International Rock Gardener

ISSN 2053-7557

Number 102 **The Scottish Rock Garden Club** June 2018

June 2018

The IRG Team is pleased to be able to publish a description of a new species of peony, named for the late, great Jim (J.C.) Archibald by two of his many admirers, Jānis Rukšāns and Henrik Zetterlund. The SRGC is proud to host online the Archibald Archive to represent the work of Jim and Jennie Archibald in bringing such a wide range of plants to the attention - and gardens - of so many plant lovers worldwide. Imagine then, our delight to be given another species description by these two famous plantsmen, this time of a crocus to be named for two of our team. Margaret and Ian Young seem inextricably bound with the SRGC over decades as exhibitors to show secretaries, speakers and founders of the IRG amongst other things! With his Bulb Log Diary written every week since 2003, Ian has also continued his determination to communicate and inspire with plant lovers around the world in that way. The Youngs feel they have gained great friendships and knowledge from the SRGC and are happy to work voluntarily to “give back”. That Jānis and Henrik have chosen to honour them in this way is deeply appreciated by Margaret and Ian both for themselves and for the association with the SRGC. The third new species this month is an Andean *Alstroemeria* from Chile, described by John M.Watson, Ana (Anita) R. Flores with Gloria Rojas.

Cover photo: *Paeonia archibaldii* Rukšāns *species nova*.

Jānis Rukšāns and Henrik Zetterlund at the hill where *Paeonia wendelboi* was found.

---International Rock Gardener---

---Species description---

PAEONIA ARCHIBALDII Rukšāns – A NEW PEONY SPECIES FROM IRAN

Jānis Rukšāns, Dr. biol. h.c., Latvia

Email contact: janis.bulb@hawk.lv

Published in International Rock Gardener 102 – June 2018 Pages 3 - 13

The horticulturally very important genus *Paeonia* is highly complicated taxonomically. It is distributed all over the Northern Hemisphere and can be found wild from N America through NW Africa, Europe, Asia to Siberia, China, and Japan. Different botanists regard differently the status of the species already described, so the number of recognised taxa diverges greatly in the publications of various authors. So Stern (1946) recognises 33 species, Halda (2004) – 25, but in the latest monograph on the genus by Hong (2010) 31 species are included, but many species of other authors are regarded as subspecies. With the inclusion of subspecies, the number of recognised taxa sensu Hong rises to 50. The pronounced polymorphism within the genus makes the distinction of species sometimes (or rather quite often) very difficult. The situation with the Caucasian peonies is especially complicated – many new taxa published by Russian and Georgian botanists are now regarded by Hong as subspecies or synonyms of other species. But this does not mean that Hong's monograph includes all *Paeonia* species existing in nature. After Hong's work was published, one more species from Iran (*Paeonia wendelboi*) was described by me (J.R.) together with Henrik Zetterlund from the Gothenburg Botanical Garden. The range of some Caucasian and E Turkey species according to Hong enters Iran along the southern coast of the Caspian Sea – Zagros, Gilan and Mazandaran provinces, but peonies occur in Golestan Province as well (M. Assadi, 2016).

Paeonia wendelboi Rukšāns & Zetterlund

The most recent comprehensive review of *Paeonia* species growing in Iran was published in "The Iranian Journal of Botany" vol. 22. #2, pp. 75-78 (M. Assadi, 2016). According to this publication, there are three recognised species in Iran – *Paeonia mascula* (L.) Miller (in Flora Iranica as *P. kavachensis* Azn.) from W Kurdistan, where it occurs in a *Quercus* forest near Chenarch village between Marivan and Saquez; *P. wendelboi* Rukšāns & Zetterlund – a very narrow endemic, known from two small localities between Asalem and Khalkhal, and the much more widely spread *P. tomentosa* (Lomak.) N. Busch, distributed along the southern coast of the Caspian Sea (Mazandaran and Gilan provinces) and, according to M. Assadi, entering Golestan Province to the east. All these species are easily identifiable – *Paeonia mascula* has red flowers and is glabrous throughout, *P. tomentosa* is white-flowered and, as can be guessed from its name, conspicuously hairy at least on the lower surface of the leaves, and the recently (2014) described dwarf *P. wendelboi* has bright yellow flowers. The latter species had been introduced into cultivation several times – at first in the Gothenburg Botanical Garden from seeds originally collected in the wild by M. Assadi (1978) and later by J. C.(Jim) Archibald (1941-2010, a famous plant seed collector and distributor and a great friend of the author).

Another very special dwarf *Paeonia* sp. with pure white flowers and completely glabrous leaves was found by Jim Archibald ENE of Firuzkuh in Mazandaran Province of Iran at an altitude of approx. 2000 m on a steep slope near the tree-line in a rich diversity of dense, deciduous scrub. Shortly before his death Jim Archibald shared some seeds of this peony with the author of this publication and now they have started blooming. According to Jim's report, its large, pure white flowers with cream anthers on pale pink filaments sometimes open almost at ground level in spring. With its globular flowers and glabrous carpels it bears some resemblance to *P. obovata* growing wild in the Far East (visitors to Rukšāns' garden when seeing this peony in flower usually ask – is it *P. obovata*?). The more mature, thin-textured foliage somewhat reminds one of *P. tomentosa*, though the leaves of the Archibald's plant are completely hairless beneath and at the start of vegetation are deep purple, retaining some hints of purple during the vegetation.

Paeonia tomentosa in Iran - distinctly hairy leaves.

Actually, this glabrous peony species was found long before Archibald did so and is listed in Flora Iranica (Riedl, 1969) under the name of *Paeonia wittmanniana* Hartw. ex Lindl. var. *nudicarpa* Schipcz., although the area of *P. wittmanniana* is restricted to Georgia, Armenia and Turkey (Hong, 2010 – as *P. daurica* Andrews subsp. *macrophylla* (Albov) D.Y. Hong). Records of *P. wittmanniana* from N Iran by Boissier are referable to *P. tomentosa* (M. Assadi, 2016), regarded by Hong as *P. daurica* subsp. *tomentosa*. Specimen Renz and Iranshar 17756 with glabrous follicles cited by M. Assadi was collected above Talar e-Sarband in a Sangdeh forest, not far from the Archibald's locality in the eastern part of Mazandaran Province. It seems that this gathering was not known to Hong as the only samples of a peony from Mazandaran Province cited in his marvellous monograph came from the western part of Mazandaran Province, from a degraded forest above Siah Bisheh, the locality where *P.*

tomentosa was observed by Rukšāns in 2008 (WHIR-125B) and is shown here. It appears that this locality has now been destroyed and no plants were found there in May, 2018.

Paeonia tomentosa

Paeonia tomentosa on a steep Iranian hillside.

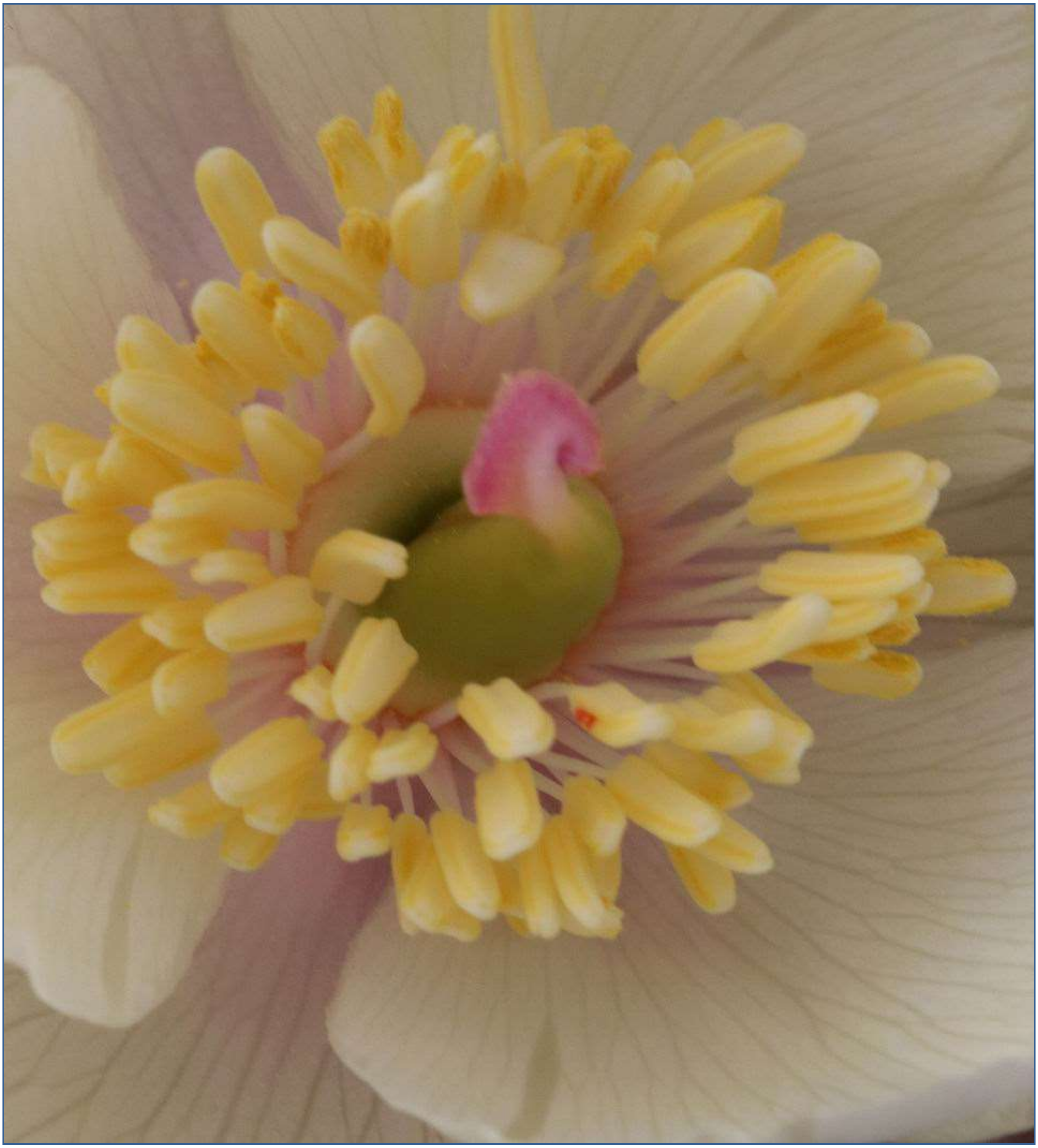
We cannot agree with the statement of M. Assadi (2016) about this “glabrous” peony that “it seems it does not need to raise a distinct taxon for it”.

What is it that makes this peony so special as to be worthy of its own species name? Firstly, it is its dwarf habit – according to Archibald, “sometimes [flowers] open almost at ground-level”. Although Hong (2010) regards the plant height as unimportant in the taxonomy of *Paeonia*, sometimes the differences are so impressive that they cannot be ignored.

This dwarf habit of Archibald’s peony is retained in cultivation – regardless of whether it grew in the open garden or in the greenhouse its height never exceeded 30 cm, being even shorter than the yellow-flowered *Paeonia wendelboi*. *P. tomentosa* (as it is regarded by M. Assadi) can even reach 1 m height and such were the plants of this species observed by me (they were 0.7-0.8 m high). The other feature that separates it from the white-flowered Iranian peony *P. tomentosa* is the completely glabrous leaves and follicles. We did not observe any hair or even papilla on its leaves, leaf margins, enervation or other parts. In addition, its leaves have a very special deep purplish red colour which fades with age, but keeps some purple hints on the leaf margins almost up to the end of vegetation. There are some other species in which the young leaves can be purplish tinted in some populations, but none holds this colour so long even after flowering.

Paeonia ruprechtiana (*P. daurica* subsp. *coriifolia*) - red leafed form.

We found similar forms of *Paeonia ruprechtiana* Kem.-Nath. (*P. daurica* subsp. *coriifolia* sensu Hong) in Georgia (CMGG-004), but their flowers were dark, reddish pink and the texture of the leaves was smoother. There are other taxonomically less important features that are mentioned in the description of the new species which confirm its distinct specific status. We decided to name it after its introducer into cultivation Jim Archibald as *Paeonia archibaldii.*



Paeonia archibaldii, close-up of flower centre.

Paeonia archibaldii **Rukšāns** ***species nova***

Type – Ex culturae in horto Jānis Rukšāns, plants from Iran, the eastern end of the Elburz, Mazandaran Province, ENE of Firuzkuh, 35.52 N and 52.57 E, alt. 2000 m, originally collected by J.C. Archibald. Holo: GB (Gothenburg).

Syn.: *Paeonia wittmanniana* var. *nudicarpa* sensu Riedl, 1969.

Paeonia archibaldii

Habitat and distribution – at altitudes around 2000 m, in clearings and margins of deciduous forests and dense deciduous scrub. At present known only from the type locality and its surroundings, but it is possible that plants growing to the east of it as far as Gorgan could belong to the same species (in Flora Iranica *Paeonia wittmanniana* var. *nudicarpa* is mentioned as growing in Gorgan, too).

Flowering time – May.

Diagnostic characters. **Roots** carrot-shaped, attenuate downwards, up to 3 cm in diameter. **Stem** – green, but at the base and below the lower leaves with some reddish staining, bottom scales glabrous, red. **Lower leaves** biternate with 9-11 leaflets, distinctly glabrous throughout, at the start of vegetation and until blooming noticeably purplish red, later gradually becoming greenish from the midvein, dark green at very end of vegetation, but still retaining the purplish staining at the edges. **Leaflets** obovate, shortly acuminate at the apex; in young plants the shape variable – from broadly obovate to even lanceolate, upper leaves triternate, with entire or segmented leaflets. **Petioles** glabrous, leaves glabrous throughout – on the surface, along the margins and enervation. **Flowers** solitary and terminal with 5-7 pure white petals. **Involucrate bracts** – 1-2, leaf-like, at blooming time deep bluish purple with red innervation, **sepals** – 2, orbicular, brownish green with red innervation and a wide reddish purple margin, rounded at the apex, glabrous. **Carpels** glabrous with a style less than 1 mm long, **stigma** pink. **Filaments** 6-7 mm long, white, staining pinkish at the base or light pinkish throughout, glabrous. **Anthers** 4-5 mm long, creamy yellow, **disk** – greenish white to creamy white, flat, 1-2 mm wide.

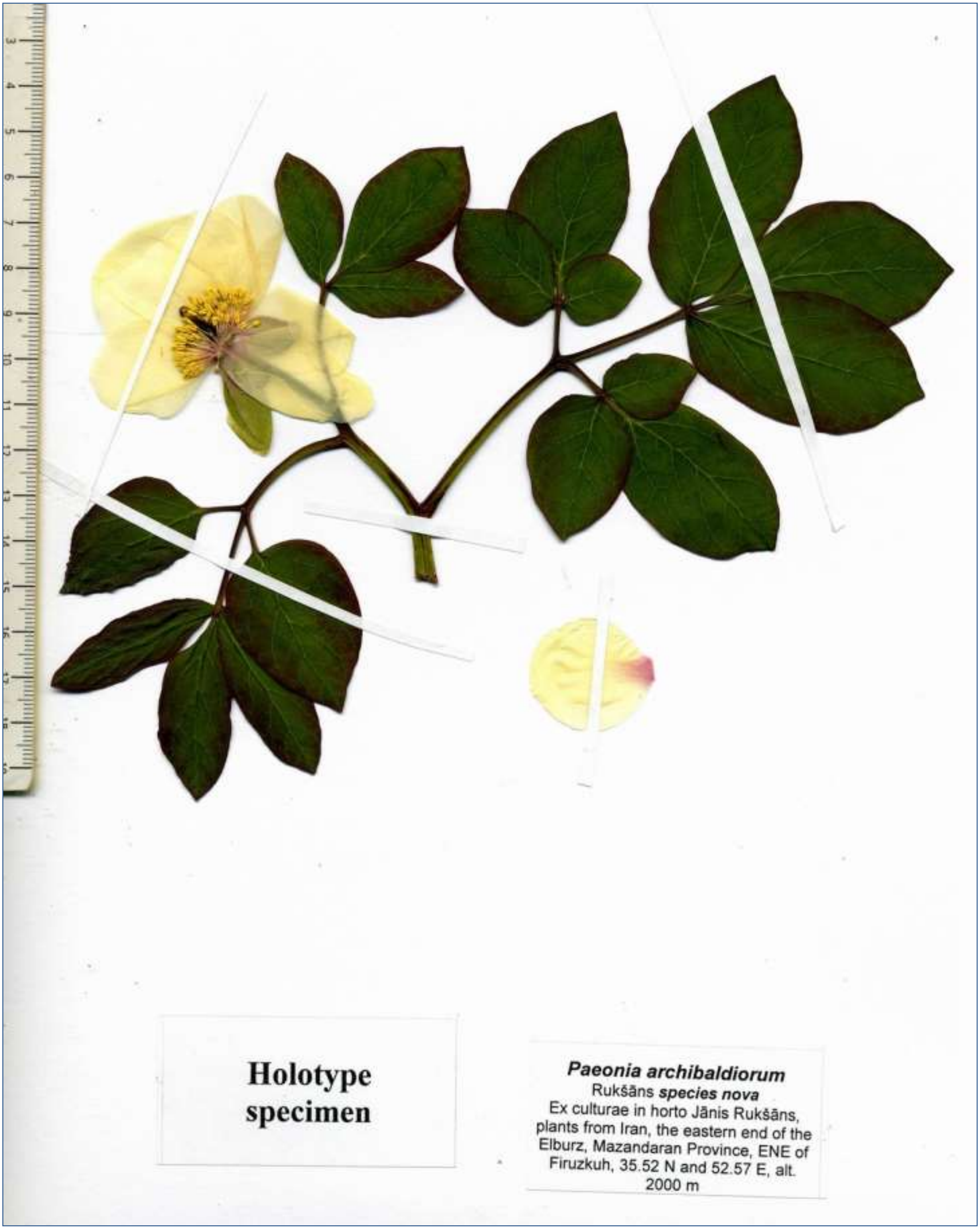
Chromosome number – unknown.

Etymology – named after James Cartledge Archibald, who was the first to introduce this beautiful species into cultivation and drew our attention to it.

Right: *Paeonia archibaldii,* lower scales
Below: *Paeonia archibaldii,* involucrate bract

Paeonia archibaldii - sepals, end of blooming

Right:
Paeonia archibaldii– biternate glabrous leaves after blooming.



Paeonia archibaldiorum
Rukšāns ***species nova***
Ex culturae in horto Jānis Rukšāns,
plants from Iran, the eastern end of the
Elburz, Mazandaran Province, ENE of
Firuzkuh, 35.52 N and 52.57 E, alt.
2000 m

Paeonia archibaldii - holotype specimen (marked with "working" name)

Paeonia archibaldii

References.

Archibald, J., JJA seedlist master, SRGC Archibald Archive.

Assadi, M., 2016. A taxonomic revision of the genus *Paeonia* (Paeoniaceae) in Iran. Ir. J. Bot. 22 (2): 75-78.

Halda, J., 2014. In: Halda, J. & Waddick, W. (eds). The Genus *Paeonia,* 1-127. Timber Press.

Hong, De-Yuan, 2010. Peonies of the World. Taxonomy and Phytogeography, 1-302. Royal Botanic Gardens, Kew.

Hong, De-Yuan, 2011. Peonies of the World. Polymorphism and Diversity, 1-94. Royal Botanic Gardens, Kew.

Riedl, H., 1969. Paeoniaceae. In W. Rechinger (ed.), Fl. Iranica 60: 1-6. Akademische Druck-u. Verlagsanstalt, Graz.

Rukšāns, J., Zetterlund, H., 2014. An Iranian peony to honour Per Wendelbo. Alpine Gardener 82 (2): 230-237.

---Species description---

CROCUS YOUNGIORUM – A NEW *CROCUS* (Liliiflorae, Iridaceae) SPECIES FROM THE ANATOLIAN DIAGONAL

Jānis Rukšāns, Dr. biol. h.c.
Henrik Zetterlund, Gothenburg Botanical Garden

Email contact: janis.bulb@hawk.lv

Published in International Rock Gardener 102 – June 2018 Pages 14 - 24

Summary: Variability of *Crocus munzurense* in Tunceli Province of Turkey is discussed; a new species *Crocus youngiorum* is described.

Key words: Turkey**,** Tunceli Province, *Crocus munzurense, Crocus youngiorum*.

The genus *Crocus* ranges from Portugal and the north-western coast of Africa as far as the north-western corner of China. Today, more than 240 species are recognized. The greatest number is in the Balkans and Turkey, which might be regarded as the centre of origin and development of the genus. In Turkey many crocus species are found along the Anatolian diagonal. Brian Mathew (1982) earlier regarded the majority as belonging to the extremely variable *Crocus biflorus* ssp. *tauri*. This name hid several very distinct species (Kerndorff et al., 2013). In numerous expeditions to this region that began in the 1990s, we and other researchers gathered samples from many different populations; some of them were later recognised as individual species by Helmut Kerndorff, Erich Pasche (2013) and others. Several of them still have not been further researched and remain unnamed for various reasons.

Eight samples from our collections in Tunceli Province have blue or purplish tinted flowers and corm tunics with basal rings. In 2013 Kerndorff and Pasche published *Crocus munzurense* from this region, although the type locality (HKEP-9347) is reported as the more northerly Erzincan Province; the species is named after the Munzur mountain range, which separates the two provinces. Kerndorff and Pasche had mentioned *C. munzurense* for the first time in 2003, when they gave specific details that distinguished it from other similar species. Subsequently one of these authors sent Jānis Rukšāns a sample of *C. munzurense* (HKEP-9911), most likely gathered at the same type locality. In 2007, another specimen of the same gathering came from Michael Kammerlander, who gave the locality of origin as the Munzur Dağları, Tunceli Province.

Crocus munzurense HKEP-9911

All but one of our eight samples look very similar to *Crocus munzurense* (HKEP-9911) in respect of their flowers and some other features. We found none similar in Erzincan Province; as a matter of fact, all those grown by us from the area of the province north of the Munzur Dağları more or less resemble *C. sakaltutanensis* (Rukšāns, described in 2016), which is very different from *C. munzurense* in many features. Of course, it cannot be denied that *C. munzurense* also grows on the northern slopes of the Munzur Dağları.

About this, a short time ago one of our correspondents wrote to us: “My daughter recently said something interesting about ghosts. You cannot prove that they do not exist, because it is impossible to prove that. It is only possible to prove that something does exist. Smart child... This applies to the plant locations, too. Unless you have monitored the entire region from January to June (for the spring flowers) you cannot be sure and even then it just might not exist there anymore.”

Unfortunately, the exact localities of the type specimen HKEP-9347 and the sample HKEP-9911 are unknown and unavailable to other researchers. One exception is HKEP-9910 which was collected near Kaplıkaya Tepe, but this population, representing another species related to *C. munzurense*, was later reported by Kerndorff et al. (2013) as being destroyed (probably by farming or by the filling of a water reservoir N of village - J.R.).

One outstanding feature that allows the separation of *Crocus munzurense* sensu lato from other related species is its hairy and papillose leaves, rather uncommon in the genus, especially among the so-called ‘*biflorus*’ crocuses; all the plants in our collections from Tunceli Province have similar leaves. There are two other characteristics not mentioned in the original publication of *C. munzurense*: the presence or absence of hairs or papillae on the stigmatic branches; and the quite special character of the corms – they produce pea-sized cormlets at the base of the replacement corm. We saw this latter feature in cultivation but can say nothing about wild populations.

According to Kerndorff et al. (2013), the *Crocus munzurense* group comprises two different species (the other population HKEP-9910 having been later destroyed, it was impossible to gather more data on it). The flowers of both species were very similar, making it easy to distinguish them from other crocuses. Both could be easily separable by the length of their filaments, which in *C. munzurense* are on average 3 mm long and in sample 9910 are 5 mm. This statement prompted us to take a closer look at the crocuses from this region in our collections (the Rukšāns collection now contains more than 1650 different samples of crocuses). We mapped all the known localities and discovered that all those whose flowers were similar to *C. munzurense* s.l. came from the valley of the River Pülümür to the North of Tunceli. A last group of three samples came from around 50-60 km south-east of Tunceli along the road to Erzincan. These three samples (KPPZ 90 -186A, -186B and one from Jim Archibald) have narrow leaves and form cormlets at the base of the replacement corm. The single feature separating them from the plants collected in the Pülümür Valley is the presence of sparse papillae or minor hairs on the stigmatic branches; this feature was not mentioned in the description of *Crocus munzurense* so we can suppose that in typical *C. munzurense* they must be glabrous.

Crocus munzurense aff. KPPZ-90-186A

Crocus munzurense aff. KPPZ-90-186

C. munzurense N. of Tunceli, Archibald 17870 and *C. munzurense* aff. SE Tunceli to Elazig.

Crocus munzurense SASA-211

Crocus KPPZ 90-223

Two other samples with exactly known collection localities are SASA-211 (north of Kirmizi Köprü village) and KPPZ 90-223. SASA-211 is very similar to typical *Crocus munzurense* but plants with slightly feathered exteriors of the flower segments are more common in this population, and corms do not form cormlets around the base of the new corm. Sample KPPZ 90-223 is more distinct: its leaves are up to 3 mm wide; its corms look somewhat different. The stigmatic branches in both (SASA-211 & KPPZ 90-223) are distinctly glabrous – as in sample HKEP-9911. There is a sample from Jim Archibald (17870) with darker blue flowers, from "*north of Tunceli*", but more detailed data are now unavailable. The only trait separating it is the slightly darker flowers, but they are still within the colour variability reported by Kerndorff et al (2013). The aforementioned all match to some extent the original description of *Crocus munzurense*, only KPPZ 90-223 falling somewhat outside the general concept, according to the width of its leaves. Things are quite otherwise with sample KPPZ 90-209, which differs significantly from typical *C. munzurense*. Two features immediately push it out of the range of variability of *C. munzurense* s.l. Firstly, its leaves are up to 4 mm wide; although the leaves in KPPZ 90-223 are up to 3 mm wide they are still narrower than in 90-209, while typical *C. munzurense* is characterized by Kerndorff et al (2013) as having narrow (1.5 mm) leaves. Secondly, *C. munzurense* is described as having "*strange sky-blue to lilac colour of the flowers without any stripes outside of the segments, a white zone above the yellow throat*". The latter feature is not mentioned anymore in the later publication and the colour range is broadened to "*Few individuals have violet feathers*" (Kerndorff et al., 2013) - but this characterizes all the other samples regarded by us as *C. munzurense* s.l.

KPPZ 90-209

Crocus youngiorum KPPZ 90-209

In contrast to *C. munzurense* s.l., the flowers of sample KPPZ 90-209 are very distinctly striped and feathered purplish and their colour represents a completely different kind; the flowers are in purplish shades and not in the bluish ones of *C. munzurense* s.l. The stigmatic branches are distinctly and densely papillose, even hairy. There are admittedly some papillae on the stigmatic branches of *C. munzurense* s.l. from south-east of Tunceli, but none equals the plants from the Munzur Valley in this trait.

All these indicated features make sample KPPZ 90-209 so special that they support its classification as a new species. Its range is separated from the Pülümür valley (from where typical *C. munzurense* was most likely described) by the Karasakal Dağları and Karaoğlan Dağı. It was found in 1990, when an international group (M Kammerlander, E Pasche, J Persson, H Zetterlund – hence the abbreviation KPPZ) was led here by the Gothenburg Botanical Garden. *Colchicum munzurense* was described from the same place. In 1990, when the KPPZ expedition visited the Munzur Dağları, it was a peaceful region popular with tourists and there were no restrictions on entrance to the mountains along the side roads, with plenty of roadside restaurants, petrol stations and other facilities. The very spectacular road from Tunceli to Ovacik through the Munzur Vadisi Millî Parkı (National Park) was open to tourists and explorers. Some years later the Kurdish revolt against discrimination and suppression of their culture started and everything changed dramatically. When our team wanted to visit the Pülümür and Munzur valleys in 2004 and 2005, we were rigorously questioned by gendarmes at a checkpoint long before the valley – why we wanted to use exactly that road and so on. When at last we were permitted to enter, it was only to pass through the Pülümür Valley, and we were warned not to make any side turns or stops and not to converse with the locals. The entire tourist infrastructure had been destroyed and abandoned.

The impossibility of revisiting the locality whence crocus sp. KPPZ 90-209 came forced us to use cultivated plants when describing the new species. It had been demonstrated by earlier research on *C. rhodensis* (Rukšāns, 2018) that there are no significant morphological differences between cultivated plants and plants in the wild. Observations were therefore made both in the Rukšāns collection and on plants grown in the Gothenburg Botanical Garden. Our description is based on the observations of ten plants made during three seasons.

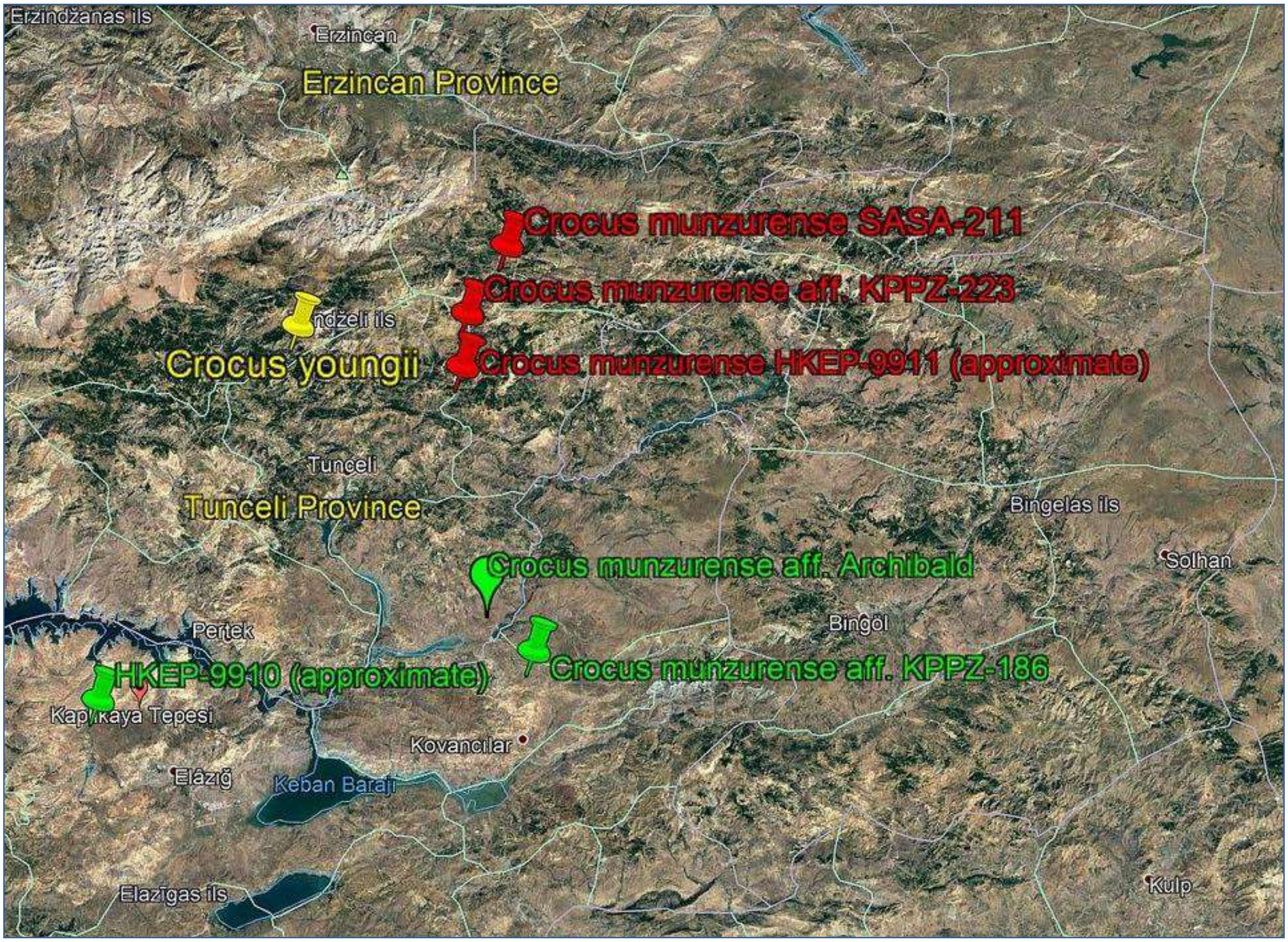
Crocus youngiorum KPPZ 90-209

Crocus youngiorum KPPZ 90-209

Holotype specimen

Crocus youngii sp. nova
KPPZ 90-209 - 27 km from Tunceli along Munzur river towards Ovacik. S facing slope in light deciduous oak forest. Alt. 1000m. Leg. H.Zetterlund, 11-04-1990 ex culturae in horto Jānis Rukšāns

Crocus youngiorum KPPZ-209 Holotype herbarium specimen (marked with “working” name).



Map of *Crocus youngiorum* and *C. munzurense* localities

Crocus youngiorum KPPZ-209 corms

Crocus youngiorum Rukšāns & Zetterlund species nova

Type: Ex culturae in hortus Jānis Rukšāns, 11-03-2018. Plants collected in Turkey, Tunceli Province, 27 km from Tunceli along the Munzur River towards Ovacik, along a roadside S of the river in a narrow ravine on a south-facing slope at 1000 m alt., leg. H. Zetterlund, 11-04-1990 (KPPZ 90-209). Holotype: GB (Gothenburg). Ic.: World of Crocuses, p. 351 – as *munzurense* aff.

Habitat and distribution – known only from the type locality, growing in light deciduous oak forests and scrub based on calcareous rocks, together with *Colchicum munzurense* KPPZ 90-208 (a form with stoloniferous corms) in Tunceli Province, the Munzur River Valley.

Flowering time – March.

Corm – slightly flattened, up to 15 mm in diameter, forming pea-sized cormlets around the base.

Tunics – more or less papery (membranous), with a few splits at the base, subsplits absent or occasional.

Tunic neck – up to 3-5 mm long, formed by broad-based triangles with the tips turned outward.

Basal rings – mostly 2, poorly developed, papery, without teeth, but with a distinctly uneven, somewhat pronged edge.

Prophyll – absent.

Cataphylls – 3, the upper cataphyll slightly greenish in the topmost part.

Leaves – dark green, 4-**5**-7 and (3-)4 mm wide, distinctly hairy along the edges and keel, with 3 ribs in each lateral channel, at the start of blooming poorly developed, during the anthesis quickly elongating and reaching the middle of the flowers, at the end of blooming even overtopping them; the white stripe less than 1/3 of the leaf width.

Perianth tube – light to deep purple, without stripes.

Bract and bracteole – well developed, of the same length, but somewhat subequal in size, silvery, mostly ending slightly above the cataphylls, rarely reaching the middle of the perianth tube.

Throat – glabrous, medium-sized, deep yellow, in the upper part a diffused whitish zone followed by the lilac of the flower segments.

Filaments – 5-**6**-7 mm long, light yellow, with minute and sparse papillae or glabrous.

Anthers – 8-**9**-11 mm long, yellow, on average 1.5 times longer than the filaments, occasionally almost equal in length.

Connective – white.

Style – light greenish yellow becoming orange near the top, the very tip yellow, divided into 3 orange, distinctly papillose, (4)5-6(8) mm long branches, gradually widening at the top with a fringed edge, sometimes subdivided into short secondary branches, mostly more or less equal with the tips of the anthers, rarely shorter; in 2018 the same plants almost invariably had stigmatic branches overtopping the anthers, in 20 % ending below the tips.

Flower segments – the inside light lilac, on the outer segments translucent outer striping.

Outer segments – 36-**39**-44 mm long and 11-**14**-16 mm wide (n=10), obovate with acute to subacute tips, the outside light lilac to whitish with 3 very distinct deep purple median stripes feathering towards the outer rim, at the base confluent into a dark purple basal blotch. Length to width ratio: 2.8.

Inner segments – 33-**37-**42 mm long and 10-**15**-17 mm wide, light lilac with a small deep purple basal blotch. Length to width ratio: 2.5.

Capsule - up to 23 mm long and 9 mm wide, deep purple with greenish to greyish stripes, something spindle-like, gradually narrowing from middle to pointed tip with around 1 cm long appendage, carried at ground level at maturity.

Seeds – fresh seeds up to 4 mm long and 2.5-3 mm wide. Purplish brown, with 1-1.5 mm large, prominent caruncle and distinct raphe.

2n = unknown.

Etymology – named after Margaret and Ian Young from Aberdeen, Scotland, United Kingdom, moderators of the Scottish Rock Garden Club plant forum, editor of the monthly online magazine *The International Rock Gardener* and writer of the weekly Bulb Log.

Crocus youngiorum
KPPZ-209 seed capsules

Bibliography:

Kerndorff, H, E Pasche 2003. *Crocus biflorus* in Anatolia. The Plantsman. New Series 2: 77-89.
Kerndorff, H, E Pasche, F R Blattner& D Harpke, 2013. *Crocus biflorus* Miller (Liliiflorae, Iridaceae) in Anatolia – Part IV. Stapfia 99: 159-186.
Mathew, B. 1982. The Crocus. A Revision of the Genus *Crocus* (Iridaceae). London: B.T. Batsford Ltd. 224 pp.
Rukšāns J, 2017. The World of Crocuses. The Latvian Academy of Science, Latvija, 568 pp.
Rukšāns J, 2018 How to characterize a Crocus species? International Rock Gardener. 99: 2-21.

---International Rock Gardener---

---Species description---

A RARE, NARROWLY ENDEMIC NEW SPECIES OF *ALSTROEMERIA* (Alstroemeriaceae) FROM THE TRANSVERSAL ANDEAN FOOTHILLS OF CENTRAL CHILE, AND ITS INTERESTING ECOLOGY

JOHN M. WATSON[1], ANA R. FLORES[1] & GLORIA ROJAS[2]

[1]*Casilla 161, Los Andes, Aconcagua, Valparaiso, Chile. E-mail: john.anita.watson@gmail.com*
[2]*Sección Botánica, Museo Nacional de Historia Natural, Santiago.*

Published in International Rock Gardener 102 – June 2018 Pages 25 - 54

Abstract

Alstroemeria piperata, the novelty described here, is only known from two localities less than 3 km apart in the western sector of Los Andes Province, Valparaiso Region. Various aspects of its ecology are discussed, as based on two seasons of *in situ* observations and the comparative performance of a small sample in cultivation. Factors considered include its exceptional production of sterile vegetation, the unusual habitat, temporal and floral variability from year to year, pollination, and actual or potential negative concerns likely to increase its vulnerability and affect assessment of its conservation status. Diagnostic morphological characters are given, and also a key to distinguish *A. piperata* from other *Alstroemeria* species with broadly similar features.

Key words: adventive threat, conservation status, clay, cultivation, herbivory, insect/plant mutualism, matrix, patch dynamics, vegetative colonization.

Resumen

Alstroemeria piperata, la novedad que se presenta aquí, está limitada a dos localidades en el sector occidental de la Provincia de Los Andes, Región de Valparaiso, que están separadas por menos de 3 km entre si. Se discuten varios aspectos de su ecología, basado en dos temporadas de observaciones *in situ* y el rendimiento comparativo de una muestra pequeña en cultivo. Los factores considerados incluyen su excepcional producción de brotes estériles, un hábitat inusual, su variabilidad temporal y de floración de año en año, polinización, y las preocupaciones negativas, ya sean reales o potenciales, que pueden aumentar su vulnerabilidad y que afectan la evaluación de su estado de conservación. Se dan caracteres morfológicos diagnósticos y también una clave para distinguir *A. piperata* de otras especies de *Alstroemeria* con características más o menos similares.

Palabras clave: amenaza de plantas adventicias, colonización vegetativa, cultivo, dinámica de parches, estado de conservación, greda, herbivoría, matriz, mutualismo entre insectos y plantas.

Introduction

The medium-sized genus *Alstroemeria* is exclusive to South America. It consists of two geographically discrete units of approximately the same numerical content (Ravenna 2000, Assis 2002, Muñoz-Schick & Moreira-Muñoz 2003, Sarwar et al. 2010). One group occupies Atlantic exposures, with its centre of diversity in Brazil. The other, to which the new species belongs, is Andino-Pacific in distribution, extending southwards down into Patagonia. Chile hosts the great majority of its taxa.

The overall species count of the genus is uncertain, in particular due to the large quantity of unassessed taxon names published by Ravenna between 1988 and 2009 (IPNI 2017), but probably stands at ca. 90, as estimated from The Plant List (2013) and personal knowledge. Within that figure, the Chilean statistic is also somewhat open to question. Again, this largely results from the significant number of taxa published by Ravenna from 1988 to 2003 (e.g. Ravenna 1988, 2000), mainly with type specimens which cannot be accessed on request, apparently because they lack attached field notes (P. Ravenna pers. comm.), or may possibly be destroyed in part or in total (P. Ravenna pers. comm.). His novelties are either accepted uncritically, e.g. 24 species for Chile at the highest confidence level by The Plant List (2013), or omitted entirely (e.g. Muñoz-Schick & Moreira-Muñoz 2003), or mentioned in passing, as per this work. The present authors accept 40 species (Bayer 1987, Muñoz-Schick & Moreira-Muñoz 2003, Eyzaguirre Philippi 2008, Muñoz-Schick et al. 2011, Hoffmann et al. 2015, Negritto et al. 2015), all but seven of them national endemics. That total excludes the entire unassessed Ravenna output, but includes the novelty presented here, which is the latest of several new species of the genus in Chile to be published over recent years, and also a further addition to the endemic flora of Chile and Valparaiso Region.

The new species is located in the Andean foothills of the transversal Cordón de Chacabuco, 14 km south of the town of Los Andes in Valparaiso Region, close to where we (JMW & ARF) live (which is actually a small, outlying rural community of Calle Larga) [fig. 18], so literally 'just up the road' for us. It was discovered by chance at the sector called Los Ranchillos [fig. 23] as a result of planned visits there by ourselves between August and October 2013 involving another investigation. An annual rosulate violet at Los Ranchillos had been reported by our late colleague, Carlos Celedón. It proved to be the rare *Viola chamaedrys* Leyb., [fig. 1] recorded from two locations during the latter half of the 19th Century (Reiche 1893) and not rediscovered in habitat again until recent decades, as described at the time in The Rock Garden (Watson & Flores 2014).

fig. 1 *Viola chamaedrys,* the species Carlos rediscovered and took us to see - to which we owe our encounter with the patch system and its flora. 1 October 2015. (JMW)

The violet, together with a few other taxa, is confined to a very specific and highly localised habitat of patches of otherwise almost bare soil (Watson & Flores 2014). During the period of its flowering in late

September to early October we observed large, vigorous carpets of foliage, identified as primary sterile growths of an *Alstroemeria*, which were also adapted exclusively to the same exposed terrain [figs. 2-4].

fig. 2 Anita during our first visit to the patch system with friend Carlos Celedón (behind) on a gloomy late winter's day. 18 August 2013. (JMW)

fig. 3 Characteristic uniquely super-extensive sterile preliminary growth of *Alstroemeria piperata* (F&W 12856) at main lower Los Ranchillos patch site. 1 October 2015. (JMW)

fig. 4 The type (upper) patch site showing massive coverage by preliminary carpets of *Alstroemeria piperata* equivalent to the lower location. 27 October 2015. (JMW)

fig. 5 *Alstroemeria pulchra* subsp. *pulchra* is common higher up at Chacabuco. It therefore seemed possible the extensive foliage might be that species. 23 October 2015. (JMW)

We have developed a serious interest in the taxonomy of the Chilean members of *Alstroemeria* (Watson & Flores 2010, Hoffmann et al. 2015). *Alstroemeria pulchra* Sims subsp. *pulchra* [fig. 5] occurs close by in some quantity. After some initial doubts as to whether perhaps the foliage might correspond to that taxon, we concluded the sterile phase of the plant at Los Ranchillos did not match that of any known taxon of the genus in the area, if anywhere. This suspicion was confirmed when we revisited the site in late November 2014 and found flowering individuals [fig. 6]. It proved to be the distinctive little *Alstroemeria* described for the first time below.

fig. 6 Upper patch site. *Alstroemeria piperata* (arrowed) flowering more freely among its desiccated early foliage in a favourable season. 20 December 2015. (JMW)

Materials and methods

Standard reference voucher specimens were made, including subterranean organs, separations of floral parts, and sterile as well as fertile shoots. *In situ* photographs recorded the physical aspect of the living plant, its floral variability, habitat, and details of life history as observed in the sterile phase, during anthesis and at fruiting.

A separate collection of a maturing fruit head was gathered and ripened ex situ. The seed from this was stored as an additional herbarium reference collection. Thorough investigation at both locations took place the following season, and a small living sample has been cultivated and kept under observation.

Measurements for subterranean organs were taken from the few collected reference samples and therefore may not represent the greatest extension of stolons *in situ*.

Monographs and other literature relevant to the Chilean taxa of *Alstroemeria* were consulted for comparative and relational data. The bibliographic botanical encyclopaedia of the Chilean flora (Marticorena 1992) gave accurate details and corroborations for references.

Various literary and Internet sources provided specialised details of the novelty's unusual habitat and ecology. Cooperative local inhabitants were also interviewed on this aspect.

The monograph and field guide of Peña & Ugarte (1997) served to identify pollinating Lepidoptera (butterflies). Other insects were kindly determined by the head of the Área de Entomología at the Museo Nacional de Historia Natural, Santiago de Chile and his colleague.

fig. 7 *Alstroemeria piperata*. A very dwarf form with large, strongly marked perianths. Upper, type, site. 19 November 2014 (ARF)

fig.8 Type site. *Alstroemeria piperata* A taller form with the smaller size of perianths, here lightly speckled. 30 November 2014. (JMW)

fig. 9 *Alstroemeria piperata*. This form is both dwarf and with smaller perianths. It has an average intensity of flecking. Upper, type, station. 23 November 2014. (JMW)

fig.10 *Alstroemeria piperata*, an individual with unusually sparse stippling (F&W 12819). Los Ranchillos type site. 30 November 2014. (JMW)

fig.11 A lone monstrose form of *Alstroemeria piperata* with atypical lanceolate-subulate, colourless outer tepals. 19 November 2014. (JMW)

fig.12 An unearthed F&W 12815 type specimen showing the relative proportions of the brief aerial and extensive subterranean growths. 19 November 2014. (Gloria Rojas)

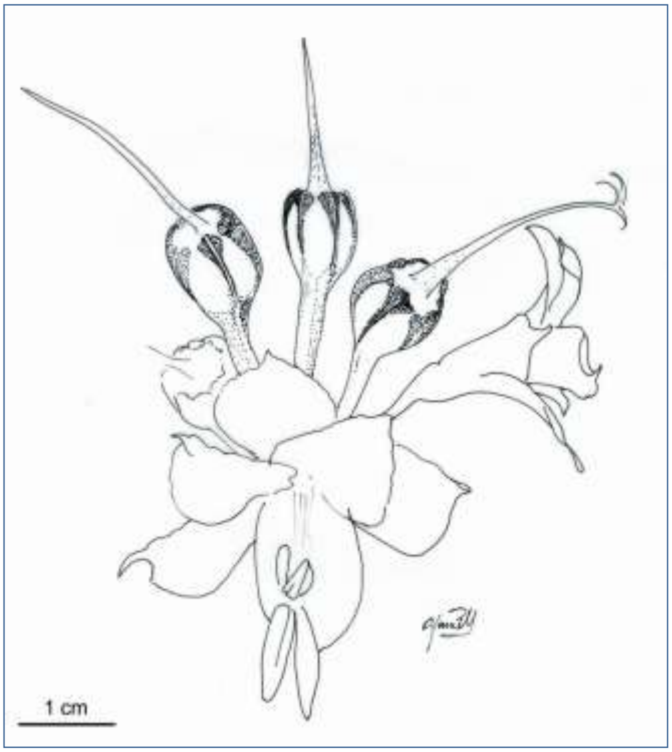


fig.13 *Alstroemeria piperata* depicted still in flower, but with early capsules forming. (Drawing - Gloria Rojas)

fig.14 Successful fruit set by a healthy clump in a good rainy year. Two plants have five capsules each, another nearby had six. Type station. 10 January 2016. (ARF)

fig.15 *A. piperata* root system detail. Fine indumentum on the tubers and the nature of the red clay are clearly apparent.
19 November 2014. (Gloria Rojas)

fig.16 Sterile preliminary shoots of *A. piperata*
(F&W 12856) at the Los Ranchillos lower patch site.
1 October 2015. (JMW)

fig.17 Upper (type) site. Just four *Alstroemeria piperata* individuals in flower (arrowed) in an extensive stretch of dessicated early foliage. 20 December 2015. (JMW)

Taxonomic results

Alstroemeria piperata A.R. Flores & J.M. Watson, *sp. nov.* [figs.7-17]

Type:—CHILE. V Región de Valparaiso, Provincia de Los Andes, Los Ranchillos, between the Chacabuco pass and Rungue, 2.8 km N of Rte G-105-E, 1442 m. 32º55'S 70º42' W, 19 November 2014, F& W 12815 (holotype SGO!, isotypes CONC!, Herb. Watson & Flores!).

Diagnosis:—Evidently closely related to *Alstroemeria achirae* Muñoz-Schick & Brinck, from which it differs morphologically by its always simple—never compound—umbel; obovate—not oblanceolate—inner-upper tepals; yellow—not reddish pink—filaments; and pale—not bright yellow—anthers.

Description:—*Life form*: Perennial, dwarf, glabrous, glaucous, geophytic herb from spreading rhizomatous and tuberous root system, with primary cycle of sterile growth followed by secondary cycle of fertile shoots. ***Root system*:** Clustered tubers, each at termination of individual 0.5-5 cm filiform stolon branching off from subcylindrical, subterranean, white crown rhizome ca. 4.5-6 cm long and 6-10 mm diameter at crisply fleshy active growth point. ***Tubers*** fusiform, brittle, 2-5 cm long x 0.8-1.4 cm diameter, surface silky-pilose and somewhat mucilaginous, apex occasionally with 1(-3) thread-like terminal feeder roots to ca. 8 cm long. ***Sterile growth*** vigorous, multiple, strongly and densely colonial, radiating from crown rhizomes as white stolons ca.10-20 cm long x 1.5-2 mm diameter, each terminating in solitary depressed, subacaulous or erect aerial shoot, height from 2-5 cm (in fully exposed situation) to 12 cm (in centre of colony) and 18 cm or more (at base of small shrubs). Foliage dense, patent to suberect; ***leaf*** 2-10 cm x 3-8 mm, entire, narrowly oblanceolate, plane or more or less torsioned towards apex to fully resupinate at times, usually acute, less commonly obtuse, attenuate-cuneate in basal half, where channelled and transforming to pseudopetiole, slightly fleshy-thickened, glaucous. ***Fertile growth*** radiating from crown rhizome as white stolons ca. 5-15 cm long x 2-3 mm diameter, each terminating in solitary, erect, patent- to suberect-foliate, stout aerial scape 7-12 cm high. Foliage dense to sparse; *leaf* 1-2 cm x 1-4 mm, sessile, plane, entire, linear or linear lanceolate or narrowly triangular or narrowly ovate, acute to acuminate, glaucous, often dead or dying back at anthesis. ***Inflorescence*** a simple 2-10 radial umbel, maximum dimensions ca. 9-10 cm wide x 5 cm high, or stems rarely uniflorous; rays 0.8-3 cm. Umbel provided with subtending ring of up to ca. 9 bracts, these ca. 1-1.5 cm x 0.8-1.2 mm, linear to lanceolate, acuminate. ***Perianth*** flaring-infundibuliform, smallish medium-sized for genus, bright lemon to rich egg-yolk-yellow, sometimes paler in throat; inner tepals commonly more strongly coloured; outer tepals sometimes notably pale. ***Tepals*** 6, free, often slightly recurved, more or less stained purplish pink to reddish at apex, occasionally also on face somewhat below apex, and mid-longitudinally on reverse of outer tepals, including over several thin, subparallel mid-veins. All tepals mucronate at apex; mucro ca. 1 mm long, upcurved at margins, pale greenish or purplish pink. Faces of all tepals more or less covered by variably dense, fine stippling of dark or dull red basal speckles and outer very short dash-lines up to ca 0.2 mm long on entire face of inner-upper tepals and part of outer and lower-inner tepal faces (rarely only inner-upper tepals marked). ***Outer tepals*** 2.4-2.8 x 0.7-1.1 cm, obovate, obtuse. ***Inferior inner tepal*** 2-2.4 x 0.5-0.8 cm, obovate, acute to subobtuse, apex occasionally strongly recurved. ***Superior inner tepals*** 2.6-3.2 x 0.6-1 cm, obovate, obtuse; margins strongly incurved in throat of perianth, meeting to form short basal nectar tubes. ***Filaments*** ca. 1.7-2.8 cm, straight at first, then strongly upcurved apically, bright yellow, rarely dull, pale orange or white. ***Anthers*** 3.5-5 mm, white, pale whitish tan or yellowish cream. ***Style*** 2-2.3 cm, pale, pinkish towards tip, upcurved apically and frequently not fully developed during early anthesis and therefore not evident. ***Stigma*** strongly trifid when mature. ***Fruit*** ca 1.2 cm diameter loculicidal, orbicular, beaked, 3-chambered, explosive capsule; 6-ribbed; beak finally 4-5 mm. ***Seeds*** 3-5 mm long, rust-brown, variously shaped as suborbicular, compressed orbicular, oval, hemispherical or irregularly angular; or more rotund when fewer seeds per capsule; surface minutely tuberculate, (4-)8-14 per capsule.

Further material examined: CHILE. V Región de Valparaiso, Provincia de Los Andes, Los Ranchillos, Rte G-105-E, between the Chacabuco pass and Rungue, 1295 m. 32º56' S 70º42´W in sterile primary growth, 18 August 2015, F.& W. 12853 (Herb. Watson & Flores!). *Ibid*., 1 October 2015, F& W 12856 (Herb. Watson & Flores!).

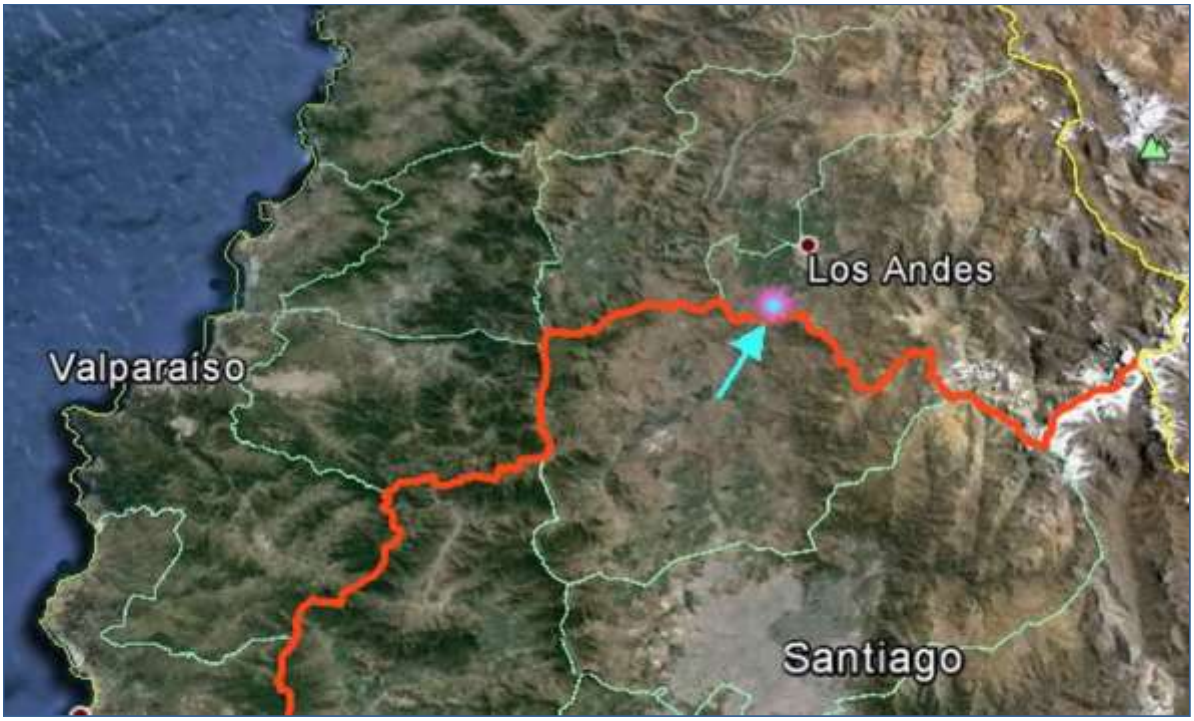


fig.18 Blue-arrowed colour spot shows *Alstroemeria piperata* location at border of Valparaiso Region, with Santiago (Metropolitan) Region south of red boundary line.

Distribution: As known, *Alstroemeria piperata* is confined to two discrete clusters of patch islands. It therefore qualifies as both a rare, narrow endemic of Chile and also of Valparaiso Region [fig.18]. The lower station [figs. 2, 3, 20, 21, 23] is situated at ca. 1290-1300 m in close proximity to the rural road (Rte G-105-E) connecting the Chacabuco pass sector with Rungue to the west on the main Pan-American highway (Rte 5 N). The higher (type) station [figs. 4, 6,17,19] at ca. 1440-1450 m lies roughly 1.8 km on average to the north via an aerial access track. *A. piperata* is more abundant at the latter site.

fig.19 A surprisingly numerous *A. piperata* colony, which probably owe their survival to shelter by scattered shrubs.
29 December 2015. (JMW)

fig.20 A lower site patch surrounded by acacia savannah - *Descurainea erodiifolia* foreground, *Alstroemeria piperata* mats behind. Note dead and dying 'woodies'. 27 October 2015. (JMW)

fig. 21 *Olsynium junceum* growing at the interface of patch and matrix and entering the patch in a good year. Lower site. 27 October 2015. (JMW)

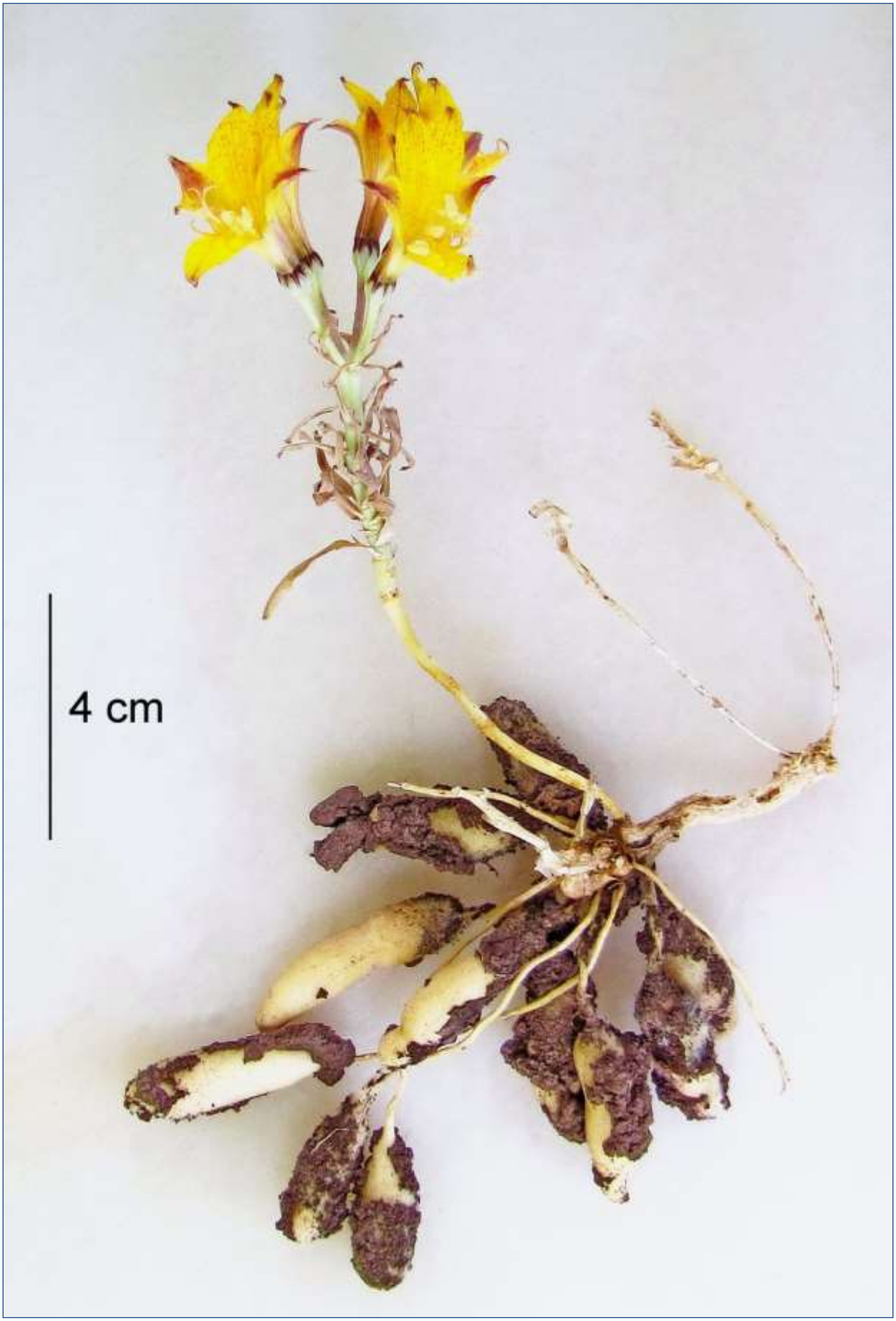


fig.22 An *Alstroemeria piperata* type specimen (F&W 12815) prior to pressing. 20 November 2014. (ARF)

Environment and habitat: See below.

Phenology: Sterile growth is initiated from May onwards by winter rains, including very short-lived snows, being well established by August. Flowering: November to end of January, varying according to the inconsistent timing and variable quantities of precipitation from year to year. Fruiting (from formation to seed ejection): December to February.

Etymology: The name was suggested by the fanciful similarity of the small speckles distributed over the faces of the yellow tepals to ground black or red pepper sprinkled over a dish of eggs.

fig.23 A view across central Los Ranchillos looking east towards the distant Andes and showing the twin peaks distinctive landmark. 26 Aug 2013. (JMW)

Conservation status: The lower station is in an area widely and quite intensively grazed by small, omnipresent flocks of goats. In the two seasons of our study some variable deleterious effect has been noted for *A. piperata* during the sterile phase, but damage was limited, probably due to the existence of much surrounding edible vegetation during general early growth at the time.

fig. 24 Faeces of the dreaded goat. What voided vegetation might those harmless-looking pellets consist of, one wonders. 23 Nov 2014. (JMW)

Appreciably larger numbers of fertile shoots than in 2014-15 emerged at both stations from November to mid-January during the wetter 2015-16 ENSO (El Niño Southern Oscillation) climatic phenomenon (Couper-Johnston 2000). The last few were breaking through the ground in mid-January 2016. As observed during a visit at the end of November 2015, every lower colony had been grazed during the elongation of numerous precocious scapes, with almost all developing inflorescences devoured or badly damaged. The supposition of goats as causal agents rather than other herbivores is based on indirect but strong evidence of tracks, faeces [fig. 24] and perception of their movements (J. Watson & A. Flores pers. obs.). Introduced Eurafrican rabbits (*Oryctolagus cuniculus* Linnaeus) and Eurasian hares (*Lepus europaeus* Pallas) are widespread at Los Ranchillos, the former in significant quantity (J. A. Astargo, D. Onel pers. comms.). Their effect on *A. piperata* is unknown, although no relevant faeces have been observed where it grows.

fig. 25 A cow-pat reminds us that although grazing wild guanacos were driven away by human occupation, replacements were brought in. 23 Nov 2014. (JMW)

The upper, type, station does not appear to be subject to more than very occasional, random goat depredation, which has been noted; and faecal indications of the minimal presence of cattle at the site were also seen (J. Watson & A. Flores pers. obs.) [fig. 25]. On 10 January 2016, when the population there was in the

latter stages of anthesis, a few severed and dried inflorescences were noted at two discrete points, although other scapes nearby were undamaged, and numbers of early flowering individuals had already formed capsules at a late stage of maturity.
A very local group of excavations was encountered near one point of the detached flower heads. From the nature of these small pits they are presumed to be caused by a rodent digging for alstroemeria tubers and other subterranean storage organs. It is probably the medium-sized, native degú, *Octodon degus* (Molina) [fig. 26], whose principal habitat is these *Vachellia* (syn. *Acacia*) *caven* (Molina) Seigler & Ebinger ecosystems (Mann 1978) [figs. 2-4,17, 20,21,23, 27].

fig.26 A family of degús, *Octodon degus*, a charming little burrowing rodent. They live on bulbs and tubers, etc., possibly including *Alstroemeria piperata*. 16 October 2010. (JMW)

Particularly at the upper site, but also to a lesser degree in the lower one, *Alstoemeria piperata* has been noted as flowering at times in the immediacy of scattered shrubs where the surrounding open ground only bears evidence of carpets of its sterile foliage [fig. 19]. This would seem to suggest that it is subject to one or more forms of mammalian herbivory, but finds successful protection in association with woody elements.

fig.27 *Vachellia caven* savannah, the predominant basic vegetation system on flatter ground.
7 January 2016 (ARF)

fig. 28 Very rarely seen superficial insect damage to *Alstroemeria piperata* tepals - possibly the dirty work of a leaf-cutter bee. 14 December 2014. (JMW)

Despite the abundant presence of arthropods in variety, minimal damage to the alstroemeria by these was observed [fig. 28], and nothing that would have prevented the formation of fruits.

Limited but significant invasion by vigorous surrounding and marginal taxa into the distinctive local habitat of *A. piperata* was recorded during the 2015-16 season [figs. 20-21], presumably due to favourable conditions created by late and heavy precipitation resulting from ENSO. Asil & Neumann (2009) report that sufficiently increased irrigation of clay soils facilitates germination and establishment of taxa that are otherwise suppressed or killed by the same medium in drier conditions. From a historical perspective (Couper-Johnston 2000) this is assumed to be an occasional and temporary event for the sector, and that matrix and patch vegetation (see below), whether native or adventitious, will otherwise be in effective equilibrium. Nevertheless, among the adaptive introduced taxa, aggressive *Erodium cicutarium* (L.) L'Hér. ex Aiton, in particular, showed evidence that it may represent a future menace to this unique and rare floral assemblage.

Although the countryside containing the type site is owned by a commercial consortium, the evident lack of a readily available water supply seems likely to deny or at least severely limit any intrusive development.

Random off-road vehicle sorties and regular organised motocross events take place over the terrain where *Alstroemeria piperata* is found, and at times pass across its lower colonies. Due to its extent and vigour when in the sterile phase, this appears to have no critical effect on its basic survival.

In general, the present established state of the species seems relatively secure, at least with respect to the sterile, clonal phase, even though recruitment looks to be inappreciable. Nevertheless, despite the absence of any obvious immediate direct threat to its existence, the extreme rarity of the new species here (two known stations) and its exclusive edaphic adaptation to a highly specialised habitat (see below), above all in a zone of considerable human intervention, potentially classifies it as endangered (EN) (IUCN 2012).

Considering the recent discovery of this very restricted local endemic, together with the presence of other notably rare elements of the Chilean flora (Luebert & Muñoz-Schick 2014), including at least two or three further novelties (J.M. Watson & A.R. Flores ined.), some category of official protective status for the Los Ranchillo district would seem an urgent necessity, ideally also to cover the entire general area of the historical Chacabuco Pass.

[Ed.: An article on the subandean flora of the Chacbuco Pass area will follow in IRG 103, July 2018.]

fig. 29 *Alstroemeria* x *chrysantha*. Similar yellow perianth to *Alstroemeria piperata*, but different markings. [Tongoy, Coquimbo Region.] 9 December 2008. (JMW)

Taxonomic relationships:—Although sharing at least one morphological character with each of the 11 comparative taxa comprising the key below, *Alstroemeria piperata* is apparently not closely allied to any but *Alstreomeria achirae*, and perhaps more remotely to *Alstroemeria citrina* Phil. It differs principally from both in its obligatorily simple rather that habitually compound umbel; also from the former by the broader tepals and the almost omnipresent stippling on all tepals.

fig. 30 *Alstroemeria citrina.* Perianth close to *A. piperata,* but umbel compound. [Quebrada Honda, Choapa.] November 2007. (M. Teresa Eyzaguirre Philippi)

fig. 31 *Alstroemeria garaventae.* Same flecking on all tepals as *A. piperata*, but different coloured perianth. [Cerro El Roble, Valparaiso Region.]
12 December 2010. (JMW)

fig.32 *Alstroemeria* aff. *kingii*. Equivalent all-yellow perianth to *A. piperata*, but no markings. [Canto del Agua, Atacama Region.] 9 October 2010. (JMW)

fig. 33 *Alstroemeria pseudospathulata*. Differs from *A. piperata* in foliage and tepal flecking. [Zapala, Nuequén Province, Argentina] 10 January 2008. (JMW)

fig. 35 F&W 11088. Dwarf *Alstroemeria versicolor.* All tepals flecked as A. piperata, but perianth different colour and shape. [Los Queñes. Maule Region.] 30 December 2005. (ARF)

fig.34 F&W 11780 *Alstroemeria traudliae*, our first new species of the genus, at the type site. [Mantos de Hornillo, Coquimbo Region.] 20 October 2008. (JMW)

Key to differentiate *Alstroemeria piperata* from other habitually or facultatively short Andino-Pacific species with predominantly yellow perianths or all tepals stippled and dashed on faces:

Comparative species: *A. achirae*, *Alstroemeria* x *chrysantha* (Ehr. Bayer) J. M. Watson & A. R. Flores [fig. 29], *A. citrina* [fig. 30], *Alstroemeria garaventae* Ehr. Bayer [fig. 31], *Alstroemeria kingii* Phil. [fig. 32], *Alstroemeria patagonica* Phil., *Alstroemeria pseudospathulata* Ehr. Bayer [fig. 33], *Alstroemeria pygmaea* Herb., *Alstroemeria traudliae* J. M. Watson & A. R. Flores [fig.34], *Alstroemeria versicolor* Ruiz & Pav. [fig.35].

1. Perianth yellow or other colour, with all tepals predominantly or always speckled and dashed overall on faces ... 8.
- Perianth yellow, with tepals never or very rarely speckled and dashed on all six faces.

2. Leaves plane or resupinate. Umbels simple, compound, or flowers solitary. Plants Andean or Patagonian ... 6.
- Leaves resupinate. Umbels compound. Plants from northern lowlands or central interior foothills of Chile.

3. Lamina 1 mm wide. All tepals never speckled and dashed. Plants from northern lowlands ... 4.
- Lamina 3 mm wide. All tepals occasionally speckled and dashed. Plant from central interior foothills ... *A. citrina*

4. Perianth marked or bicoloured ... 5.
- Perianth unmarked, uniform yellow overall ... *A. kingii*

5. Tepals variably speckled, lined and blotched maroon or dark red, or bicoloured and unmarked, never simply speckled and dashed overall. Perianth colour and markings always notably polymorphic within populations .... *A.* × *chrysantha*
- Inner-upper tepals heavily speckled and dashed dark red or blackish brown overall. Perianth colour and markings more or less uniform ... *A. traudliae*

6. Lamina not thick and fleshy, never spathulate, sometimes withered at anthesis. Perianth small, solitary, rarely paired ... 7.
- Lamina thick, fleshy, basal foliage spathulate, rosette-forming, usually present at anthesis. Perianth medium-sized. Inflorescence a multi-flowered umbel, very rarely solitary... *A. pseudospathulata*

7. Lamina 1-5 mm wide, margins usually crispate. Patagonia ... *A. patagonica*
- Lamina 5-20 mm wide, margins always plane. Tropical and subtropical high Andes (not in Chile) ... *A. pygmaea*

8. Perianth flaring, small, basically dull orange, light brown or rarely yellow, often greenish tinged. Tepals more or less equal-sized, reflexed ... *A. versicolor*
- Perianth funnel-shaped, medium-sized. Tepals unequal, all not reflexed ... 9.

9. Perianth pink, pale reddish or white, never yellow ... *A. garaventae*
- Perianth always yellow ... 10.

10. Umbel compound. Inner-upper tepals narrowly oblanceolate. Filaments reddish pink ... *A. achirae*
- Umbel simple. Inner-upper tepals broadly oblanceolate to obovate. Filaments yellow ... *A. piperata*

Discussion

National status: Together with *Alstroemeria citrina*, *Alstroemeria marticorenae* Negritto & C.M. Baeza and *Alstroemeria spathulata* C. Presl [also *Alstroemeria aulica* Ravenna and *Alstroemeria sabulosa* Ravenna where accepted], *Alstroemeria piperata* raises to four [or six respectively] the endemic species total for the genus in Valparaiso Region (Novoa 2013, Negritta *et al*. 2015).

Environment and habitat: The overall background ecosystem is somewhat intermediate between a pre-cordilleran or interior spiny-sclerophyll, mediterranean mattoral type and intermontane spiny-savannah open woodland, with the fluctuating and sometimes dominant overall presence of *Vachellia caven* [fig.27], particularly on more level sectors (Gajardo 1995, Luebert & Pliscoff 2006).

Within the preponderant mattoral-savannah vegetation, *A. piperata* inhabits a particular and very local minor niche. This consists of scattered, restricted, sometimes adjacent areas of dense iron-clay soil, a dull, deep red or dark in coloration [figs. 2-4, 6, 19], which sustain a more or less sparse cover of a specialised flora. On average, each discrete area is ca. 5 m across. Some elements of this community are regional rarities, for example *Heliotropium geissei* F. Phil. (Luebert & Muñoz-Schick 2014). Others, including the present novelty, are not known beyond these clusters of fairly small, natural land-island clearings. The formations are referred to by local inhabitants as *tierra muerta* (dead ground) on account of their uninhabitable condition for most surrounding vegetation and worthlessness for agricultural or pastoral use (J. A. Astargo, pers. comm.). Asli & Neumann (2009) found that supersaturated clay soils inhibit plant functions, which may explain the lack of surrounding vegetation if it is also assumed that taxa which have adapted to the clay are not adversely affected. Although evidently resulting from geological origins, this 'microsystem' is reminiscent of the small excremental clearings created and maintained by wild and domestic South American camelids (Koford 1957, pers. obs.). Significantly, Koford noted: "most plants that grow on or close to these (faecal) piles are conspicuously different from the plants of the surrounding pasture.

Land-islands in general have been well-studied and provided with the scientific nomenclature of 'patches', where the surrounding ambient vegetation is known as the 'matrix' (Pickett & Thompson 1978). The interaction of these two systems is defined as 'patch dynamics'. Much has been published on a variety of such environments, both before and after their formal definitions were coined (e.g. Koford 1957, Forman & Godron 1981, Pickett & White 1985). In addition the parallel equivalence between land island and ocean island biology and statistics has also been noted and evaluated (e.g. Gardner & Engelhardt 2008).

General observations: The wide discrepancy of one month or more between both the superficial growth periods and flowering times of the 2014-15 and 2015-16 seasons should be considered, as well as the scarcity of inflorescences during the former period when compared with their relative abundance and collective duration throughout the latter. Clearly, the timing factor can be attributed to climatic variation: heavy but short-lived rainfall in early 2014 and later but much more prolonged ENSO (El Niño–Southern Oscillation) precipitation throughout the spring of 2015 (pers. obs.).

Presence of a covering of fine indumentum on the tubers is an interesting phenomenon [fig. 15]. Subterranean systems of the genus *Alstroemeria* are usually portrayed with no sign of this feature (e.g. Bayer 1987, Muñoz-Schick & Moreira-Muñoz 2003), which in the case of *A. piperata* is certainly not obvious in voucher specimens either [cf. fig. 22, pers. obs.]. In fact no herbarium material of various taxa of the genus reviewed by the present authors revealed any immediate indication of superficial pilosity. Nevertheless, the densely fine-haired character state is in fact noted as common to the tubers of all perennial species in Chile (Bayer 1987). Although its purpose is unclear, during the washing of tubers before pressing it was noticed that they exuded a mucilaginous substance which moistened and softened the immediately surrounding densely concreted subsoil. We speculate this may occur during the period of active growth to facilitate easier subterranean penetration and expansion. In addition, it may enable uptake by the hairs of mineral and water resources from the malleable coating of clay when in the colloidal state.

Particularly during the 2014-15 season, fertile shoots were extremely infrequent as compared with the remarkably wide extensions of sterile growth [e.g. fig. 17], a peculiarity unknown to us for any other taxon of the genus. At times a dense carpet several metres in extent had not generated a solitary flowering scape. By contrast, as noted above, although still well-separated as a rule, significantly larger numbers of flowering and fruiting scapes appeared at both sites during 2015-16 [figs.6,14,19]. Despite a degree of damage from herbivores, particularly early on, most of these reached full anthesis, and several fairly substantial groups of mature fruiting heads were encountered [fig. 14].

This exceptionally high ratio of sterile to fertile shoots, even during a favourable year, is a feature which begs to be addressed. One possible explanation might be that over the course of its evolution the species has been subjected to intense overground herbivory, resulting in the survival of genotypes which expend most of their productive energy on subterranean, clonal expansion penetrating through intractable terrain.

Fluctuating but regular herbivory by goats where *A. piperata* grows [fig. 24] raises the issue of the actual impact and role of these animals. It has been suggested that lack of any disturbance such as grazing leads to domination by the most competitive organisms, while heavy grazing allows only the more resistant to survive, thereby leading to the conclusion that steady, intermediate levels are most conducive to maximum diversity (Dornelas 2010). How this relates to the specialized flora of these patch islands may be difficult to assess, since the outcome depends not only on a precise balance between over- and undergrazing, but also on the selectivity of the herbivores. Clearly a preferred item will suffer greater depredation, while unpalatable plants are certain to benefit, as frequently observed for the Turkish flora, inter alia (JMW pers. obs.). Otherwise the most crucial factors must surely be the number of foliage-feeding animals present, their range, and how often they graze the patch flora.

Alstroemeria angustifolia Herb. var. *velutina* (Ehr. Bayer) Muñoz-Schick [figs. 36, 37] was observed with *A. piperata*, but as very uncommon, and at the type site only. Although its anthesis coincided with that of *A. piperata*, no hybrids were seen.

fig.36 Upper (type) site. *Alstroemeria angustifolia* var. *velutina*, least numerous of its genus at the Chacabuco sector. We saw just a small colony. 19 November 2014. (JMW)

fig.37 An elegant skipper butterfly, *Hylephila venusta venusta*, uses its proboscis to reach down for nectar in an *Alstroemeria angustifolia* perianth. 29 December 2015 (JMW)

fig.38 *Cosmosatyrus chilensis*, one of many species of 'browns' in Chile. Large numbers of this butterfly were seen visiting *Alstroemeria piperata*. 19 November 2014. (JMW)

Pollination based on personal observations from 2014 to 2016: The main insect visitors to *A. piperata* perianths were butterflies (Lepidoptera). During 2014 and 2015 the most common was Wygnanski's common black satyr, *Cosmosatyrus chilensis* G. Felder & R. Felder subsp. *wygnanskii* Junge (Nymphalidae: Satyrinae, a subfamily known in Britain as ‘browns’ [fig. 38]. It showed an insatiable preference for the new plant. Satyrinae larvae in general typically feed on Poaceae species (Higgins & Hargreaves 1983, Peña & Ugarte 1997), which are abundant in the sector (pers. obs.).

The latter authors also noted that a related species in central Chile prefers yellow flowers, a significant observation under the circumstances. Another species of the same subfamily, *Auca coctei* (Guérin), the common black butterfly [fig. 39], was seen to feed at late inflorescences of *A. piperata* in early January 2016.

fig.39 *Auca coctei,* the common black, on *Quillaja saponaria*, the soap-bark tree. It's there to feed from flowers, not wash its feet! 20 December 2015. (JMW) fig.40 In an *Alstoemeria piperata* patch *Pyrgus fides,* the common dusky skipper, sups from a *Conanthera trimaculata* dainty, bell-like flower. 23 November 2014. (JMW)

Pyrgus fides Hayward (Hesperiidae: Pyrginae), the dusky skipper [fig. 40], was also observed, but fairly infrequently. This active little butterfly, here close to the southern extreme of its distribution (Peña & Ugarte 1997), was much less common than the brown. It visited blue *Conanthera trimaculata* (D. Don) Meigen as well as *Alstroemeria piperata*. *Hylephila venusta venusta* (Hayward) (Hesperiidae: Hesperiinae), the elegant skipper [fig. 37], took nectar from *A. angustifolia* var. *velutina*, a rare companion congener of *A. piperata* at the type site, as noted above. It is not unreasonable to suppose it visits both taxa of the genus.

In the course of later *in situ* investigations, two distinct species of lycaenid ('blue') butterflies (Lyacaendae: Polyommatinae) were observed at the type site (on 14 December 2014 and 20, 29 December 2015, respectively). The first, a solitary individual, visited one of the six well-dispersed *Alstroemeria piperata* flowering specimens then present in the population. Unfortunately its stay was too fleeting and active to record identification for certain, but a brief view of the underwing pattern followed by a passing impression of the upper wing surface in flight indicate that it was very probably *Pseudolucia andina andina* (Calvert), the Andean blue or Andean hairstreak at a low elevational level of its vertical distribution. This provisional determination is strongly reinforced by the presence there of its recorded larval food-plant, *Astragalus* (Peña &Ugarte 1997, pers. obs.). The second species, *Pseudolucia collina* (Philippi), the pale blue hairstreak [fig. 41], was determined on various occasions in 2016, but not seen to settle on *A. piperata*.

fig.41 A commonly seen, pretty lycaenid butterfly, *Pseudolucia collina*, the pale blue, here feeding at *Helenium aromaticum*.
29 December 2015. (JMW)

During visits in mid-December 2015, two butterflies of the Pieridae family were occasionally recorded. One, *Tatochila autodice* (Hübner) *blanchardi* (Butler) (Pierinae), the Chilean common white [fig. 42], was photographed while feeding from *Alstroemeria piperata*. The second, a male of *Phoebis sennae* (Linnaeus) *amphitritae* (Feisthamel) (Coliadinae) the caper yellow or cloudless sulphur, overflew the alstroemeria colonies. It was not seen to settle.

fig.42 Chilean white butterflies like this *Tatochila audice*, the common white, are not a pest. Rather, they are useful pollinators, as here on *Alstroemeria piperata.* 20 December 2015. (ARF)

Other insects were also observed and in several cases identified (M. E. E. Donoso, in litt.). Notable among them, a lone black- and white-banded wasp-mimicking mydas fly, *Mitrodetus dentitarsus* (Macquart) (Diptera: Mydaeidae), was seen on *Alstroemeria piperata* at the lower site in 2014.

However, in December 2015 numerous members of this species were avidly visiting *A. piperata* at the upper station [fig. 43], often spending several minutes at each plant, sucking nectar intensively from every flower of the inflorescence. They were also recorded then at the lower patch flora site again, on an undescribed *Oxalis* sp. A horsefly (Diptera: Tabanidae) of the genus *Caenopangonia*, probably *C. hirtipalpis*, settled and fed from the alstroemeria on 29 December 2015.

Pollen beetles (Coleoptera) of two or more families, were also present on and inside some alstroemeria perianths throughout the course of our *in situ* observations: e.g. *Decamerus haemorrhoidalis* Solier (Trogossitidae), *Arthrobrachus* sp. (Melyridae), and two undetermined taxa.

Occasional further unidentified winged insects settled on *A. piperata* flowers from time to time, among them two species of solitary hymenopterans (Apoidea), one small and metallic, the other a medium-sized, fast-flying, grey-pubescent bee, which was observed in 2014 entering the perianth throats of one of the three flowering specimens in the area of the lower *A. piperata* population.

For the 2014-15 season a maximum of six viable capsules was observed on one flowering stem, clearly resulting from successful pollination. Capsules examined averaged 10-12 seeds. If this represents a constant average, a well-developed fruiting head might therefore be expected to contain ca. 60-70 seeds.

fig.43 Type site. A striking (and harmless) wasp fly. *Mitrodetus dentitarsus*, An avid visitor in some numbers to *Alstroemeria piperata*. 20 December 2015. (JMW)

fig.44 Possible second location of *A. piperata* at Altos de Catemu, Valparaiso Region, as based on assessment of sterile vegetation. 26 Oct 2015. (JMW)

<u>A related discovery</u>: On 26 October 2015, a few closely adjacent, small clumps of very short sterile growths of an *Alstroemeria* species were observed near the unsurfaced road on the Altos de Catemu, and a sample shoot was pressed (CHILE. Valparaiso Region: Altos de Catemu, Las Majadas, 4.5 km S of and above Cerro Negro, 1300 m, 32º37'21.42"S 70º51'34.35"W, 26.10.15, F&W 12900, Herb. Watson & Flores). The colony extended no further than a few metres, and each group comprised a maximum of 6-8 shoots. The terrain was exposed and densely compressed, with a cover consisting mainly of small annual grasses and herbs [fig. 44], then in a state of semi- or total dessication. On 1 November 2012, during an earlier visit to these more northerly transversal foothills, which included the same location, two species only of the genus were observed in flower, *Alstroemeria angustifolia* var. *velutina* [fig. 36] (refs. F&W 12530, F&W 12536 & F&W 12541) and, more rarely, *Alstroemeria pulchra*

subsp. *pulchra* [fig. 5] (ref F&W 12537). The former taxon was widespread, extremely variable and present on both the southern and northern scarps of the range. By contrast, *A. pulchra* subsp. *pulchra* grew exclusively on the northern scarp. No alstroemerias were seen in 2012 on the extensive upper plateau in between, where the sterile growths were subsequently encountered. These latter are also unlike either *A. angustifolia* or *A. pulchra*, but identical to *A. piperata* in facies. However, they depart habitually from the latter species in the greatly reduced number of sterile shoots, and the integrated transition between their plant community and adjoining formations. There is no abrupt division, as at Los Ranchillos, nor any noticeable change in soil structure.

Not least considering the vulnerable rarity of *A. piperata*, this interesting population would be well worth further investigation.

Ex situ cultivation: In October 2014 small portions, one each from two large clonal colonies at the type site, were removed and planted experimentally in the unadulterated natural clay soil medium. The larger plant was set in a 30 cm dia. × 21 cm deep plant pot, the other in a rather smaller flexible black-plastic container. The specimens consisted of a main rhizome with several tubers on stolons and a few shoots, which died back shortly after transplantation. Water was largely withheld until April 2015, when it was subsequently provided at regular intervals, maintaining the subsoil effectively and continuously moist. Shortly following commencement of this regime, numerous dicotyledonous seedlings appeared. Most were very small and disappeared after a few days. The majority that persisted were identified and then weeded out, although a few were left so their reaction to the clay regime could be assessed. Later still, four alstroemeria shoots broke the surface of the soil in the larger pot and developed into short, healthy growths. Subsequently, over several months, more appeared, combining to a final total of seven, the latest being notably more elongated. The smaller specimen produced only three sterile shoots. During November 2015, two flowering scapes with five flower buds each emerged in the larger pot [fig. 45], followed by one with three buds in the plastic container. All reached full anthesis during early to mid-December 2015, but early fruit formation aborted subsequently. Despite the pots remaining unwatered during the dormant phase as previously, neither plant appeared the following season, and emptying the containers revealed their dead root systems. The reason for this is unknown.

fig.45 *Alstroemeria piperata* flowering in our Calle Larga garden near Los Andes, Valparaiso Region. Note red clay soil from the patch where it grew. 10 Dec 2015. (JMW)

The production of three flowering stems by the two plants from very limited previous sterile growth might have been response to more constant ground humidity over a longer period. If so, early precipitation, as is commonplace, stimulates sterile growth, thereby ensuring clonal survival of the species, whereas the numerical content of the fertile phase may depend on the amount of later rain- and snowfall. Even if only rare, an exceptional season of the latter event would be important for facilitating significant genetic exchange and subsequent seed production. The presence of an ENSO phenomenon during the floriferous 2015-16 season lends support to this hypothesis.

Conclusion

We classify *A. piperata* as a very rare, non-competitive, opportunistic colonizer. No other alstroemerias of this western group, even those of comparative rarity, are adapted and confined to such a specialised, extremely limited habitat. This raises speculative questions concerning how it might have evolved, and from what ancestral stock, which might be partially answered by molecular analysis.

Cultivation would benefit the species by enabling further study and also, importantly, securing its existence *ex situ*. A vital first step towards this has to be discovering why the two potted plants died after flowering, and how this may be avoided. It is equally essential that the species must be able to flourish in soils of markedly different compositions from those of its natural habitat. But at least *A. piperata* may be expected to be reasonably frost tolerant once established, if established.

Acknowledgements

We dedicate this paper to an indefatigable explorer of the Aconcagua Province wild places, the late Carlos Celedón. Without him the new species would not have come so readily to light. We are indebted to the Onel family at Los Ranchillos. Their friendship, knowledge of natural phenomena, interest in the local natural history and unsparing cooperation has greatly benefitted our work. They are José Antonio 'Cotello' Astargo and family, and his uncle, Daniel Onel. The many incorporated authoritative suggestions generously offered by Dr Ehrentraud Bayer represent a significant advance. Mélica Muñoz provided interesting information about the floral community containing *A. piperata*. Further grateful thanks are extended to Mario Enrique Elgueta Donoso, head of the Entomological Area of the Santiago Natural History Museum, and his colleague, Christian Gonzáles, for full or partial identification of various insects. Without their professional expertise these could only have been presented at a much more basic level. The enthusiastic encouragement and support of Dr Raúl Reyes and colleagues has greatly stimulated our progress.

Bibliography

Asli, S. & Neumann, P.M. (2009) Colloidal suspensions of clay or titanium dioxide nanoparticles can inhibit leaf growth and transpiration via physical effects on root water transport. Plant Cell Environ. 32(5): 577-584.

Assis, M.C. (2002) Novas espécies de *Alstroemeria* L. (Alstroemeriaceae) de Minas Gerais, Brasil. Revista Brasil. Bot. 25(2): 177-182.

Bayer, E. (1987) Die Gattung *Alstroemeria* in Chile. Mitt. Bot. Staatsamml. München 24: 1-362.

Couper-Johnston, R. (2000) El Niño. The weather phenomenon that changed the world. Hodder & Stoughton, London, UK. 354 pp.

Dornelas, M. (2010) Disturbance and change in biodiversity. Philos. Trans. R. Soc. London [Biol.]: 3719-3727.

Ezaguirre Phillipi, M.T. (2008) Validación de *Alstroemeria citrina* Phil. (Alstroemericeae). Gayana Bot. 65(2): 241-244.

Forman, R.T.T. & Godron, M. (1981) Patches and structural components for a landscape ecology. Bioscience 31(10): 733-740.

Gajardo, R. (1995) La vegetación natural de Chile. Clasificación y distribución geográfica, 2 ed. Editorial Universitaria, Santiago de Chile. 165 pp.

Gardner, R.H. & Engelhardt, K.A.M. (2008) Spatial processes that maintain biodiversity in plant communities. Perspect. Plant Ecol*. Syst.* 9: 211-228.

Higgins, L.G. & Hargreaves, B. (1983) The butterflies of Britain and Europe. W. Collins Sons & Co. Ltd., London. 256 pp.

Bibliography, continued

Hoffmann, A.E., Watson, J.M. & Flores, A.R. (2015). Flora silvestre de Chile: cuando el desierto florece. Fundación Claudio Gay, Santiago de Chile. 263 pp.

IPNI, The International Plant Names Index (2018) Published on the Internet http://www.ipni.org. (accessed 18 May 2018).

IUCN (2012) IUCN red list categories and criteria, version 3.1, 2. ed. Gland, Switzerland and Cambridge (U.K.). 32 pp. Available from: http://www.iucnredlist.org/ (accessed 3 May 2018)

Koford, C.B. (1957) The vicuña and the puna. Ecol. Monographs 27: 152-219.

Luebert, F. & Muñoz-Schick, M. (2014) *Heliotropium geissei* (Heliotropiaceae): nuevos registros, tipificación, posición sistemática y estado de conservación. Gayana Bot. 71(1): 30-36.

Luebert, F. & Pliscoff, P. (2006) Sinopsis bioclimática y vegetacional de Chile. Editoral Universitaria, Santiago de Chile. 316 pp.

Mann, G. (1978) Los pequeños mamíferos de Chile. Gayana Zoología. Edición de la Universidad de Concepción, Chile. 342 pp.

Marticorena, C. (1992) Bibliografía botánica taxonómica de Chile. Monographs in Systematic Botany 41, Missouri Botanical Garden. 587 pp.

Muñoz-Schick, M., Morales, V. & Moreira-Muñoz, A. (2011) Validación de *Alstroemeria parvula* Phil. (Alstroemeriaceae). Gayana Bot. 68(1): 114-116.

Muñoz-Schick, M. & Moreira-Muñoz, A. (2003) Alstroemerias de Chile, diversidad, distribución y conservación. Taller La Era, Santiago de Chile. 139 pp.

Negritto, M.A., Baeza, C.M., Ruiz, E. & Novoa, P. (2015) *Alstroemeria marticorenae* (Alstroemeriaceae), a new species from central Chile. Syst. Bot. 40(1): 69-74.

Novoa, P. (2013) Flora de la Región de Valparaiso; patrimonio y estado de conservación. Fundación Jardín Botánico Nacional, Viña del Mar, Chile. 360 pp.

Peña, L.E. &.Ugarte, A.J. (1997) Las mariposas de Chile. The butterflies of Chile. Editorial Universitaria, Santiago de Chile. 359 pp.

Pickett, S.T.A. & Thompson, J.N. (1978) Patch dynamics and the design of nature reserves. Biol. Cons. 13: 27-38.

Pickett, S.T.A. & White, P.S. (1985) The ecology of natural disturbance and patch dynamics. Academic Press, London & Oxford, U.K., Boston, New York & San Diego, USA. 472 pp.

Ravenna, P. (1988) New or noteworthy species of *Alstroemeria* (Alstroemeriaceae). Phytologia 64(4): 281-288.

Ravenna, P. (2000) New or interesting Alstroemeriaceae 1. Onira 4: 33-46.

Reiche, K. (1893) *Violae* chilenses. Ein Beitrag zur Systematik der Gattung *Viola*. Bot. Jahrb. Syst. 16: 405-452.

Sarwar, A.K.M.G., Hoshino, Y. & Araki, H. (2010) Pollen morphology and infrageneric classification of *Alstroemeria* L. (Alstroemeriaceae), Grana, 49(4): 227-242

The Plant List (2013) *Version* 1.1. Published on the Internet; http://www.theplantlist.org (accessed 22 May 2018).

Watson, J.M. & Flores, A.R. (2010) A rare new subspecies and change of rank in *Alstroemeria* L. (Alstroemeriaceae) for taxa narrowly endemic to Chile's Atacama Region. Herbertia 63: 101-117.

Watson, J.M. & Flores, A.R. (2014) Our viola hunting season kicks off with a bang. The Rock Garden, Journ. Scot. Rock Gard. Club 133: 97-101.