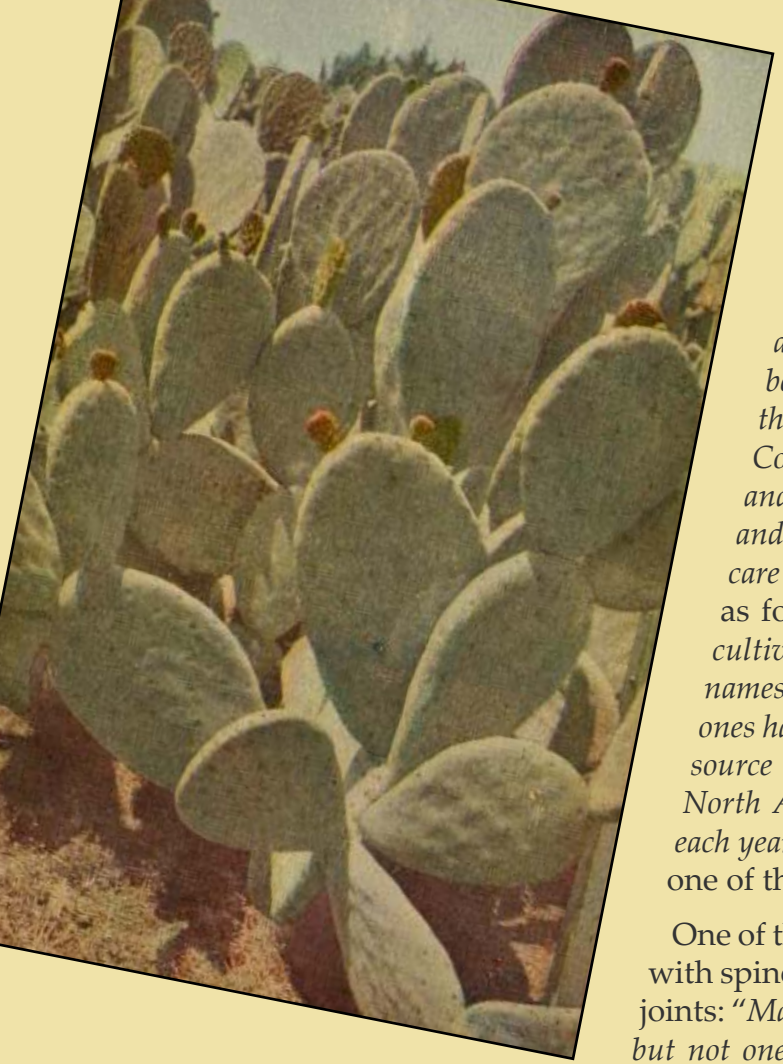
Burbank (c. 1913b) described the beginning of his experience with cacti, reporting that "*For more than fifty years I have been quite familiar with thornless cactus of many species and varieties. In fact, one of the first pets which I had in earliest childhood was a thornless cactus, one of the beautiful* Epiphyllum".

He reported also "*The best botanists, even those who have made the Opuntias a special study, declare it to be one of the most difficult genera to classify, as new forms are constantly appearing and the older ones so gradually and imperceptibly merge together*".

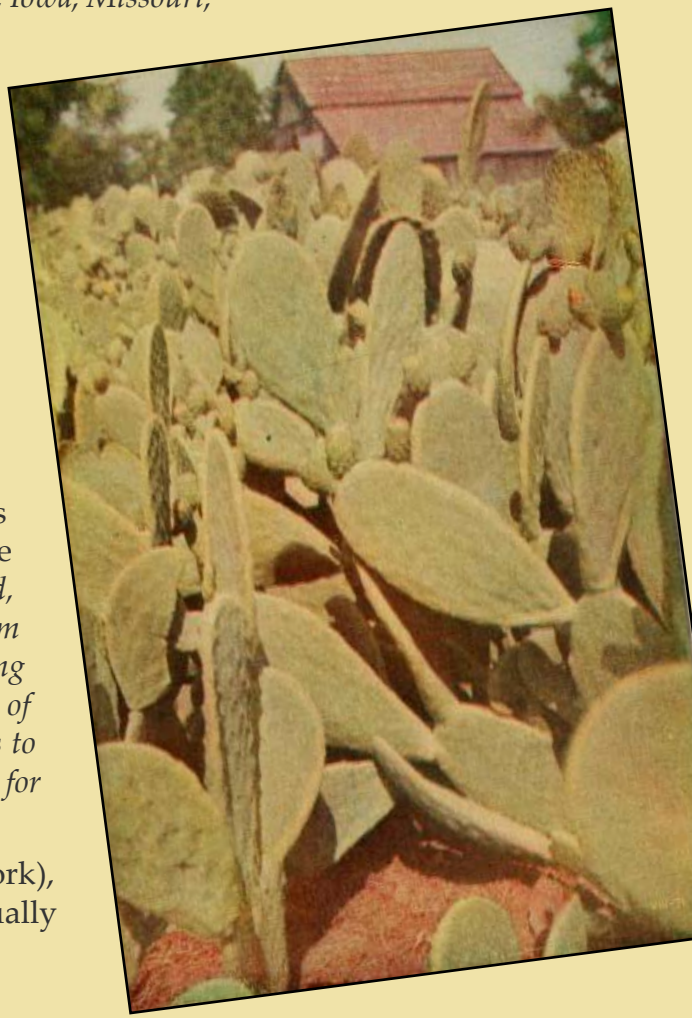
The author dedicated in-depth work to this genus of plants. "*Some seventeen years ago, while testing the availability of a great number of proposed forage plants from the various arid regions of the world with a view to the improvement of the most promising, I was greatly impressed with the apparent possibilities in this line among the Opuntias, which from their well-known vigor and rapidity of growth, easy multiplication and universal adaptability to conditions of drought, flood, heat, cold, rich or arid soil"* decided to place them ahead of other cacti, in terms of priority: *"both as forage plants and for their most attractive, wholesome and delicious fruits, which are produced abundantly and without fail each season"* (Burbank, c. 1913b).



Old photos of Burbank's experimental cultivations at Santa Rosa in California [on this page and the following one].



The origin of the species and varieties which Burbank exploited in his selection experiments were obtained from many places. "*By my collectors and others, for the earliest experiments in this work, the best Opuntias from all sections of Mexico, from Central and South America, from North and South Africa, Australia, Japan, Hawaii and the South Sea Islands, were secured. The United States Agricultural Department at Washington, through my friend, Mr. David G. Fairchild, also secured eight kinds of partially thornless ones for me from Sicily, Italy, France and North Africa, besides a small collection of Mexican wild thorny ones which were in the Government greenhouses at the time. Besides these I had the hardy wild species from Maine, Iowa, Missouri, Colorado, California, Arizona, New Mexico, Dakota, Texas and other States. All these were grown and their agricultural and horticultural values studied and compared with great care*". They were varieties often grown for a long time as food in these areas: "*Some of these ... have been locally cultivated for ages, but have never received specific horticultural names or descriptions, though the fruits of these and the thorny ones have long been used extensively as food and are the principal source of food for millions of human beings in Southern Europe, North Africa, Mexico and other lands, for about three months in each year*" (Burbank, c. 1913b). A good exemple is 'Anacantha', one of the best cultivars he obtained.



One of the main aspects of his work was the creation of varieties with spineless fruits, good for food, and with spineless and edible joints: "*Many so - called thornless or partly thornless ones were obtained, but not one among the thousands from all these sources was free from thorns and spicules, and even worse, those which were the most promising in these respects often bore the poorest fruit, were the most unproductive of fruit or produced less fodder, or were less hardy than the wild thorny species and varieties. The first work was to select the best of these, cross them, raise numerous seedlings, select the best of these and so continue hoping for improvement*" (Burbank, c. 1913b).

Some of the fruiting varieties bore vicious spines (as in the case of the variety 'Papiki', cited in this work), while others were almost (if not entirely) spineless. Forage varieties, on the other hand, were usually devoid of spines, or practically so (Howard, 1945).

Invasive, dangerous plant

Burbank hybrids have a long history as invasive plants. Nobel (1998) reports that in 1914 tons of jointsof Burbank spineless prickly pear were shipped to Australia as forage for animals. The plants grew well, flowered and produced viable seeds; unfortunately these seeds produced armless plants but also spiny plants, similar to their ancestors. Spiny plants were not consumed by cattle or sheep, so they started to invade the land. In 1925, in Eastern Australia, prickly pears including *O. stricta* (Haw.) Haw., *O. ficus-indica* (L.) Mill and *O. vulgaris* Mill. were invading new land at an approximate rate of 100 hectares (250 acres) per hour. They infested about 10 million hectares, mainly in Queensland. This author also reports that this happened in South Africa too, where in the early twentieth century (1914) the spineless Burbank cultivar of *O. ficus-indica* (the author does not specify any cultivar name) was introduced as forage, and also as an ornamental and hedging plant. Once naturalized, the progeny of these plants produced spines from the areoles, just like its ancestor.

It's important to report that the cultivars by Burbank had to be reproduced vegetatively, as reported by the author in the article "How to grow the Burbank spineless cactus" (Burbank, c. 1913c) published in the work Luther Burbank's spineless cactus: "*Cactus should always be raised from cuttings, never under any circumstances from seed, as it always runs back to the thorny kind when grown from seed, but never when grown from cuttings*".

Opuntia **'Papiki'**


Opuntia **'Papiki'**

The cultivar 'Papiki'

A few years after Burbank's death, most of his varieties and names were lost, as reported by Howard (1945): "*A few of the fruiting kinds deserved to survive and indeed may yet be found in numerous private gardens throughout the milder parts of California; but nearly always the variety name has been lost*".

Recently (in 2008), Roy Wiersma published his important work, "Luther Burbank spineless cactus identification project", which resulted in the intention of this author to find and grow again the cultivars sold in the first decades of the 20th century by Luther Burbank. In this work, Wiesma reports on all the information available in the works and catalogues by the grower, where the morphological characters, hystory, etc. of the various cultivars are reported, as well as showing photographs of them.

In one of these images it's possible to observe a specimen with characteristic spines and areoles: typically whitish, three per areole, slightly curved, corresponding to the cultivar 'Papiki', about which Wiersma (2008) reports "(1907). No official Burbank listing for sale", and "Obtained November 29, 2005, from Vista, California. While I have not found that Luther Burbank sold this variety (see 'Marin' for description), he did mention it as being one good for fruit. This was imported into Hawaii in 1791 along with 'Marin'. 'Yellow Panini' is the current name ascribed to [#72] and it's likely to be 'Papiki' among other reasons since the fellow I got my piece from originally obtained his piece from Hawaii. I have found no labelled photographs of 'Papiki'".

As reported by Wiesma, it's cited in the chapter dedicated to 'Marin', the other variety introduced in Hawaii: "Another variety called 'Papiki' which means cattle-pen, was introduced by Sr. Marin at the same time and is quite common, and though very heavily armed wth spines is often eated by various domestic animals".

Opuntia 'Papiki' now in Iberian Peninsula

Opuntia 'Papiki' is the second *Opuntia* cultivar sold by Luther Burbank which escaped from cultivation and is now naturalized as allochthonous in Spain, the first was the cultivar 'Titania' (reported by Guillot, as 'Santamaría', in 2003):

- [Valencia] 30SYJ8221, Godella, road margin, 75 m, 28-III-2001; 30SYJ1197, Olocau, road margin, 430 m, 7-V-2002.

And by Guillot & Laguna in 2013:

- [Valencia] 30SYJ0688, Liria, 245 m, in an area of scrub, located between the city center and the monastery of San Miguel, together with other species belonging to the tribe Opuntioideae, as *Cylindropuntia spinosior* and *Opuntia ficus-indica*. E. Laguna, 9-VI-2013).

We observed a 'Papiki' in Valencia in:

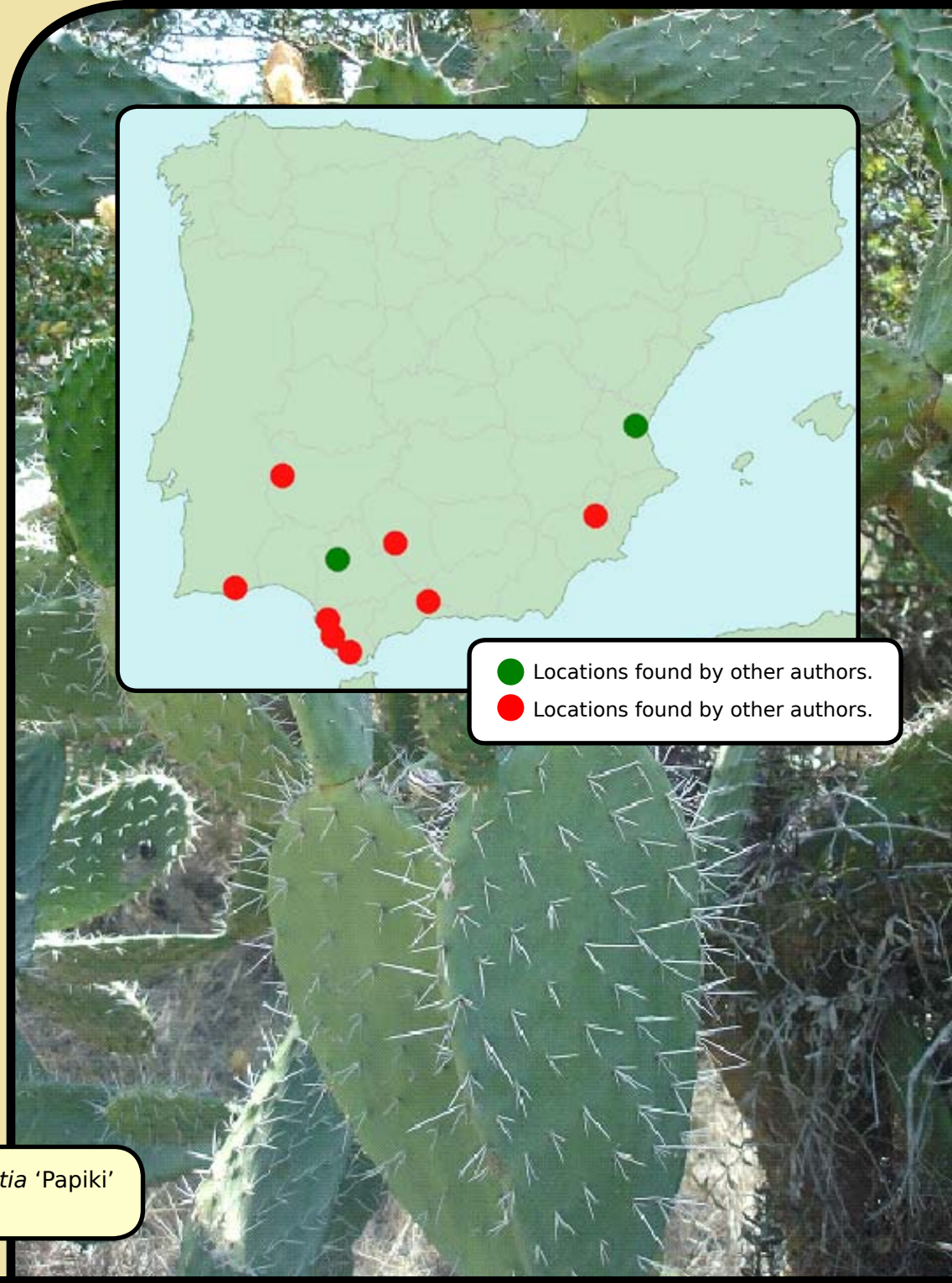
- [SEVILLA] 29SQB6160, Guillena, en los márgenes de la carretera A-460, a la salida del pueblo en dirección Burguillos, 37 m. J. López-Pujol. 7-VII-2014.

- [Valencia] 30SYJ2079, Godella, near the Campolivar urbanization, 120 m. D. Guillot. 4-V-2014.

We also found pictures of specimens which probably belong to this cultivar:

- On the Biodiversidad Virtual website (http://www.biodiversidadvirtual.org/) in Cádiz, by Sanchez (2012): "Cultivated and naturalized in scrubland".

- Rubal (2013a): "Pine forests on coastal dunes" (Bahia de Cadiz: Coastal Pines and salt).



Distribution map of *Opuntia* 'Papiki' in Iberian Peninsula


Opuntia **'Papiki'**

- Rubal (2013 b): "Grasslands, hedges" (Bahia de Cadiz Natural Park).

- Rubal (2013 c): "Pasture" (Bahía de Cádiz Natural Park).

- Rubal (2014): "Pine forests on calcareous rocks" (Pinar de Rancho-Linares Puerto de Santa María).

- Ramirez (2011): "Weed grassland".

- Ramirez (2012): "not cultivated park" (orange flower) [Sevilla]

- Zafra (2012) [Córdoba] "plant about 3 feet tall", "Boundaries, vacant land" (in El Arrecife, Córdoba, J. Zafra, pers. comm.).

- Crespo (2012) [Badajoz]: "Old abandoned land" (very close to Bajadoz City, growing in an abandoned farm, close to an urbanized area, J. M. Crespo, pers. comm.).

Visiting the Anthos website in 2014 (http://www.anthos.es/) we found photos of 'Papiki', for example:

- Aedo (2006) "Murcia: Sierra de la Pila, San Joy, 38°14'22'' N, 01º14'00'' W, 575 m, C. Aedo (26-XI-2006)".

- J. Ramirez (2013) "España, Málaga: Colmenar".

We can see images of specimens that probably correspond to this cultivar in other countries, for example in the United States, in Hawaii (Starr & Starr, 2014).

In EOL we found an image from Algarve, Portugal by Foden (2014) and by Jacinto (2014) (Algarve, photo taken on December 16, 2006), which corresponds to 'Papiki'.

Probably the specimens showed by EOL in Sicily by Mercadante (2014) correspond to this cultivar "*Opuntia ficus-indica* (L.) Mill CACTACEAE Local.: Sicilia, Italia Ref. Fried, G. Guide des Plantes Invasives Belin,. 2012".

Conclusion

In our experience, this cultivar cannot be considered, as a dangerous, invasive plant in Spain. Where we found it, the specimens are healthy and big, but occur in limited amounts, covering rather restricted areas, at least currently. The main problem of the presence of this cultivar concerns the dangerous spines which cover its stem. ■

Aknowledgements: To Jesús Manuel Crespo Martín, Jesús Sánchez and José Zafra Mohedano for the valuable information they have provided us about the location of some of the specimens of *Opuntia* 'Papiki'.

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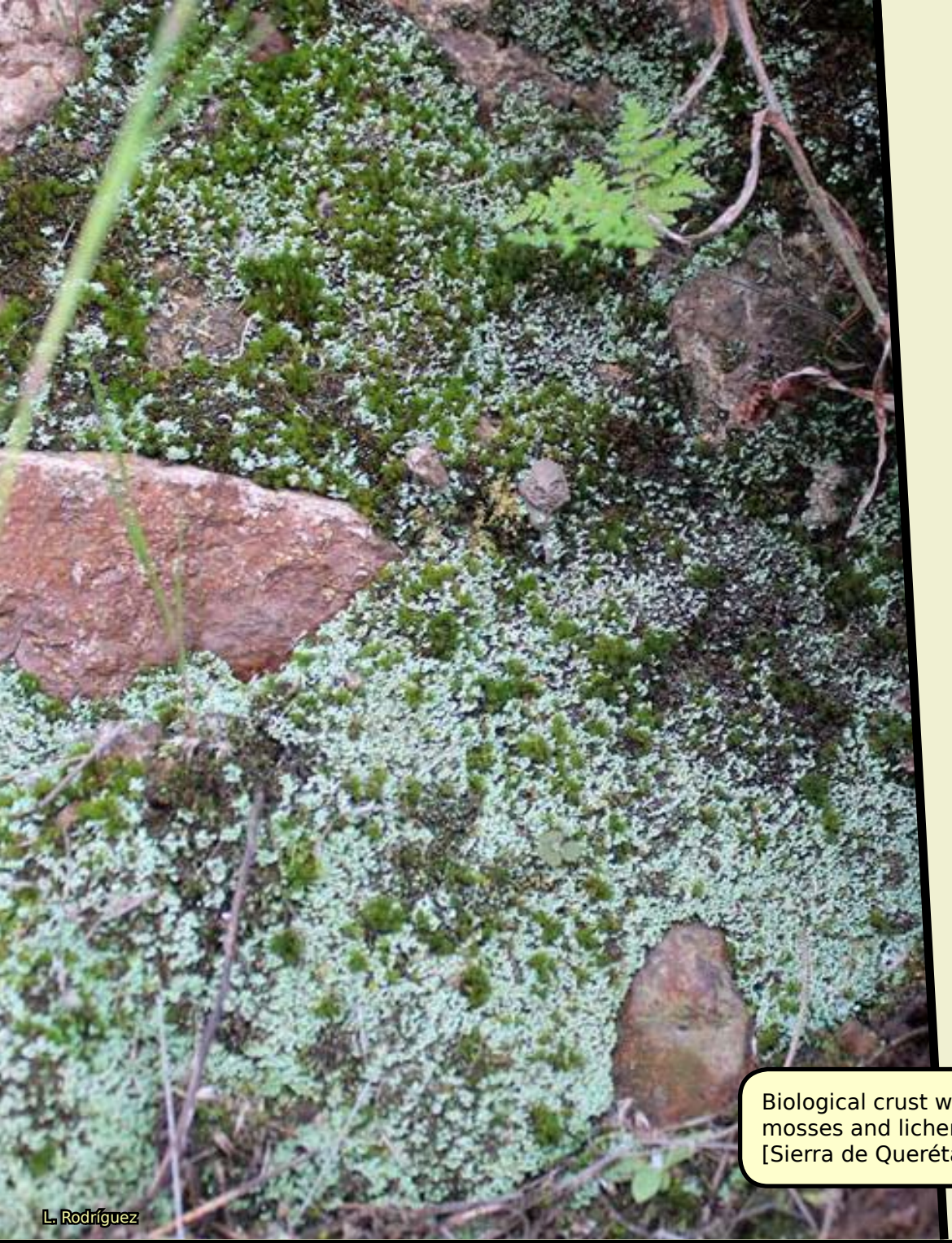
The biological crust of the soil: much more than sand

by Gabriel Millán



Biological crust with mosses and lichens [Sierra de Querétaro]

L. Rodríguez

The surface of the desert hides microscopic cities; incredible communities inhabited by mosses, algae, lichens, fungi, bacteria and other micro-organisms. This tiny world is known as the biological soil crust (BSC) and is a complex system of associated and interacting living organisms. Many authors consider the BSC as a sort of barrier between the soil and the atmosphere, a border through which both the "worlds" develop innumerable ecological interactions.

This crust is present almost everywhere around the world, in desert, alpine and polar areas, and it has been estimated that the BSC covers around 40% of the terrestrial surface of the world. In countries like Mexico one can find it in mountainous areas but above all in the deserts, where it forms an often blackish layer which may eventually cover more than 70% of the soil surface. This layer is also variably coloured and it can vary from dark black to orange, with shades of brown, red, green and yellow, depending on its main biological component.

Although we usually imagine arid and semi-arid areas as desolate places with nothing but rolling balls of dry weeds, focusing our main interest on vascular plants, the fact is that deserts have complex systems of vegetation and a delicate ecological balance, with vascular but also non-vascular vegetation. Biological crusts are a part of this balance, occupying "blank" portions of the soil, where no weeds, cacti, agaves, yuccas, shrubs, evergreens or other plants live. Just as peel protects fruit pulp, the biological crust covers the soil of the desert, protecting it from erosion, and nourishing it too, thanks to complex chemical processes.

This crust, as mentioned above, is composed of a mixture of different organisms including fungi, algae, lichens, mosses, primitive bryophytes and cyanobacteria, some of which are capable of photosynthesis. Many micro-arthropods live inside the BSC, as springtails, mites and tardigrades. We can affirm that the biological crust is not only a complex of organisms which live together, but a symbiotic community in which every component gives benefit to the community and receives advantages from every other component.

Biological crusts with lichens and cyanobacteria.

***Pelecyphora strobiliformis* [Dr. Arroyo]**

Every crust is different

The BSC differs in various aspects, including the members which compose in higher proportions, as well as the species which this member belongs to. The most common crusts are composed of algae, lichens, fungi and cyanobacteria. This difference in composition is related, for example, to the type of soil, temperature, rainfall, altitude and location.

Since algae are considered pioneers, the crusts mainly composed of these organisms prepare the soil surface for the colonization of other entities, playing a crucial role in natural succession. In addition, these BSC protect the soil from erosion and help to fix it. They commonly occur in high, cold regions and deserts where the ground freezes and they are difficult to see without a microscope, but sometimes they give a green colour to the surface.

On the other hand, when lichens are the main element, the BSC are very characteristic, since these organisms show very specific colours and forms: some are green, red, brown, white and black; some of them grow like a sort of bark, some others form a blackish gelatinous layer, or they can show a three-dimensional aspect. They develop more slowly than mosses, and the distribution of this kind of crust is closely related to rainfall. They are widespread in Mexico, United States, Australia, etc.

In the case of BSC dominated by mosses, the pH and clay content of the soil are crucial for their growth. They occur most frequently in wetter microclimates in arid and semi-arid areas, such as under shrubs, in cracks of the rocks and at the base of rosette-shaped plants.

The BSC composed of cyanobacteria have a worldwide distribution, being one of the crusts with a higher resistance to extreme conditions of humidity and temperature. Usually blackish, they have a characteristic and a cement-like consistency, which helps to prevent erosion.

Pelecyphora aselliformis (left) and *Ariocarpus retusus* (right) growing in biological crusts of cyanobacteria.

P. Nájera

C. Velazco

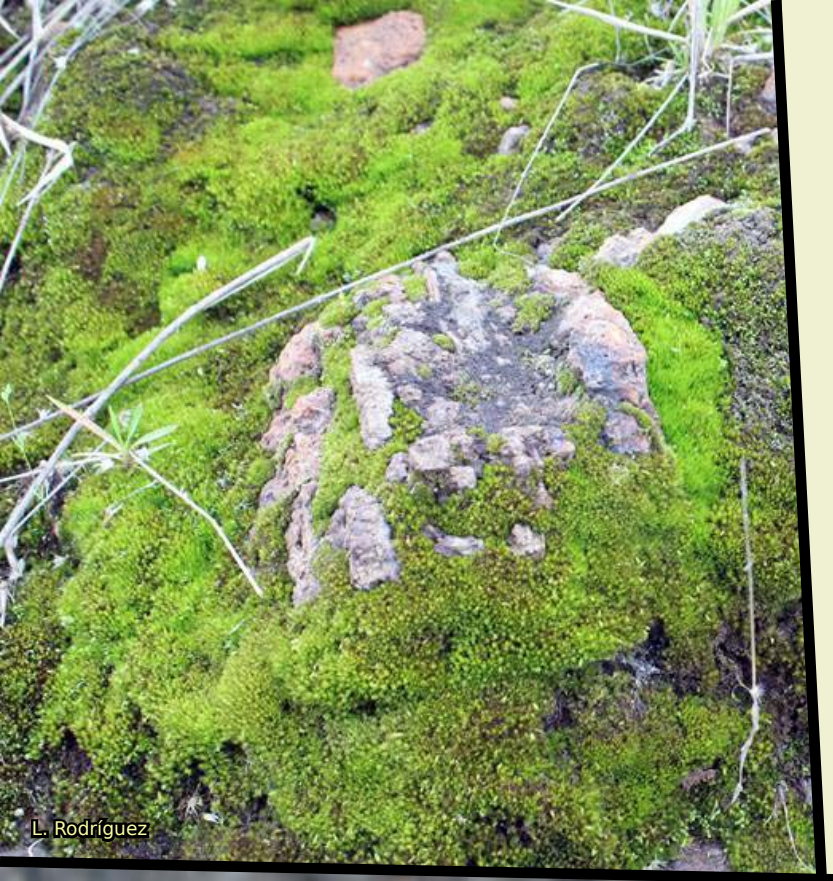
A fundamental crust for the soil and for plants

Until a couple of decades ago, biological crusts of the soils had not been investigated in-depth and their importance for ecosystems was little known, but in the past 20 years the attention given to these natural communities has increased. Thanks to much researche on them, we now know their importance for the ecosystems.

These studies demonstrated that the BSC forms a barrier that protects the soil against erosion by water, air and, in some cases, animal trampling. This cementification process involves compoents of the crust such as lichens, which give stability to the ground thanks to filaments called hyphae, and cyanobacteria, which produce a sticky substance that helps to "cement" the soil surface. Together with algae and mosses, these organisms form a sort of net in which organic and mineral particles settle, so the job of this "team" makes possible the formation of such a characteristic layer.

The investigations on these communities of microorganisms have also revealed their importance for soil fertility and for the survival of plants. Just as humans, plants need water and nutrients for their development, elements that are often scarce in the desert. Biological crusts are, for this reason, very important: first of all, they increase the capacity of the soil to absorb and maintain water, also retaining moisture on the soil surface, then cyanobacterias process the nitrogen dissolved in the air into the crusts, fixing it into the soil as nitrogen available for plants. In addition, they enrich the soil with phosphorus, carbon and potassium. The combination of moisture and nutrients brought by the biological crust helps in the germination of seeds and the subsequent growth of seedlings of both large and small plants.

***Ariocarpus kotschoubeyanus* [La Morita]**


L. Rodríguez

The BSC are very important for cementing soil: thanks to the substances produced, they harden and consolidate the particles of sand and other minerals together. In addition, BSC plays an important role in the hydrological cycle, since they allow greater soil infiltration that helps maintain moisture. This moisture is also related to another of the great contributions of BSC to the ecosystems: the apportation of nutrients to the soil. It has been demonstrated that BSC engages primarily in two processes, nitrogen fixation and the carbon cycle. However, it has been demonstrated that they also influence the amount of organic matter and the level of manganese, calcium, potassium, magnesium and phosphorus available in the soil which they cover.

Considering that nitrogen, cyanobacteria and cyanolichens of the biological crusts have the ability to capture atmospheric nitrogen, fixing and reducing it to ammonium available for vascular plants, leaving it into the soil in a matter of minutes or hours. In desert and semi-desert ecosystems the main nitrogen fixation is carried out by the BSC communities, and the entity of the process is a function of temperature, light and humidity. With regard to the carbon cycle, biological crusts fix atmospheric carbon through photosynthesis by cyanobacteria and cyanolichens, then release it into the soil through leaching and decomposition. These processes are essential to increase soil fertility. Like nitrogen, the carbon cycle exploited by BSC depends on factors such as humidity and temperature

Turbinicarpus schmiedickeanus inside a biological crust of cyanobacteria and lichens.

P. Nájera

Ferocactus latispinus on a biological crust of cyanobacteria [Soledad Graciano]

C. Velazco

L. Rodríguez

Biological crust with mosses and lichens [Sierra de Querétaro]

The long, hard recovery of this superficial layer

The formation of the biological crust on the soil is a slow and complicated process, which involves many elements, so its recovery is difficult and very slow when it's damaged. The crusts are entities which can be damaged by environmental and physical factors, such as the impact of animal and people trampling or vehicles passing, fires, invasive species, pollution, garbage and chemical waste, agriculture, etc. When the crust is damaged or removed, the soil is bare, exposed to erosion and deprived of nutrient supply. Depending on the entity of the crust affected, it's estimated that lichens and cyanobacteria need 35 to 65 years to recolonize the surface of the soil, while mosses need about 250 years to retake their place.

Proper grazing management by restricting the transition zones of cattle and their grazing areas can be one of the first actions to be applied in order to allow the restoration of biological soil crusts.

Ariocarpus retusus **[Dr. Arroyo]**

P. Nájera

Disturbed area in a biological crust of cyanobacteria [La Morita]

Thelocactus hexaedrophorus [Dr. Arroyo]

Lophophora koehresii [La Morita]

Ariocarpus kotschoubeyanus

***Coryphantha maiz-tablasensis* [La Morita]**

Visiting the crust

In 2013 I took part in an expedition to various localities in the desert of the Mexican state of San Luis Potosi, together with some friends who asked me to join the trip. Looking for some *Turbinicapus* Buxb. & Backeb., on the second day we visited La Morita, where we camped along a dirt road on the bed of an ancient, dry lake.

When we got out of the van, Pedro, the guide, said that we were in the right place for *Ariocarpus kotschoubeyanus* (Lem.) K.Schum: walking around a bit we found several specimens of A. *kotschoubeyanus* emerging from biological crusts produced by cyanobacteria, not far from some *Echinocereus cinerascens* Lem., that were growing mainly in the shade of some bushes. After a night spent under a starry sky, the next day we explored the place in detail: we found many other specimens of *A. kotschoubeyanus*, growing beside *Lophophora koehresii* (Říha) Bohata, Myšák & Šnicer and *Coryphantha maiz-tablasensis* Fritz Schwarz (solitary or clustering); all species were evidently enjoying the benefits granted by biological crusts. Walking along the lake bed, we noticed that the cyanobacterial crusts were fragmented, showing serious deterioration: we could evaluate in this way the damage done by human and livestock trampling (and vehicles) caused at the soil surface, since they had broken and fragmented the crust, allowing erosion by water and air.

Disturbed area in a biological crust of cyanobacteria [La Morita]

***Ariocarpus kotschoubeyanus* [La Morita]**

We left the place and reached the road to Las Tablas, in search of *Turbinicarpus lophophoroides* (Werderm.) Buxb. & Backeb. Several kilometres further on, Pedro took another dirt road that ended on a plain where the soil was whitish with darker shades. Just out of the car, we found *Coryphantha maiz-tablasensis* again and, at last, *T. lophophoroides* growing on saline soil covered by a thin layer of blackish biological crust. Then, leaving the place, on a flat area close to the locality of Dr. Arroyo (Nuevo Leon), I also observed a similar biological crust, but the species of cacti growing there were dfferent: I found *Thelocactus hexaedrophorus* (Lem.) Britton & Rose, *Ariocarpus retusus* Scheidw. and *Pelecyphora strobiliformis* (Werderm.) Frič & Schelle ex Kreuz..

During this short journey I saw just a few examples of the various BSC in desert areas, however, it's already clear that BSC are essential for germination, establishment, nutrition and development of vascular plants which grow on flat areas but also in most of the desert biotopes like cacti It's evident that their disruption may have serious consequences for the survival of many species and also on the ecological balance, hence conservation and, better still, restoration of the biological crusts of the soil is fundamental for the desert ecosystem.

***Turbinicarpus lophophoroides* [Las Tablas]**

Coryphantha maiz-tablasensis [La Morita]

Echinocereus cinerascens
Coryphantha maiz-tablasensis [La Morita]

Lophophora koehresii [La Morita]

The importance of human attention

For the above mentioned reasons, next time you walk in the desert, please remember that the crust you are trampling on is a huge community of microscopic organisms which live together, and each of them is very important for the crust but also for the survival of the entire ecosystem, and please pay attention to avoid any unnecessary damage. ■

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Editor's note:

In his paper, the author focuses on the biological crusts of the Mexican desert soils, while pointing out the ubiquity of these structures, which can be found at all latitudes and in varied environments. Under the European latitudes, it is probably in the sandy environments of the dunes and back-dunes that you can see the finest examples of quasi-continuous biological crusts covering the sands over considerable areas in close association with vascular plants.

This photo (taken on the Atlantic coast) shows such a biological crust involving mainly bryophytes and lichens. Note the regular spacing of clumps of vascular plants on this mat, richly coloured emerald green and red-brown during the winter (time of the photo) which becomes blackish-gray in summer, this colour has also given its name to this type of biological community: the "gray dune".

In such an environment, a *Crassulaceae* is particularly abundant: *Sedum acre*.

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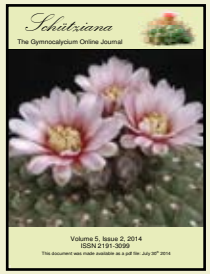
Die rätselhaften Früchte der Sansevierien / Madagaskar und seine Sansevierien / die Gattung *Sansevieria*, nom.cons. (Liliaceae) / *Sansevieria roxburghiana* von der Koromandelküste / *Sansevieria* - ein persönlicher Weg dazu..



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Xerophilia 3(2) / n° 9 [2014-06]

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Ariocarpus kotschoubeyanus / Sierra Corral los Bandidos / Ariocarpus agavoides and A. kotsch. var. albiflorus / Biosphere reserve / Turbinicarpus pseudomacrochele ×horripilus / A new Mammillaria / Turbinicarpus viereckii subsp. reconditus / Aztekium valdezii / Peru / African tour / Turbinicarpus mandragora / Little opuntioids / Crassula rubricaulis in NZ / variegated Carpobrotus edulis / Sedum fuscum.

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