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## Content

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Wick, Mario	<b>Editorial</b>	p. 2
Strub, Thomas Sperling, Reiner	<b>Representatives of the Subgenus <i>Gymnocalycium</i> from the Southern Part of the Argentinian Province Santiago del Estero</b>	pp. 3-31

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**Cover picture: *Gymnocalycium* spec. Ojo de Agua, SPE 374-177-18, southeast of Villa Ojo de Agua, province Córdoba, Argentina, 494 m a.s.l. (picture: R. Sperling).**

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## Editorial

### Dear *Gymnocalycium* enthusiasts

**Mario Wick**



Unfortunately, the consequences of the Corona virus do not stop at our hobby. We decided with a heavy heart to cancel the 36<sup>th</sup> International *Gymnocalycium* Conference from October 2<sup>nd</sup> to 4<sup>th</sup> 2020 in Radebeul near Dresden.

I am therefore all the more pleased that our friends Thomas Strub and Reiner Sperling have looked around again in the north of the Argentinean province of Córdoba and in the southern part of the province of Santiago del Estero. They are once again taking up the topic of the 35<sup>th</sup> International *Gymnocalycium* Conference in September 2019 and report on the representatives of the subgenus *Gymnocalycium* from this area.

As usual, enjoy yourselves reading!

We would like to express our warmest thanks to Mrs Iris Blanz (Austria) who supports us with the translation into English, to Mrs Larisa Zaitseva (Russia) for the translation into Russian, to Mr Victor Gapon (Russia) for the content corrections of the Russian edition, to Mr Takashi Shimada (Japan) for the translation into Japanese, to Mr Jiahui Lin (China) for the translation into Chinese and to Mr Daniel Schweich (France), who has mirrored our publications under <http://www.cactuspro.com/biblio/>.

## Representatives of the Subgenus *Gymnocalycium* from the Southern Part of the Argentinian Province Santiago del Estero

**Thomas Strub**

Hölzlistrasse 23, 4102 Binningen (Switzerland)

Email: [thomas.strub@kabelbinningen.ch](mailto:thomas.strub@kabelbinningen.ch)



**Reiner Sperling**

Kamp 2, 33154 Salzkotten (Germany)

Email: [reiner-sperling@web.de](mailto:reiner-sperling@web.de)



### ABSTRACT

Representatives of the subgenus *Gymnocalycium* (subgenus *Ovatisemineum* Schütz) which occur in the southern part of the Argentinian province Santiago del Estero are presented. Localities, characteristics of the soil and of the respective species as well as the main characteristics setting apart the species are pointed out. Additionally, the results of chromosome number analysis are referred to.

### KEYWORDS

***Cactaceae*, *Gymnocalycium*, *affine*, *frankianum*, *robustum*, spec. Ojo de Agua.**

### INTRODUCTION

The main topic of the 35<sup>th</sup> *Gymnocalycium* meeting in Radebeul in September 2019 were the species of the subgenus *Gymnocalycium* (subgenus *Ovatisemineum* Schütz), which can be found in the southern area of the Argentinian province Santiago del Estero and also in the northern part of the province Córdoba. These are *Gymnocalycium frankianum* and *Gymnocalycium kuehhasii* as well as *Gymnocalycium affine* aff. and *Gymnocalycium spec.* Ojo de Agua.

In SCHÜTZIANA 2019, Volume 10, Issue 2, the group of *Gymnocalycium kuehhasii*'s related species was presented in detail. *Gymnocalycium spec.* Ojo de Agua is just a working title without any taxonomic relevance.

*Gymnocalycium kieslingii* and its forms *castaneum* and *alboareolatum* as well as *Gymnocalycium baldianum* var. *albiflorum* are going to be presented in one of the forthcoming SCHÜTZIANA issues, thus completing the group of relatives of the subgenus *Gymnocalycium*'s representatives (subgenus *Ovatisemineum* Schütz) from northern Córdoba and the neighbouring provinces.

The aim of the Working Group GYMNOS is to examine the chromosome sets of all the species that have been dealt with. The analysis of *Gymnocalycium kuehhasii* and its subspecies resulted in a

diploid set of chromosomes. As opposed to this, the chromosome set of *Gymnocalycium affine*, which occurs in the same area as *Gymnocalycium kuehhasii*, is tetraploid. Therefore, a species barrier could be asserted.

There was hope that analysis of the chromosome sets of *Gymnocalycium frankianum*, *Gymnocalycium affine* aff. and *Gymnocalycium* spec. Ojo de Agua would also result in different chromosome sets to be able to make distinctions. Unfortunately, this was not the case. All the species examined showed tetraploid chromosome sets.

### *Gymnocalycium frankianum*

*Gymnocalycium frankianum* grows in the south western region of the Argentinian province Santiago del Estero in the Sierra de Guasayán (fig. 1), a small mountain region of north-south alignment (fig. 2). Due to its lack of roads or dirt roads, large areas of the Sierra de Guasayán can hardly be accessed. This might also be a reason why there are not many localities of *Gymnocalycium frankianum* are known.

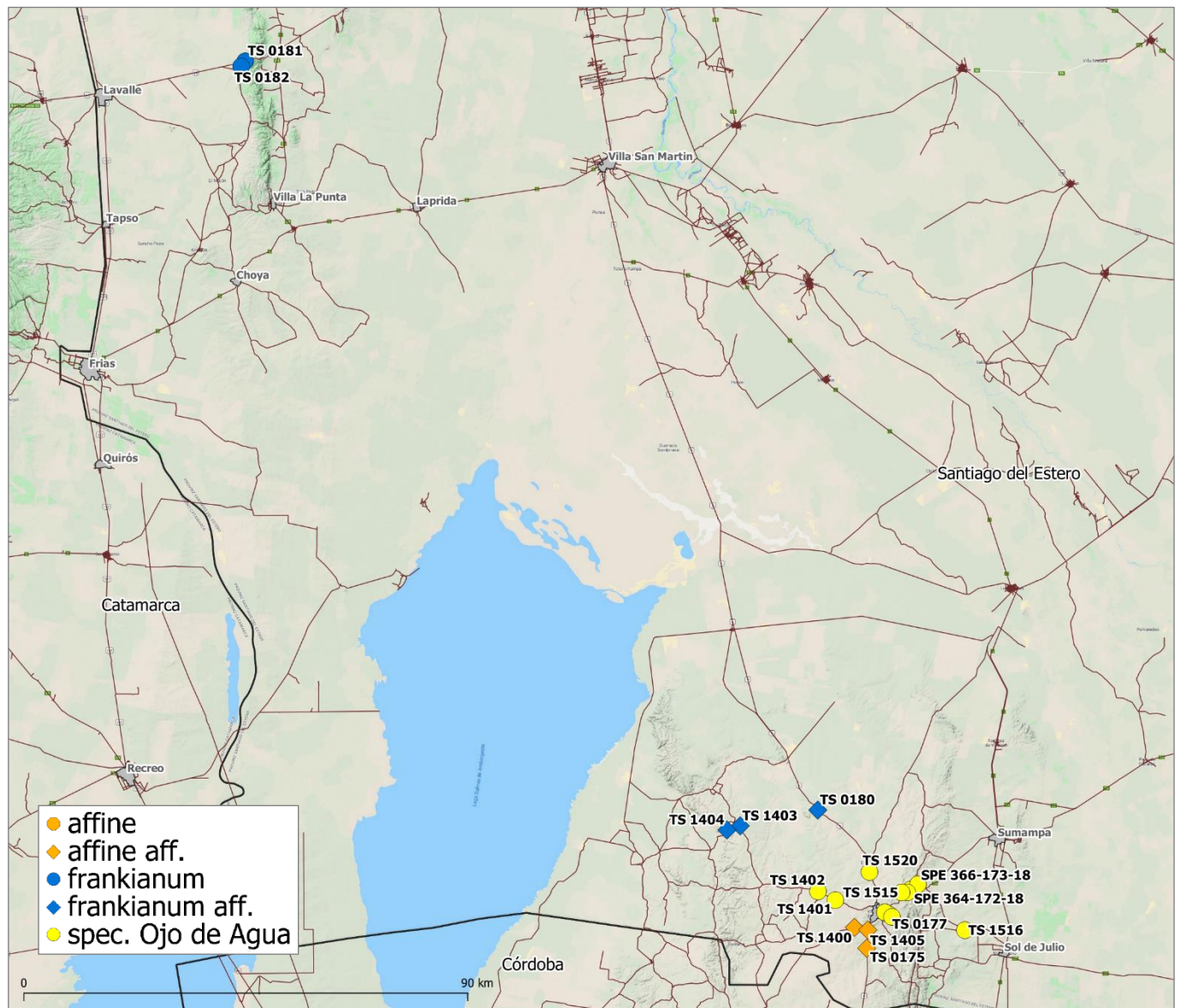


Fig. 1: South western area of the Argentinian province Santiago del Estero. The localities of *G. frankianum* are situated on the map section's north western part.

## Plants at habitat

At the localities of *Gymnocalycium frankianum* the soil contains ferrite enriched in components of laterite (fig. 3 and 4). On the one hand, *Gymnocalycium frankianum* grows between bands of granite rock in small depressions in which the soil consists of granite detritus sediments with humous enclosures (fig. 5). On the other hand, the plants also grow in meadow-like terrain with relatively high grass on humous granite detritus (fig. 6).

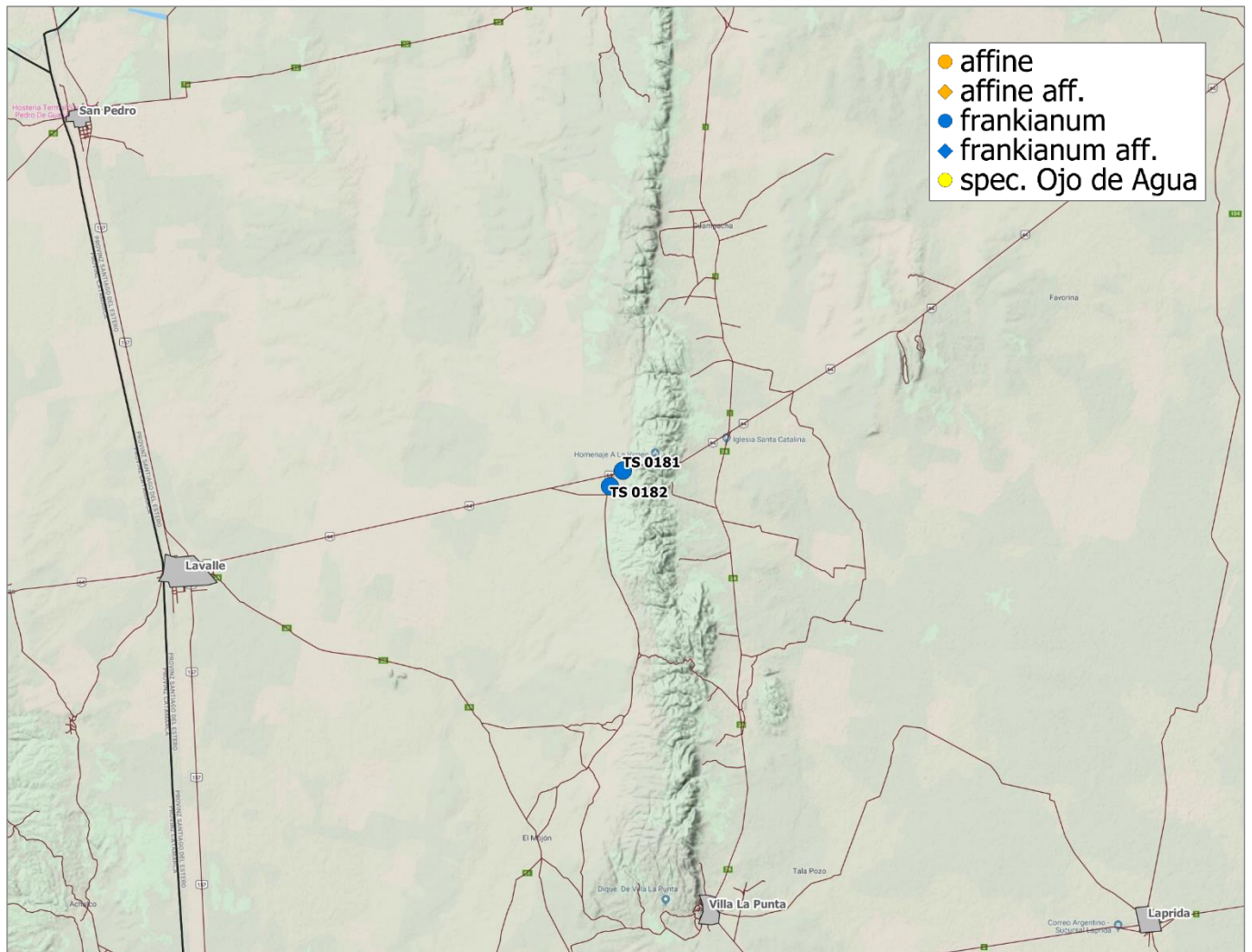


Fig. 2: Sierra de Guasayán with localities of *G. frankianum*. The predominant part of the area can only be reached with difficulty via roads or dirt roads.



Fig. 3-4: Vegetation and soil condition in the Sierra de Guasayán: it remains of Chaco vegetation with ferrite containing reddish rocks.



Fig. 5: TS 181 *G. frankianum*, growing between bands of granite rocks.



Fig. 6: TS 182 *G. frankianum*, growing in meadow-like terrain.

### Accompanying vegetation

Another spherical cactus, *Echinopsis aurea* (fig. 7), can be found close to the localities of *Gymnocalycium frankianum*. Both genera prefer rather rocky habitats. Remains of Chaco vegetation prevail in the Sierra de Guasayán consisting of acacia, *Stetsonia coryne*, *Cereus spec.* and *Opuntia quimilo* as well as *Opuntia sulphurea* (fig. 8). These genera populate a sandier microhabitat than *Gymnocalycium frankianum* and *Echinopsis aurea*.



Fig. 7: TS 181a *Echinopsis aurea*, growing sympatrically with *G. frankianum* (photo: Volker Schädlich).



Fig. 8: TS 1523a *Cereus spec.*, growing in predominantly sandy soil.



Fig. 9: TS 1523b *Opuntia quimilo*.



Fig. 10: TS 1523c *Opuntia sulphurea*.

## Plants in cultivation

*Gymnocalycium frankianum* has got a greyish brown appearance in bright sunlight. Its spines are short, curving towards the body. They are horn-coloured with a darker base. The flower grows to a length of approximately 5-6 cm and possesses a green style. The seed is relatively large. The whole testa of the seed is covered by a cuticle (arillus skin) which is self-detaching to a very small degree. The hilum of the seed tends to be wide (fig. 11-14).



Fig. 11: TS 182 *G. frankianum*, brownish plant body when exposed to sunlight.



Fig. 12: TS 182 *G. frankianum*, brown epidermis due to exposure to sunlight.



Fig. 13: TS 181 *G. frankianum*, with a green style.



Fig. 14: TS 182 *G. frankianum*, relatively large seed, the testa is covered in a cuticle which peels off (photo: Volker Schädlich).

## Chromosome number

Analysis has proved that *Gymnocalycium frankianum* possesses a tetraploid set of chromosomes.



***Gymnocalycium frankianum* aff.**

There is a large gap of about 250 km in linear distance between the type locality of *Gymnocalycium frankianum* in the Sierra de Guasayán and *Gymnocalycium frankianum* aff., which grow in the northern foothills of the Sierra de Ambargasta. In between there is sandy alluvial soil which is not suited for the plants of the subgenus *Gymnocalycium* to grow in. An exchange of genetic material is hardly possible over such a long distance, even if it is considered that the pollinators are wild bees and small beetles (fig. 15).

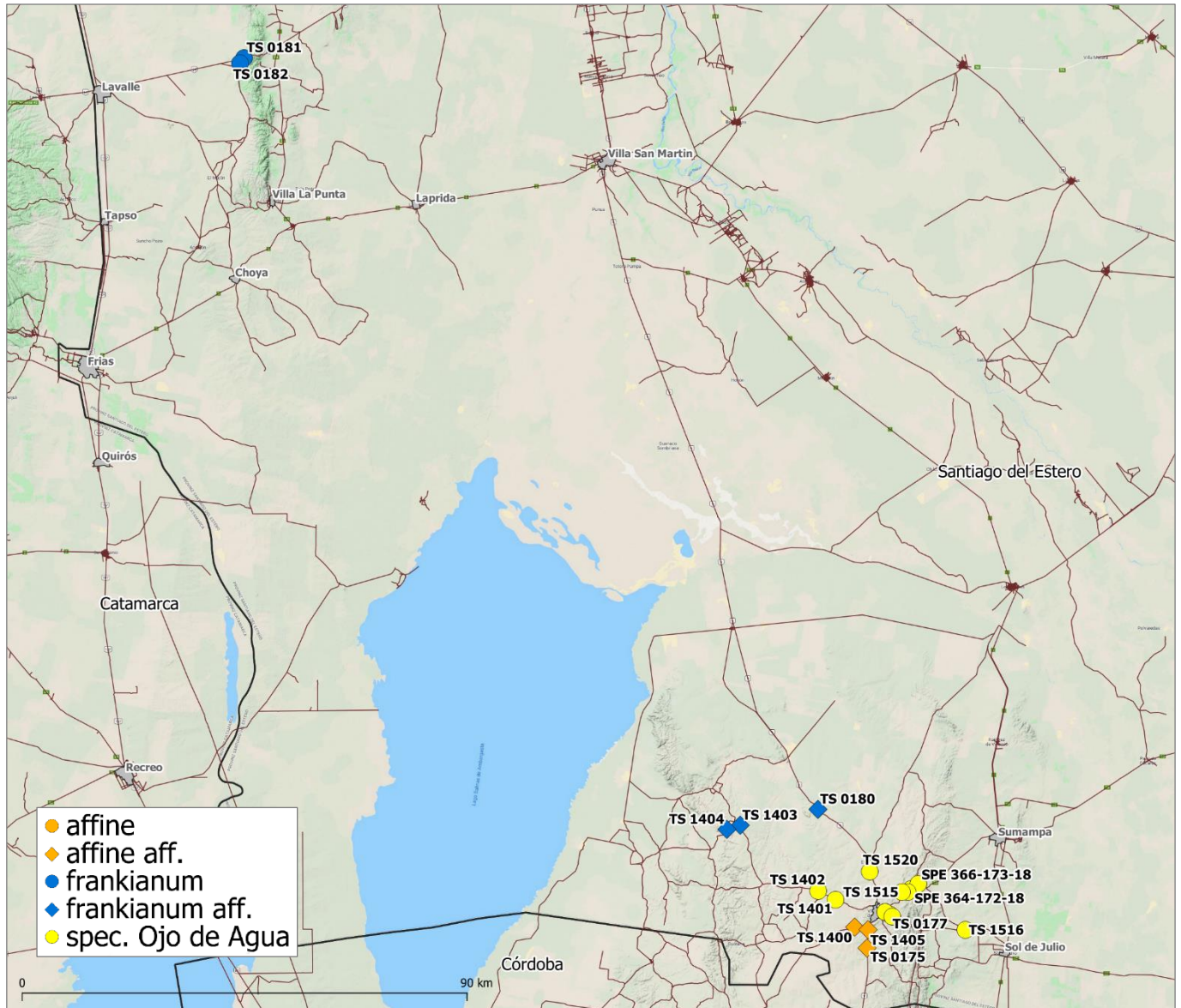


Fig. 15: South western region of the Argentinian province Santiago del Estero. *G. frankianum* localities are situated in the north western area, *G. frankianum* aff. localities can be seen in the southern part of the map's section. There is a distinct gap between the localities of *G. frankianum* and *G. frankianum* aff.

Ruta 9 connects Villa San Martín in the north with Villa Ojo de Agua in the south (fig. 15, fig. 20). The tarmac road runs in a dead straight line along Chaco vegetation. The terrain is flat and sandy. As there is no rocky bedrock, no representatives of the subgenus *Gymnocalycium* can be found here.

The native people are of indigenous origin and predominantly poor. The population dwells in small houses along the road. Cacti found in the nearby Chaco are sold at the roadside, among others *Opuntia*, *Cleistocactus* as well as *Gymnocalycium schickendantzii* from the subgenus *Muscosemineum* are offered (fig. 16).

Before the Ruta 9 meets the northern foothills of the Sierra de Ambargasta and the Sierra de Sumampa it runs along the Salinas de Ambargasta. In this area only salt tolerating plants can survive (fig. 17).



Fig. 16: Cacti vendor at the roadside.



Fig. 17: Salinas de Ambargasta, the area is not suited for plants from the subgenus *Gymnocalycium* to thrive.

The northern foothills of the Sierra de Ambargasta and Sierra de Sumampa are the first “mountains” after the Sierra de Guasayán (fig. 18-19) when approaching from the north. These “mountains”, however, are merely subdued hills which surmount the surrounding area by just a few metres.

### Plants at habitat

*Gymnocalycium frankianum* aff. grow on those slopes of hills which are in the direction of/slanted towards/exposed to sunlight. They are found in ferrite containing granite detritus between granite rocks (fig. 19).



Fig. 18: Locality of TS 180, San Francisco.



Fig. 19: TS 180 *G. frankianum* aff., growing in ferrite containing granite detritus between granite rocks.

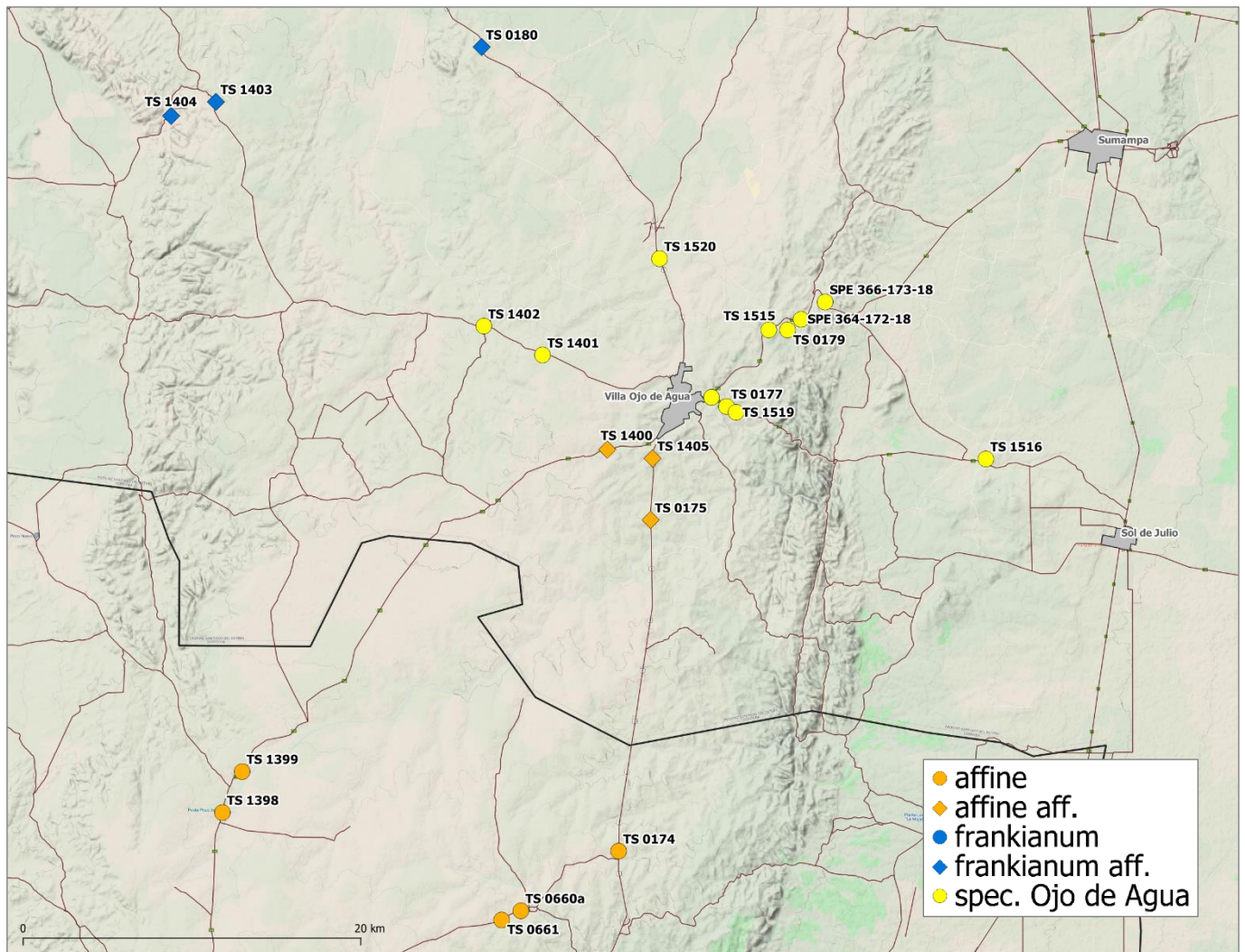


Fig. 20: Northern foothills of the Sierra de Ambargasta (western part of the map section) and northern foothills of the Sierra de Sumampa (central part of the map section).

### Accompanying vegetation

The accompanying vegetation is Chaco-like, consisting of *Stetsonia coryne*, *Cleistocactus baumannii*, *Opuntia sulphurea*, *Harrisia tortuosa* and acacia as well as *Echinopsis aurea*, *Acanthocalycium spiniflorum* and *Frailea castanea* (fig. 21-26).



Fig. 21: TS 1403e *Stetsonia coryne* (photo: Maja Strub).

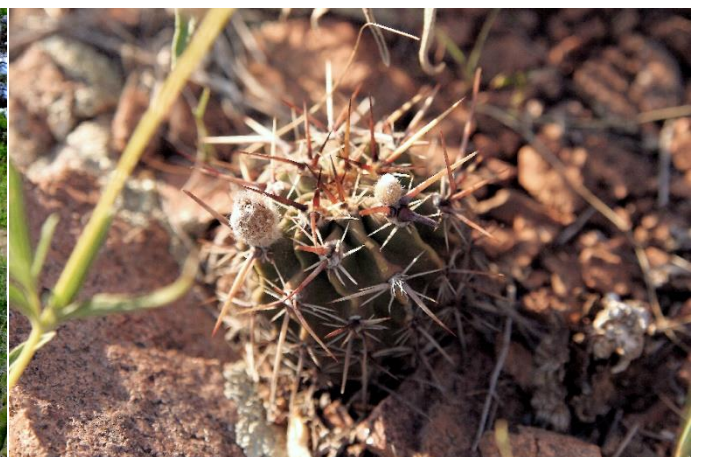


Fig. 22: TS 180a *Echinopsis aurea* (photo: Volker Schädlich).



Fig. 23: TS 1404a *Acanthocalycium spiniflorum*.



Fig. 24: TS 1404b *Cleistocactus baumannii*.



Fig. 25: TS 1403d *Opuntia sulphurea* (photo: Maja Strub).



Fig. 26: TS 1404c *Frailea castanea* (photo: Maja Strub).

### Plants in cultivation

*Gymnocalycium frankianum* aff.'s plant body becomes brownish, too, when exposed to bright sunlight. The spines are horn-coloured with a darker base. The flower is about 5-6 cm long and possesses a green style. The seed is relatively large and its hilum tends to be wide. The whole testa of the seed is covered in a cuticle which is self-detaching (fig. 27-30).



Fig. 27: TS 180 *G. frankianum* aff., the spines are horn-coloured with darker base.



Fig. 28: TS 180 *G. frankianum* aff., at sun-exposed sites the epidermis becomes brownish.



Fig. 29: TS 180 *G. frankianum* aff., flower with a green style.



Fig. 30: TS 180 *G. frankianum* aff., relatively large seed with a wide hilum. The whole testa of the seed is covered in a cuticle which is self-detaching (photo: Volker Schädlich).

### Chromosome number

The number of chromosomes is tetraploid in *Gymnocalycium frankianum* aff., this corresponds to the findings concerning *Gymnocalycium frankianum*.

### *Gymnocalycium* spec. Ojo de Agua.

*Gymnocalycium* spec. Ojo de Agua are plants which combine various features of species from the surroundings. The influence of *Gymnocalycium frankianum* aff. from the north as well as that of *Gymnocalycium affine* from the south can be discerned.

### Plants at habitat

*Gymnocalycium* spec. Ojo de Agua grow not only in northern and western, but also in eastern direction of Villa Ojo de Agua, the southernmost department capital of the province Santiago del Estero (fig. 31).

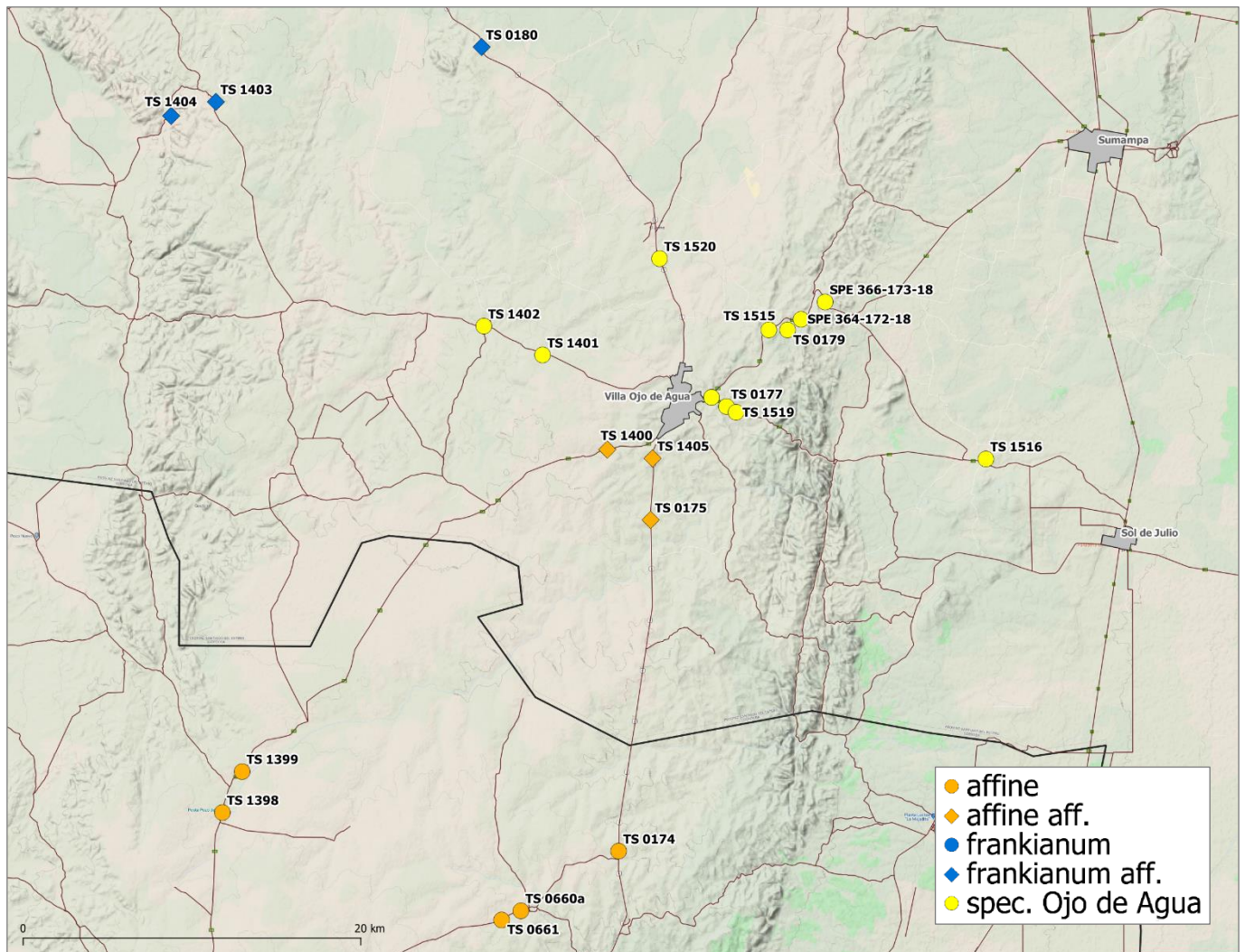


Fig. 31: *Gymnocalycium* spec. Ojo de Agua. The localities are situated north, east and west of Villa Ojo de Agua.

The distance between the locality of *Gymnocalycium frankianum* aff. (TS 180) and that of the northernmost occurring *Gymnocalycium* spec. Ojo de Agua (TS 1520) is merely around 20 km. Despite this short geographic distance, the appearance of the plants begins to change. Spine arrangement and spine length differ, the ribs get more numerous and the plant body's colouring becomes a lighter hue of green. (fig. 34-35).

As to the localities, elevations of the ground can hardly be distinguished. The hills are subdued (fig. 32-33). However, the base is stony and not sandy like in the alluvial region situated to the north. This already suffices for the plants from the subgenus *Gymnocalycium* to thrive.

The granite does not contain ferrite anymore, but an increased number of quartz inclusions.



Fig. 32: Habitat of TS 1520, north of El Jume. Hills are hardly recognizable (photo: Horst Kallenowsky).



Fig. 33: Habitat of TS 669, east of Villa Ojo de Agua. The hill is subdued.



Fig. 34: TS 1520 G. spec. Ojo de Agua, ferrite containing rock is missing. The spines are shortened.



Fig. 35: TS 669 G. spec. Ojo de Agua, with short spination.

### Accompanying vegetation

The typical representatives of the Chaco vegetation occur in predominantly sandy expanses, such as *Stetsonia coryne*, *Opuntia quimilo*, *Cleistocactus baumannii*, *Trichocereus lamprochlorus*, *Harrisia tortuosa* as well as *Gymnocalycium schickendantzii* (fig. 36-39). *Echinopsis aurea* grows in depressions interspersed with stones (fig. 40).



Fig. 36: TS 1521 *G. schickendantzii*, growing in a sandy region.



Fig. 37: TS 1401b *Stetsonia coryne*, growing in dense acacia thornbush (photo: Maja Strub).



Fig. 38: TS 1519g *Trichocereus lamprochlorus*.



Fig. 39: TS 1519c *Harrisia tortuosa*.



Fig. 40: TS 1519b *Echinopsis aurea*, growing in predominantly stony areas.

### Plants in cultivation

*Gymnocalycium* spec. Ojo de Agua has its individual appearance. The plant body is greyish-green in cultivation and not greyish-brown anymore. The spines are partly protruding, shorter and finer than they are on *Gymnocalycium frankianum* aff., which occurs in northern direction (fig. 41-44).

The flower structure and the green colouring of the style, however, correspond with *Gymnocalycium frankianum* (fig. 45-46).

The size of the seed does not differ from that of other investigated species, although the cuticle peels off only slightly. The hilum of the seed is relatively wide (fig. 47-48).





Fig. 41: TS 1520 G. spec. Ojo de Agua, in sun-exposed places the colour of the body is greyish-green and not brownish anymore. The spines are finer and shortened.



Fig. 42: TS 669 G. spec. Ojo de Agua, corresponds with TS 1520.



Fig. 43: TS 1520 G. spec. Ojo de Agua.



Fig. 44: TS 669 G. spec. Ojo de Agua.



Fig. 45: TS 1520 G. spec. Ojo de Agua, flower structure and style colour essentially correspond with those of *G. frankianum*.



Fig. 46: TS 669 G. spec. Ojo de Agua.



Fig. 47: TS 1520 G. spec. Ojo de Agua, the hilum is widened, the cuticle is only slightly self-detaching (photo: Volker Schädlich).



Fig. 48: TS 669 G. spec. Ojo de Agua, the hilum varies in width the cuticle has come off in parts (photo: Volker Schädlich).

### **Chromosome number**

Like *Gymnocalycium frankianum* and *Gymnocalycium frankianum* aff. the plants have a tetraploid set of chromosomes. No species barrier can thus be asserted judging by the number of chromosomes.

### ***Gymnocalycium affine* aff.**

#### **Plants at habitat**

Plants which remind of *Gymnocalycium affine* grow south west and south of Villa Ojo de Agua (Fig. 49). A plateau covered with grass, where no plants from the subgenus *Gymnocalycium* can be found, extends after that region. Some kilometres farther south, already in the province Córdoba, is the type locality of *Gymnocalycium affine*.

Acacia dominates the vegetation. The impression given by the scenery becomes more open. It is rather a rocky plateau than homogeneous mountains (fig. 50).

A part of the granite rock contains quartz inclusions without laterite components. In other localities the rock is made up of loose granite detritus without any quartz inclusions, but with ferrite containing components (fig. 51-53).

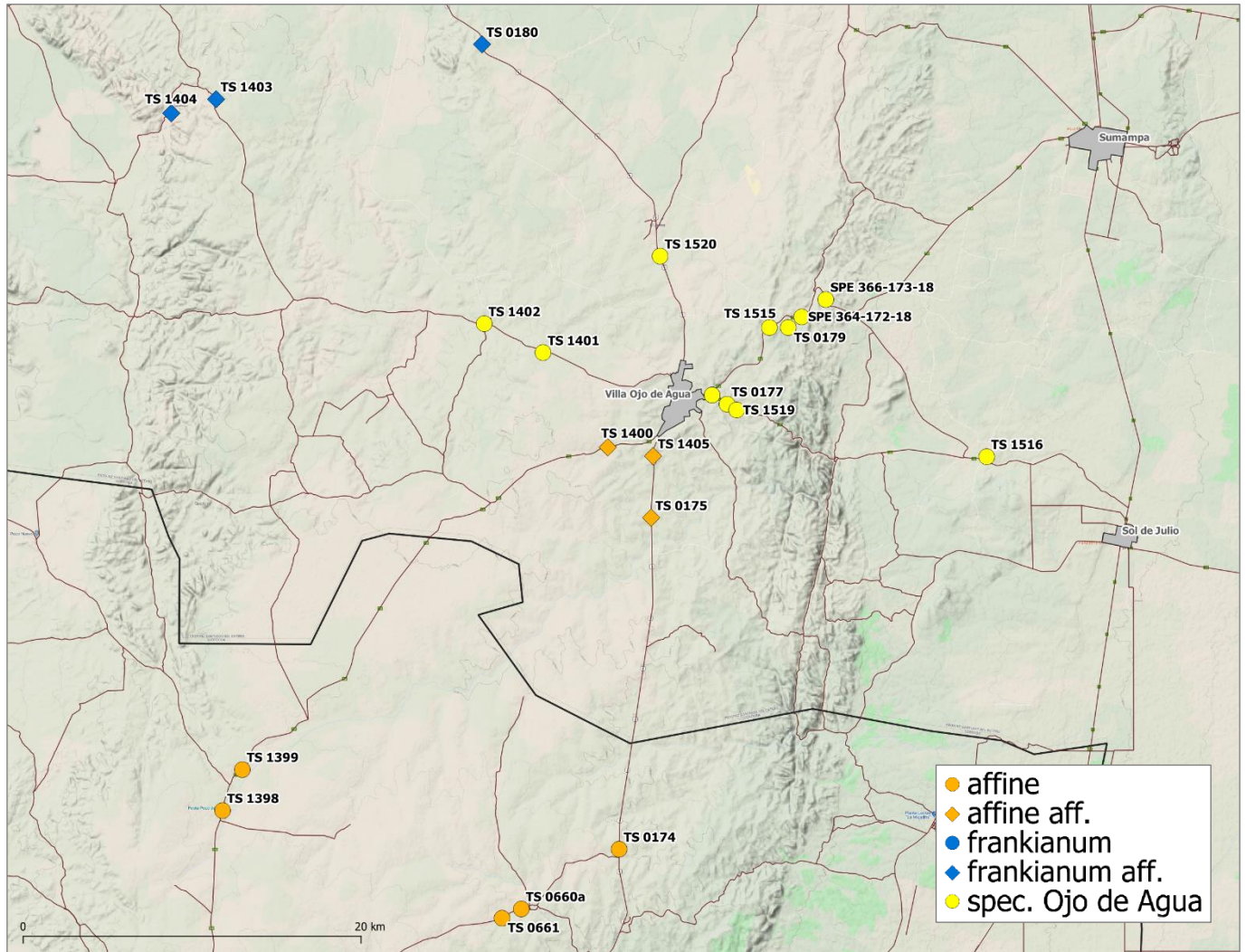


Fig. 49: Distribution area of *Gymnocalycium affine aff.* The plants grow in the southern part of province Santiago del Estero, not far from the border to the province Córdoba.



Fig. 50: Locality of TS 1400, a rocky plateau. Acacias dominate the vegetation (photo: Maja Strub).



Fig. 51: Locality of TS175, loose granite rock.



Fig. 52: TS 1400 *G. affine* aff., growing on granite rock with quartz inclusions.



Fig. 53: TS 175 *G. affine* aff., growing in reddish granite detritus.

### Accompanying vegetation

Apart from representatives of the Chaco vegetation there is *Echinopsis aurea* (fig. 54) again, but also *Trichocereus lamprochlorus* as accompanying plant (fig. 55-58).



Fig. 54: TS 1400a *Echinopsis aurea*, growing in granite detritus.



Fig. 55: TS 1400c *Trichocereus lamprochlorus*, growing in areas interspersed with rocks.



Fig. 56: TS 1515b *Opuntia quimilo*.



Fig. 57: TS 1515d *Stetsonia coryne*.



Fig. 58: TS 1515a *Harrisia tortuosa*, growing in sandy soil in the shadow of acacias.

### Plants in cultivation

The appearance of these plants differs from that of *Gymnocalycium* spec. Ojo de Agua, which occurs further north.

The body colour is lighter green. The marginal spines are tight to the body and not slightly protruding anymore. The base of the spines has a different colour (fig. 59-62).

The flower shape as well as the colour of flower and style equally differ from these features of the plants from the north (fig. 63-64).

The seed is not uniform. The cuticle comes off either little or strongly. The hilum is partly wide, in other cases it is extremely narrow (fig. 65-66).

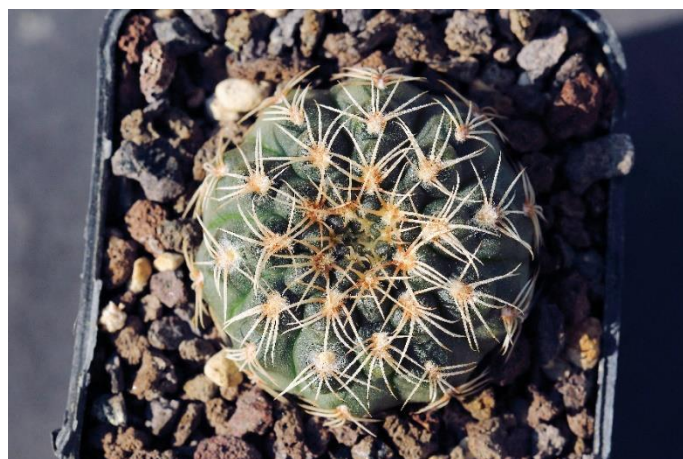


Fig. 59: TS 1400 *G. affine* aff., the epidermis is light green. The spines are tight and purely horn-coloured.



Fig. 60: TS 175 *G. affine* aff., the spines are short with a darker base.



Fig. 61: TS 1400 *G. affine* aff.



Fig. 62: TS 175 *G. affine* aff.



Fig. 63: TS 1400 *G. affine* aff., the pericarp as well as the lower part of the style are magenta-coloured.



Fig. 64: TS 175 *G. affine* aff., the lower part of the style is magenta-coloured.



Fig. 65: TS 1400 *G. affine* aff., the hilum is of middle size. The cuticle is little self-detaching (photo: Volker Schädlich).



Fig. 66: TS 175 *G. affine* aff., the hilum of the seed is markedly narrowed, the cuticle detaches to a high degree (photo: Volker Schädlich).

### Number of chromosomes

Like *Gymnocalycium affine*, *Gymnocalycium affine* aff. possesses a tetraploid set of chromosomes. As the same applies to *Gymnocalycium frankianum*, *Gymnocalycium frankianum*

aff. and *Gymnocalycium* spec. Ojo de Agua, no species barrier can be asserted from the set of chromosomes.

## Comparison of the investigated species

This chapter compares the species under investigation.

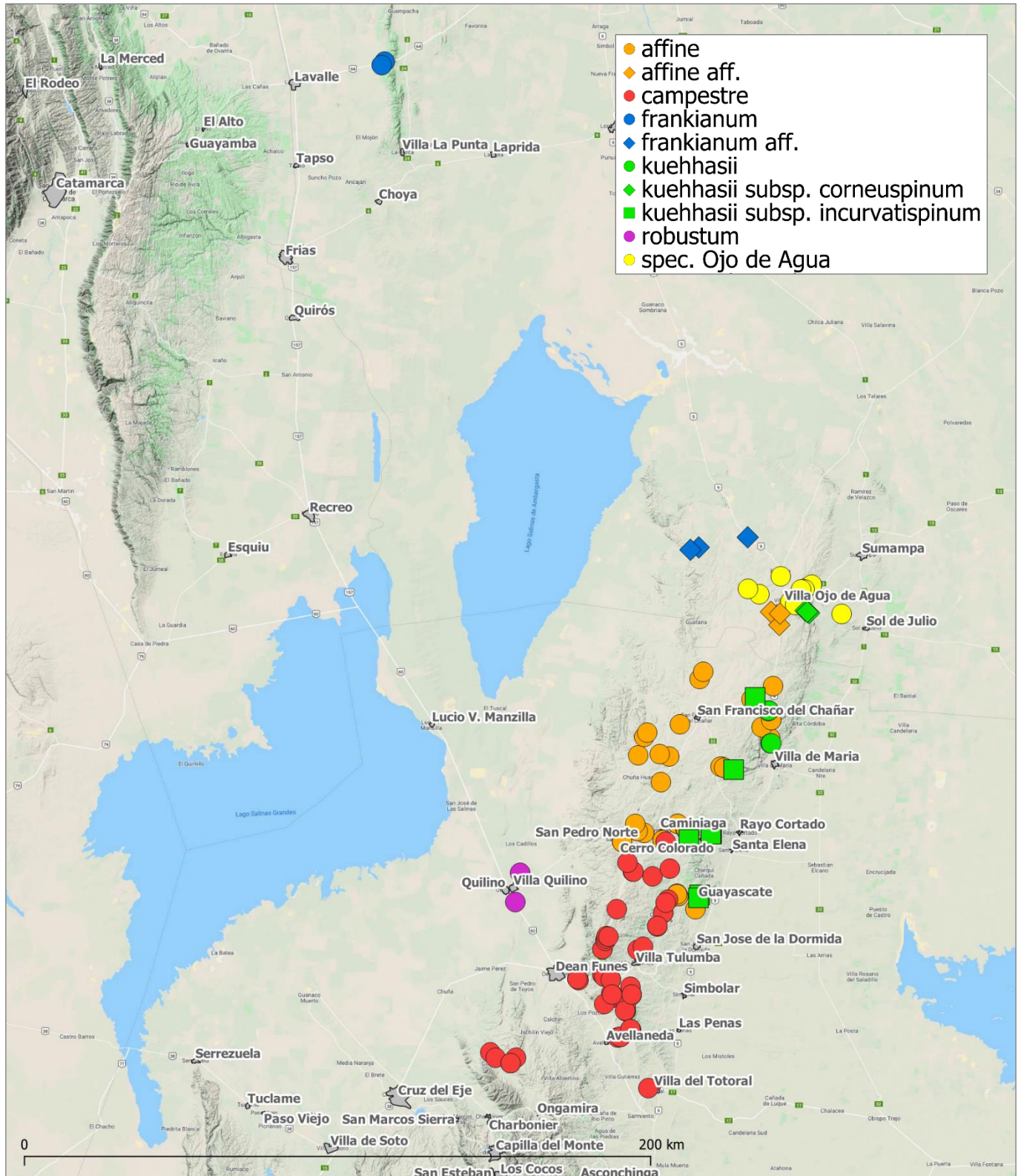


Fig. 67: Comparison of *G. frankianum*, *G. frankianum* aff., *G. spec.* Ojo de Agua, *G. affine* aff., *G. affine* and *G. robustum*.

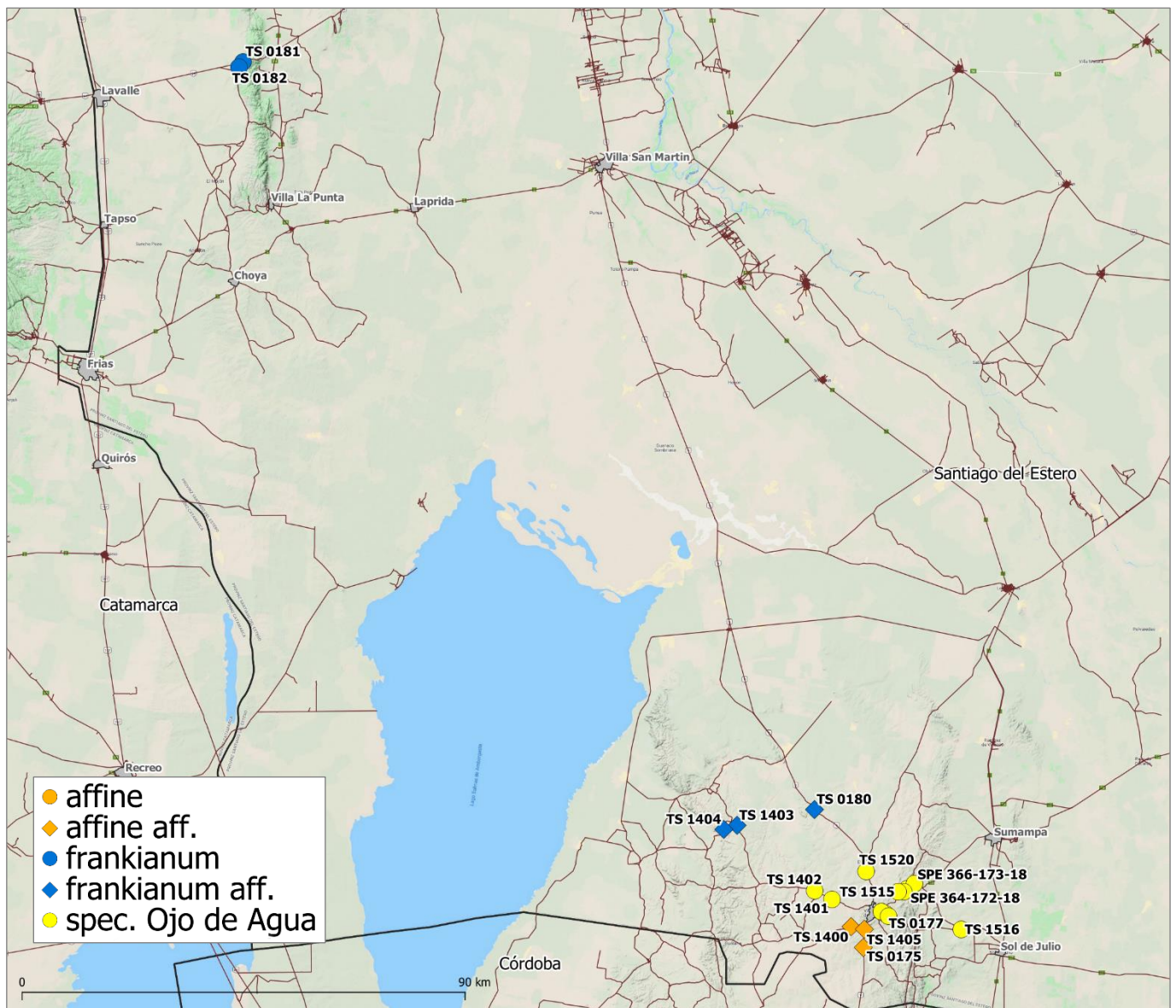


Fig. 68: Distribution area of the species.

### Appearance of the plants

*Gymnocalycium frankianum* around the type locality cannot be distinguished by habitus from *Gymnocalycium frankianum* aff., which is found in the south (fig. 69-70).

*Gymnocalycium* spec. Ojo de Agua and *Gymnocalycium affine* aff. are more similar to *Gymnocalycium affine* by habitus than to *Gymnocalycium frankianum*. This applies to body colour, number of ribs and arrangement of the spines (fig. 71-74, 76).

The appearance of *Gymnocalycium robustum* is different from that of the other species looked at (fig. 75).





Fig. 69: TS 182 *G. frankianum*, Sierra de Guasayán. The epidermis is brown when totally exposed to the sun. Spines have a darker base.



Fig. 70: TS 180 *G. frankianum* aff., Sierra de Ambargasta. Plant body is brownish when totally exposed to the sun. Arrangement and type of spines correspond with those of *G. frankianum* from the Sierra de Guasayán.

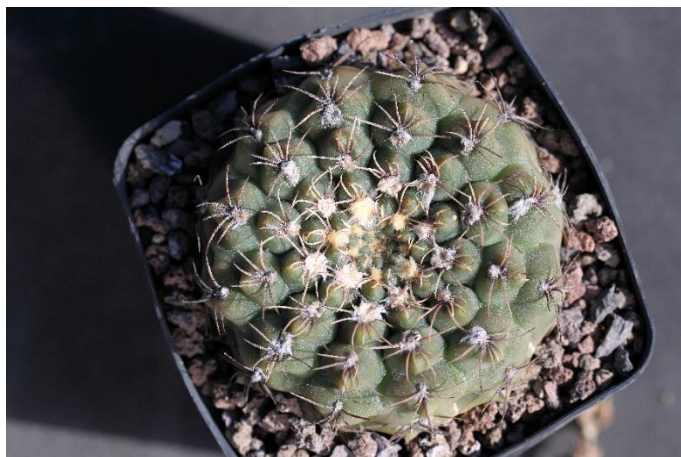


Fig. 71: TS 1520 *G. spec.* Ojo de Agua, north of Villa Ojo de Agua. The body colour is greyish-green. Spines are short and partly protruding from the body.



Fig. 72: TS 669 *G. spec.* Ojo de Agua, east of Villa Ojo de Agua. No differences to TS 1520 can be established.

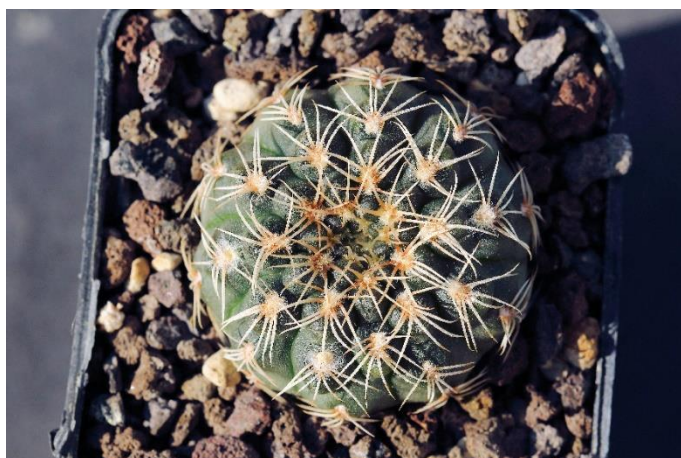


Fig. 73: TS 1400 *G. affine* aff., south-west of Villa Ojo de Agua. The body colour is light green. Spines are tight to the body and of uniform colour.



Fig. 74: TS 175 *G. affine* aff., south of Villa Ojo de Agua. Spines have a darker base.



Fig. 75: TS 681 *G. robustum*, Quilino. The body colour is greyish green. Spines with a darker base. Arrangement of spines differs from the other investigated species.



Fig. 76: TS 174 *G. affine*, San Miguel. Body green when totally exposed to the sun. Spine colour is uniformly horn-coloured.

### Flower structure

The pericarp of the flowers of *Gymnocalycium frankianum* and *Gymnocalycium frankianum* aff. is identical. The style of both species is green to greenish (fig. 77-78). The flower structure of *Gymnocalycium frankianum* aff. is similar to that of *Gymnocalycium robustum* and *Gymnocalycium spec.* Ojo de Agua, but more distinctly different from *Gymnocalycium affine* (fig. 77-84).

The form and structure of the flower of *Gymnocalycium affine* aff. corresponds with *Gymnocalycium affine*. The same applies to the style colour, of which the upper part is yellowish, the lower part magenta (fig. 81-82, 84).



Fig. 77: TS 181 *G. frankianum*, Sierra de Guasayán. The style is green.



Fig. 78: TS 180 *G. frankianum* aff., Sierra de Ambargasta. The style is green.



Fig. 79: TS 1520 *G. spec.* Ojo de Agua, north of Villa Ojo de Agua. Green style like in *G. frankianum*.



Fig. 80: TS 669 *G. spec.* Ojo de Agua, east of Villa Ojo de Agua.



Fig. 81: TS 1400 *G. affine* aff., southwest of Villa Ojo de Agua. Base of the style is magenta like in *G. affine*.



Fig. 82: TS 175 *G. affine* aff., south of Villa Ojo de Agua. Flower structure and flower colour correlates with *G. affine*.



Fig. 83: TS 681 *G. robustum*, Quilino. The style is yellowish.



Fig. 84: TS 174 *G. affine*, San Miguel. The style possesses a magenta-coloured base. The flower structure differs from the other species.

## Seeds

The size of the seeds of *Gymnocalycium frankianum* and *Gymnocalycium frankianum* aff. is identical. The hilum is relatively wide and the seeds are completely covered in a self-detaching cuticle (fig. 85-86).

The seeds of *Gymnocalycium* spec. Ojo de Agua possess a cuticle which is only partly self-detaching. The hilum size varies, being partly wide as in *Gymnocalycium frankianum* and partly narrow as in *Gymnocalycium affine* (fig. 87-88).

*Gymnocalycium affine* aff. growing in the south do not have a uniform hilum, the cuticle comes off to a more or less high degree (fig. 89-90). There is no longer a correlation with the hilum form of either *Gymnocalycium frankianum* or *Gymnocalycium* spec. Ojo de Agua (fig. 85-88). In case of the southern *Gymnocalycium affine* aff., the form of the hilum as well as the strongly self-detaching cuticle perfectly match the features of *Gymnocalycium affine* and *Gymnocalycium robustum* (fig. 89-92).



Fig. 85: TS 182 *G. frankianum*, Sierra de Guasayán. The hilum is relatively wide. The cuticle is highly self-detaching and wraps the testa of the seed (photo: Volker Schädlich).



Fig. 86: TS 180 *G. frankianum* aff., Sierra de Ambargasta. The hilum tends to be wide. The cuticle is highly self-detaching and wraps the whole testa of the seed (photo: Volker Schädlich).



Fig. 87: TS 1520 *G. spec.* Ojo de Agua, north of Villa Ojo de Agua. The cuticle is hardly self-detaching. The hilum is relatively wide (photo: Volker Schädlich).



Fig. 88: TS 669 *G. spec.* Ojo de Agua, east of Villa Ojo de Agua. The cuticle is to a more or less high degree self-detaching (photo: Volker Schädlich).



Fig. 89: TS 1400 *G. affine* aff., south west of Villa Ojo de Agua. The cuticle is little self-detaching, the hilum has the tendency to be narrow (photo: Volker Schädlich).



Fig. 90: TS 175 *G. affine* aff., south of Villa Ojo de Agua. The cuticle is highly self-detaching, the hilum is narrow (photo: Volker Schädlich).



Fig. 91: TS 681 *G. robustum*, Quilino. The hilum is narrow (photo: Volker Schädlich).



Fig. 92: TS 174 *G. affine*, San Miguel. The hilum is narrow (photo: Volker Schädlich).

### Comparison of flowering periods (Basel 2019)

The flowering period of the investigated species corresponds to a very high degree. Merely *Gymnocalycium robustum* starts flowering significantly later.

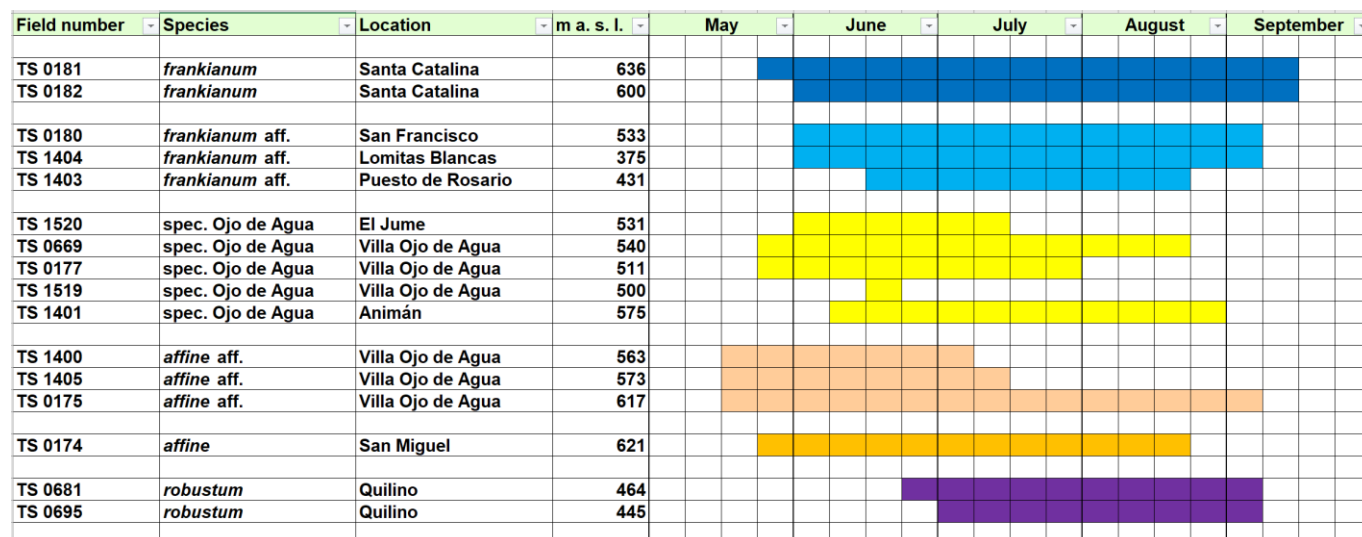


Fig. 93: Comparison of flowering period.

### Comparison of investigated characteristics

Table 1: Comparison of investigated characteristics.

Characteristic	<i>frankianum</i>	<i>frankianum</i> aff.	spec. Ojo de Agua	<i>affine</i> aff.	<i>affine</i>	<i>robustum</i>
Chromosome set tetraploid	Yes	Yes	Yes	Yes	Yes	Yes
Epidermis brown when exposed to sun	Yes	Yes	No	No	No	No
Flower with green style	Yes	Yes	Partly	No	No	No
Hilum wide	Yes	Yes	Partly	No	No	No
Average flowering period	Yes	Yes	Yes	Yes	Yes	No

The investigated characteristics of *Gymnocalycium frankianum* and *Gymnocalycium frankianum* aff. correspond. No essential differences can be recognized.

*Gymnocalycium* spec. Ojo de Agua possesses characteristics of *Gymnocalycium frankianum* which grow in the north as well as of *Gymnocalycium affine* which occur in the south.

*Gymnocalycium affine* aff., which can be found not far from the border to province Córdoba, corresponds in many characteristics with *Gymnocalycium affine*. However, it matches *Gymnocalycium frankianum* only slightly.

*Gymnocalycium robustum* deviates the most from the other species.

## Conclusion

All investigated species have a tetraploid set of chromosomes. Therefore, no species barrier can be deduced from the chromosome set.

There is an area gap of about 250 km in linear distance between the localities of *Gymnocalycium frankianum* and *Gymnocalycium frankianum* aff. The gap consists of sandy alluvial soil which is not suitable for plants from the subgenus *Gymnocalycium* to thrive. An exchange of genetic material over such a long distance is impossible. Despite this long distance, *Gymnocalycium frankianum* and *Gymnocalycium frankianum* aff. can hardly be told apart from each other. Apparently, these taxa have developed similar characteristics independent of each other due to the same environmental influences, such as climate and soil.

Plants with characteristics which are not uniform can be found in a relatively small area around Villa Ojo de Agua.

The *Gymnocalycium* spec. Ojo de Agua populations combine characteristics of *Gymnocalycium frankianum* aff. in the north and *Gymnocalycium affine* in the south, thus having intermediate characteristics.

*Gymnocalycium affine* aff., which occurs more south, corresponds in essential characteristics to *Gymnocalycium affine*.

*Gymnocalycium robustum* matches the other species the least.

In the years to come not only further field studies, but also research into cultivated plants will be carried out in order to understand both *Gymnocalycium* spec. Ojo de Agua and *Gymnocalycium affine* aff. better.

All photographs, if not mentioned otherwise, are by the lead author.

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