

The Plantsman



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Sharing the best in Gardening

The story of *Cosmos atrosanguineus*



Cosmos Chocamocho is claimed to be a hybrid between *C. atrosanguineus* and another *Cosmos* species

CHOCOLATE COSMOS, *Cosmos atrosanguineus*, has been intriguing botanists and captivating gardeners since it arrived in Britain from Mexico in 1861. As long ago as 1915 EA Bowles enthused about it, saying it was: 'as dark a maroon as can exist without being as black as your boot'.

For many decades seed was offered every year by one of Britain's leading seed houses then interest faded, the listing left the catalogue and when enthusiasm was rekindled it was thought that the plant was extinct in the wild and that only one sterile clone, grown at Royal Botanic Gardens, Kew, was in cultivation.

Now, I am able to confirm that it was never extinct, it continued to grow prolifically at a number of sites in Mexico, and has been grown from seed in cultivation for decades. With these discoveries, and the fact that new cultivars and hybrids are being introduced, the chocolate-coloured

Often stated to be extinct in the wild, chocolate cosmos is quite abundant in Mexico. **GRAHAM RICE** looks at the evidence and its diversity in cultivation.

flower with the rich chocolate fragrance is enjoying a new popularity. This is its story.

Discovery and naming

Cosmos atrosanguineus is one of 36 *Cosmos* species, 28 of which are endemic to Mexico (Sherff & Alexander 1955). It is one of eight species belonging to section *Discopoda* in subtribe *Coreopsidinae*. The other species are *C. concolor*, *C. jaliscensis*, *C. modestus*, *C. montanus*, *C. purpureus* and *C. scabiosoides*, together with two species described in 2013, *C. pseudoperfoliatus* and *C. ramirezianus*.

Cosmos atrosanguineus was first collected, as seed and as dried material, near Zimapan, in the state

of Hidalgo, Mexico, by Benedict Roezl in 1860 (Anon. 1885). Seed was received from an unknown sender in 1861 by William Thompson, founder of the Thompson & Morgan seed company in Ipswich. Seed was also received by Eduard Ortgies, head gardener at the Botanical Garden of the University of Zurich, sent to him under the name *Dablia zimapani* by Roezl. Ortgies raised more than 200 plants. Roezl was a prodigious plant collector who, among his many collections, sent 10 tons of orchids to Europe in one shipment.

William Hooker (1861) gave an account of the plant, before he received seed from Thompson later that same year, with his text and



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Chocamocha is claimed to be a hybrid between *C. atrosanguineus* and another *Cosmos* species

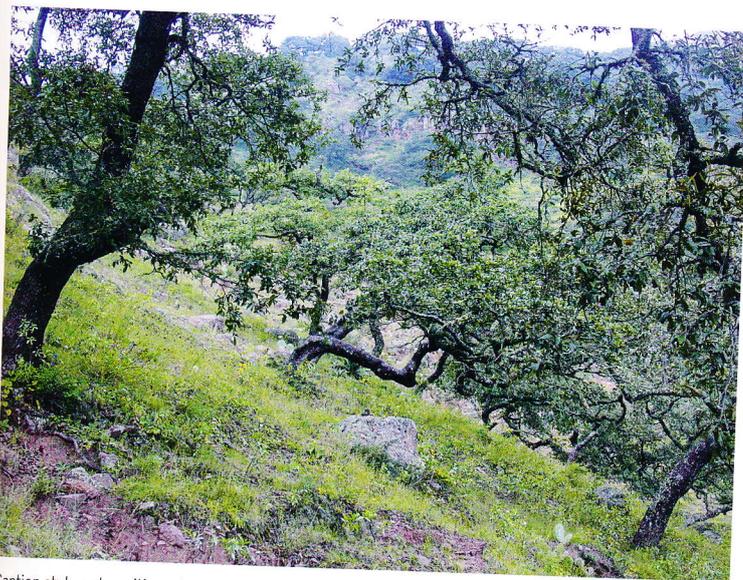
in the wild, abundant in the mountains at the time of its cultivation.

In Mexico, by Benedict O (Anon. 1885). Seed was first collected from an unknown source by William Morgan, founder of the first seed company. Morgan seed company was also received by Charles Moore, head gardener at the Botanic Garden of the University of Cambridge, sent to him under the name *Chocamocha* by Roezl. More than 200 plants were collected, a prodigious plant among his many other specimens. In 10 tons of orchids were shipped. Hooker (1861) gave an illustration of the plant, before he was superseded by Thompson later in the century, with his text and

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Caption style not positioned on an image and a *Cosmos atrosanguineus* is alive and well a caption; usually positioned 2mm or 4mm below pic

illustration derived from dried material. In 1878 dried material was again collected by E Parry and CC Palmer in San Luis Potosí in Mexico. Hooker named the plant *Cosmos*

diversifolius var. *atrosanguineus*, although without living material of *C. diversifolius* with which to compare it. Ortgies, with the benefit of comparative material, moved it to

Bidens, as *B. atrosanguineus*. It was not until 1894 that Andreas Voss raised it to species level, back in *Cosmos*, as *C. atrosanguineus*.

In recent years it has been presumed extinct; its habitat thought to have been almost totally destroyed by logging, copper mining, agriculture and development. Hind & Fay (2003) noted it as: 'believed to be extinct in the wild... This species has not been refound in the wild since it was last apparently collected in the 1860s'.

Into the garden

Thompson & Morgan first listed *C. atrosanguineus*, as *Cosmos diversifolius atrosanguineus*, in their seed catalogue of 1885 priced at 4d. By 1902 two forms were listed: *Cosmos diversifolius atrosanguineus*, now priced at 3d and given the common name black dahlia, and the cultivar 'King of the Blacks', described simply as an 'improved form', and priced at 6d. By 1942 only 'King of the Blacks' was listed, at 3d. It did not appear in subsequent editions of the catalogue.

By the time it was dropped its relatively low price suggests either that there was no shortage of seed or that it was priced to clear stocks during war-time austerity. However, it soon disappeared from cultivation.

While Thompson & Morgan were popularizing the plant, Luther Burbank began breeding work in North America. 'Often spoken of as the black dahlia,' he wrote (Whitson *et al.* 1914), 'its tubers and foliage strongly suggest the common dahlia in miniature. For four or five years I worked extensively with this so-called black dahlia, not only by way of improving the flower itself, but also in the attempt to hybridize it with the dahlia proper. I succeeded by selective breeding in enlarging the flower to about twice its original

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size, in making the petals much rounder and fuller, in adding extra petals, and in changing the color of the petals from the usual dark purplish crimson to a light crimson approaching scarlet and in a few cases to a pale pink approaching white.'

It is unclear exactly what Burbank did, as with much of his breeding work, or whether his pollinations led to interspecific or intergeneric fertilizations, or which parents contributed to the 'approaching white' form. However, a modern cultivar, 'Mexican Black', claimed to be a hybrid between *Cosmos* and *Dahlia*, is a *Dahlia* (Shaw 2015).

There were no plants of *C. atrosanguineus* growing at Kew when Brian Halliwell, an assistant curator, arrived there in 1968, but he reported (Lewendon 2006) that, 'most likely in the 80s', he received a plant of *C. atrosanguineus* from the American plantsman Le Roy Davidson. However, Kew records note its identification as being verified in 1978. Halliwell reported that it grew in the Duchess Border at Kew, in rich but well-drained soil at the foot of a sunny wall, and was still there when he retired in 1989.

Plants of this male-sterile form were passed to W Ingwersen in 1986 and J Russell in 1989 (presumably the nurserymen William Ingwersen and James Russell, but Kew only recorded their initials).

A reintroduction programme

In 1997 material was transferred to Kew's micropropagation unit at Wakehurst Place to be bulked up for possible reintroduction to Mexico. In 1998 seed was received at Kew from the National Botanic Garden of Belgium in Meise but it is unclear whether it germinated; the Kew record simply states 'dead'.

Following a request from the National Autonomous University

EVIDENCE FROM THE WILD

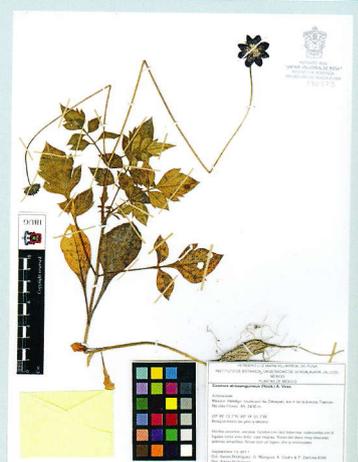
In 2007 Mexican botanist Aarón Rodríguez of the Universidad de Guadalajara, Mexico, began a research project on *Cosmos*, whose distribution is largely confined to Mexico. With his research students he searched Mexican herbaria for *Cosmos* records and found 11 relatively recent records of *C. atrosanguineus* (Castro-Castro *et al.* 2014). The earliest of these was a collection made in October 1986 by Mexican botanist Jerzy Rzedowski.

Having pinpointed the locations of earlier collections he and his team began field work. They found plants of *C. atrosanguineus* in the Mexican states of Guanajuato, Querétaro and San Luis Potosí. 'The populations are quite numerous,' Rodríguez reported. 'Plants grow in mixed pine and oak forest.' It grows from around 1,800m to 2,450m and in Guanajuato grows with *Cosmos parviflorus* as well as species of *Ageratina*, *Arbutus*, *Desmodium*, *Ipomoea*, *Oxalis*, *Salvia* and *Stevia*.

So it turns out that *C. atrosanguineus* is not extinct and that there are records of the plant from 1986 through to the recent collections of Aarón Rodríguez and his team.

Top: a herbarium sheet held at the University of Guadalajara of *Cosmos atrosanguineus*. The specimen was collected from the wild in Zimapan, Hidalgo, in September 2011.

Above: a flower of *Cosmos atrosanguineus* photographed in the wild in Mexico.



of Mexico, tissue-cultured plants from Kew's male-sterile clone were sent to Mexico for a reintroduction programme. Propagation continued in Mexico but the plan stalled, although in 2003 research was under way to preserve the clone for future reintroduction, using cryopreservation of germplasm (Wilkinson *et al.* 1998, 2003). At this time a diverse population of seed-raised plants was already in existence in New Zealand and the plant was not, in fact, extinct.

Breeding developments

Russell Poulter, a geneticist at Otago University, New Zealand, grew a few plants of the commercial male-sterile

clone whose flowers had no obvious pollen and set no seed. But in about 1990 he noticed that one plant had set two seeds which produced two more plants. In the following years cross-pollinations by hand produced a few more plants. However, as he put it: 'Among the seedlings there was quite a bit of variation, most of it bad. The worst characteristic was a deep division in the petals giving a confused looking flower. Other poor characteristics were a blood-red petal rather than a brown/blood-red, small flower size, and lack of scent. However, one or two plants had flowers with abundant pollen (very pretty against the petals). Various of these 'pollen' plants crossed with



Three cultivars of *Cosmos* ('Hamcoec') (top left), *Dahlia*

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Cosmos atrosanguineus. The specimen found in Mexico.

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Keith Hammett

Three cultivars of *Cosmos atrosanguineus* raised by plant breeder Keith Hammett. They are Eclipse ('Hamcoec') (top left), Dark Secret ('3013/01') (bottom centre) and Spellbound ('Hamcosp') (top right).

each other to set abundant seed... So at this point I had restored fertility but discovered the genome was full of mutant characteristics that needed to be got rid of.'

By 1995 Poulter was sufficiently satisfied with the quality of his plants to submit seed, under the name 'Pinot Noir', for Plant Variety Rights protection in New Zealand. It was granted in 1997. He has been maintaining this seed-raised cultivar ever since. Poulter has now spent more than 20 years creating a population of *C. atrosanguineus* that breeds true from seed and retains genetic diversity. So, while conventional wisdom in Europe and North America was that there was only one clone in cultivation and it never set seed, Poulter was raising large numbers from seed and supplying gardeners in New Zealand.

After its distribution to the horticultural trade, the Kew clone was grown from cuttings. It then proved easy to propagate by tissue culture and became widely popular. Its colour, fragrance, the mystique of its extinction and its refusal to set

seed became part of its popular allure.

In 2006 a hybrid with an unidentified species was introduced by Thompson & Morgan. Called Chocamocha ('Thomocha'), it was the first widely grown cultivar since 'King Of The Blacks'. It soon became popular for its improved habit and more consistent flowering, while retaining the chocolate fragrance and colour of the species. It rather neatly revived the seed company's connection with the species first grown by founder William Thompson in 1861.

Seed-raised plants of 'Pinot Noir' were on sale in New Zealand garden centres around 2000, sometimes as unnamed plants. But European and North American gardeners and nurseries were largely unaware of its existence. New Zealand gardener Lesley Cox sent seed to the UK in about 2010. Possibly as a result of this an increasing number of gardeners were finding fertile plants, discussing them on forums, and submitting seed to seed lists. By 2016 Cox posted on the Scottish Rock Garden Club forum: 'Although

I've had masses of seed in recent years I've not had self-sown seedlings but this year there are hundreds! I'm pulling them out every day...'

Keith Hammett, better known for his sweet pea and dahlia breeding in New Zealand, selected and crossed individuals from Poulter's plants in 2008 for commercial propagation by tissue culture. Three of the resulting cultivars have recently been introduced as Dark Secret ('3013/01'), Eclipse ('Hamcoec') and Spellbound ('Hamcosp').

Anne Wright of Dryad Nursery in Yorkshire, who had received seed from Lesley Cox in about 2010, soon after sold material to Thompson & Morgan.

Development continues in England, Germany, New Zealand and probably elsewhere. For gardeners the lesson is that recent cultivars propagated vegetatively, such as Chocamocha, Dark Secret, Eclipse and Spellbound, as well as seed-raised cultivars, should be tried as alternatives to the older, unnamed clone that has been circulating.

But it is also clear that there have been two popular misconceptions. *Cosmos atrosanguineus* is not extinct in the wild, a fact that was known as long ago as 1986 but which was never widely appreciated. It is also clear that while some plants, such as the one widely propagated by tissue culture, are male-sterile, many are male-fertile and seed-raised plants have been grown since 1990.

The plants

The following accounts are descriptions of *C. atrosanguineus* cultivars, selections and hybrids that have been, or are currently, cultivated. I have found mention of further names such as 'Chocolate Ruffle', 'Christopher', 'Hot Chocolate' and 'Pip', but without any descriptions. ▶

PLANT ORIGINS

Cosmos atrosanguineus Kew clone

In this selection grown at Royal Botanic Gardens, Kew, small, slender, dahlia-like tubers support rather weak, dark red stems carrying a slightly straggly mound of glossy, dark green leaves. The leaves are split pinnately once or twice into narrowly diamond-shaped leaflets, sometimes with reddish tints. Each flowering stem, reaching 40–60cm, carries one, saucer-shaped, chocolate-scented, flower, 4.5cm in diameter, comprising eight, obovate ray florets in rich chocolate maroon and almost black disc florets. Pollen is not produced. Plants are late to emerge in spring and flower from July to autumn.

Cosmos atrosanguineus unnamed, seed-raised forms

Seed, not differentiated by cultivar name, collected on the nursery, was made available from Plant World Seeds, Devon, in 2016. The description stated: 'Mature plants vary from tight compact clumps with short-stemmed blooms, up to large branching beauties with very long stemmed flowers which are ideal for cutting. Flowers range from small to opulently large, whilst the fragrant petals vary from notched or feathered to oval and entire.' Plants are typically 30–60cm in height.

Seed is also available from Jonna Sudenius in Belgium, collected from plants grown from seed she received from Russia. Images indicate flowers with 12 or more rays, varying from red to almost black. Plants are typically 60–80cm in height.

Cosmos atrosanguineus 'Black Beauty'

Cut flowering stems have been offered under this name but this may simply be a marketing name for the usual tissue-cultured form.



A fertile clone (left) and the infertile Kew clone (right) of *Cosmos atrosanguineus*

ANNE WRIGHT



Variation in seed-raised plants of *Cosmos atrosanguineus* sourced from Plant World Seeds

PLANT WORLD SEEDS

Cosmos atrosanguineus 'Black Magic'

This was the first widely available seed-raised cultivar. Plants are variable in habit and height, but usually about 60cm, and it is especially notable that the flowers vary in three ways. At one extreme the rays are broad, evenly shaped,

rounded and overlapping, and sometimes lobed at the tip. At the other extreme the rays are slender, variable in shape, and with noticeable gaps between them, creating a spidery look. The number of rays varies from eight to 24 and where there are fewer rays they tend to be broader. Its flowers vary in



JELITO SEEDS

Cosmos atrosanguineus is a variable, seed-raised

Cosmos atrosanguineus ('2013/01') has broad, ov

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Aime Wright



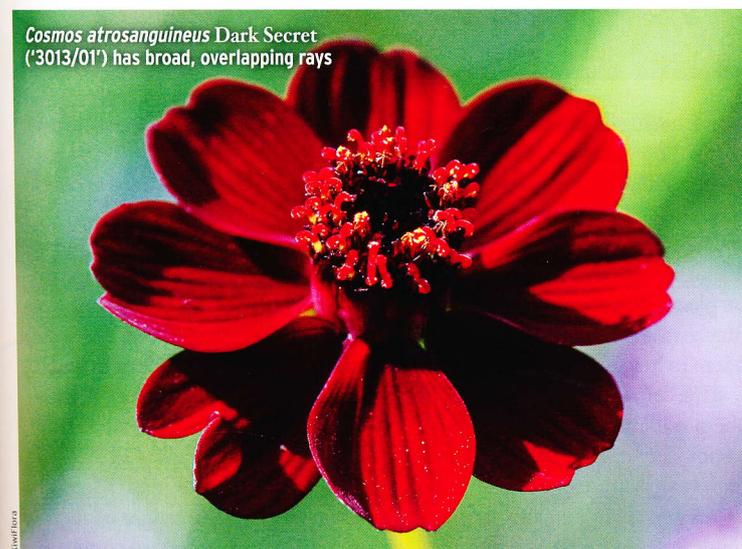
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Jelitto Seeds

Cosmos atrosanguineus 'Black Magic' is a variable, seed-raised cultivar



Swirl Flora

Cosmos atrosanguineus Dark Secret ('3013/01') has broad, overlapping rays

colour from the rich chocolate brown we associate with this plant to what is definitely red, sometimes with bronze tints. The foliage is paler than that of other selections and the plants relatively late into flower.

Its origin is from a single seedhead from a private garden in New Zealand received in 2004 by Georg Uebelhart, general manager of Jelitto Perennial Seeds. The plant it came from was said to be unrelated to 'Pinot Noir', although this seems unlikely. The following year he harvested 48 seeds. In the early generations the plants were variable, only a few carrying the required large, rounded flowers. Crosses were then made with existing clones and this improved the flower form and colour and enhanced the fertility. Repeated selection reduced the number of the less attractive forms and, although the plants of 'Black Magic' are variable, it was considered sufficiently unique to be named.

***Cosmos atrosanguineus* Coco Chanel ('3013/01')**

Coco Chanel is the trade designation used in New Zealand for '3013/01'. It was replaced by Dark Secret in North America for fear of litigation.

***Cosmos atrosanguineus* Dark Secret ('3013/01')**

The dark brown to deep wine-red flowers of this cultivar have broad rays, overlapping to create significantly more impact than many other selections, and with yellow pollen creating a bright centre. The flowers are held on relatively long stems, about 50cm in height, clad in fresh green foliage, but fragrance is relatively light.

It was selected by Keith Hammett in 2009, from seedlings derived from crosses with Poulter's material, and introduced in 2015. ➤

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Cosmos atrosanguineus Eclipse ('Hamcoec')

The largest flowered of all clones, the deep burgundy red, 5cm-blooms are held on unusually long stems above fresh green foliage and have a good chocolate fragrance. With its large flowers, long stems to 80cm, exceptional vigour and good scent this is probably the best for cutting. Selected by Hammett, it has the same origin as Dark Secret and was introduced in 2016.

Cosmos atrosanguineus: Fleuroselect entry 2016

One of the entries in the 2016 Fleuroselect trials was a seed-raised selection of *C. atrosanguineus*. In the trials, in which entries are trialled anonymously at sites across Europe, it was compared with 'Black Magic' and the familiar tissue-cultured clone.

I saw it at one of the trial sites and the flowers are rich reddish, chocolate brown and well-shaped. The colour is darkest when the flowers first open and then becomes slightly redder as the flower matures. The scent is good, but perhaps a little less strong than that of the widely grown clone. It was also earlier into flower, 45–60cm in height, more vigorous and more prolific. The foliage was very dark.

In comparison to 'Black Magic' it was more uniform in every way, including colour and flower shape, and with larger flowers. It has not yet been introduced or named.

Cosmos atrosanguineus Mystique

This is the fourth of Hammett's selections, currently known just under its trade designation, and has not yet been protected or released.

Cosmos atrosanguineus 'New Choco'

This was the first selection of *C. atrosanguineus* to receive a cultivar



A highly uniform cultivar of *Cosmos atrosanguineus* entered into a Fleuroselect trial in 2016



Cosmos atrosanguineus Spellbound ('Hamcosp') is the most fragrant of the Hammett cultivars

name, having been raised in Japan in 2003 by Takayoshi Oku from open-pollinated seedlings (Oku *et al.* 2003). It features moderately fragrant, reddish flowers about 4.5cm across carried prolifically on plants that are noticeably much wider than high, reaching 45cm in height.

This cultivar was developed with the aim of incorporating resistance to powdery mildew and tolerance of high temperatures, and is described as 'reasonably tolerant' of powdery mildew.

Cosmos atrosanguineus 'Pinot Noir'

This seed-raised cultivar was raised by Poulter in order to create a selection that was as close as possible to the wild form. Starting with two seeds in 1990, by 1995 he was sufficiently satisfied with the quality and consistency of his strain to submit it for Plant Variety Rights protection in New Zealand. The application was granted in 1997 and he has been maintaining this cultivar ever since. With a height of about 60cm, he has worked to eliminate

small flowers, poor stems, weak necks and forms, weak necks and forms outside the normal p

Cosmos atrosanguineus Spellbound ('Hamcosp')

With elegant, round flowers a little over 4cm across, this cultivar holds them on long stems above broadly divided foliage, reaching 90cm in height. The flowers are strongly chocolate brown, the most fragrant of Hammett's available selections. It has the same origin as Dark Secret and was introduced in 2015.

Cosmos Chocamocha ('Thomocha') (p112)

This hybrid between 'Black Magic' and an undisclosed selection has large flowers that are more chocolate in colour, and

REFERENCES

- Anon. (1885) *Benedict's Garden Catalogue*, ser. 2, v. 24, 24–25.
- Bowles, EA (1915) *My Garden in Autumn and Winter*. The Gardeners' Co., Ltd, London.
- Castro-Castro, A, Valdivia, G, Harker, M & Rodero, J (2006) Análisis macromorfológico y citogenético del género *Cosmos* (Asteraceae, Coreopsidae) para su identificación. *Revista de Biología* 36: 363–388.
- Hind, N & Fay, MF (1985) *Cosmos atrosanguineus* (Compositae). *Mag.* 20: 40–48.
- Hooker, WJ (1861) *Cosmos diversifolius* var. *atrosanguineus*. *Bot. Mag.* 87: t.5227.
- Lewendon, S (2006) Stability in *Cosmos atrosanguineus* (Asteraceae), a Mexican endemic species. Unpublished PhD thesis.
- Oku, T, Takahashi, H, Nakamura, I & Mii, M (2003) Hybridisation between *Cosmos atrosanguineus* and yellow cosmos (*Cosmos sulphureus*) by phylogenetic analysis and determination of subtype identity (PSID). *J. Hort. Sci. Biotech.* 83: 3–10.



Graham Rice / GardenPhotos.com



Kerflio

***Cosmos atrosanguineus* 'Pinot'**

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***Cosmos atrosanguineus* Spellbound ('Hamcosp')**

With elegant, rounded, rich crimson flowers a little over 4cm across, this cultivar holds them on long stems above broadly divided foliage, reaching 90cm in height. The flowers are strongly chocolate scented, the most fragrant of Hammett's three available selections. It has the same origin as Dark Secret and was introduced in 2015.

***Cosmos Chocamocha* ('Thomocha') (p112)**

This hybrid between *C. atrosanguineus* and an undisclosed species has flowers that are more deep red than chocolate in colour, and are less

strongly scented than the first species. However, they open earlier and more consistently over a long season from June to September or later. The roots are less tuberous and more fibrous than those of *C. atrosanguineus* and the bushy foliage is a fresher, brighter, slightly silvery green, and develops into a mound with the upward facing flowers held clearly above it.

Cosmos sterile triploid hybrid

Raised by Geertje Winsemius in 1998 at Thompson & Morgan, this was an earlier hybrid between *C. atrosanguineus* and another species. It was introduced in 2006 was recorded as 40cm in height. The identity of the other species has not been confirmed, but Charles Valin, who currently works as a breeder at Thompson & Morgan, suspects it may have been *C. linearifolius*.

***Cosmos* 'Strawberry Choco Sanse 41'**

This is probably the only hybrid between *C. atrosanguineus* and *C. sulphureus* to progress as far as a plant variety protection application, but it was never released. The latter was the pollen parent and the resultant cultivar, 30–40cm in height with red flowers, was said to differ from the seed parent in its vigorous branching, more numerous flowers, rapid growth and longer flowering period.

Conclusion

The, up-to-now, unheralded diligence of Mexican botanist Aarón Rodríguez proves beyond doubt that flourishing populations of *Cosmos atrosanguineus* exist in the wild.

And while only one sterile clone was thought to be in cultivation, Russell Poulter's aim in developing a large seed-raised population was for his plants to be re-introduced into the wild. Although we now appreciate that this is not necessary, his many years of diligence has led to some excellent recent introductions.

GRAHAM RICE is Editor-in-Chief of the *RHS Encyclopedia of Perennials*. He also writes the New Plants blog at www.rhs.org.uk/plants/plants-blogs/plants

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REFERENCES

- Anon. (1885) Benedict Roetz. *Gard. Chron.*, ser. 2, v. 24, 24 October 1885
- Bowles, EA (1915) *My Garden in Autumn and Winter*. TC & EC Jack Ltd, London
- Castro-Castro, A, Vargas-Amado, G, Harker, M & Rodríguez, A (2014) Análisis macromorfológico y citogenético del género *Cosmos* (*Asteraceae*, *Coreopsidae*), con una clave para su identificación. *Bot. Sci.* 92(3): 363–388
- Hind, N & Fay, MF (2003) *Cosmos atrosanguineus* (*Compositae*). *Curtis's Bot. Mag.* 20: 40–48
- Hooker, WJ (1861) *Cosmos diversifolius* var. *atrosanguineus*. *Curtis's Bot. Mag.* 87: t.5227
- Lewendon, S (2006) Self-incompatibility in *Cosmos atrosanguineus*, a rare Mexican endemic species of *Asteraceae*. Unpublished PhD thesis
- Oku, T, Takahashi, H, Yagi, F, Nakamura, I & Mii, M (2008) Hybridisation between chocolate cosmos and yellow cosmos confirmed by phylogenetic analysis using plastid subtype identity (PSID) sequences. *J. Hort. Sci. Biotech.* 83: 323–327
- Shaw, JMH (2015) Nomenclatural notes on horticultural hybrids: *Dablia* 'Mexican Black', *Potentilla* and other *Rosaceae*, *Stylophorum*, and *Tigridia*. *Phytoneuron* 2015-53: 1–5
- Sherff, EE & Alexander, EJ (1955) *Compositae-Heliantheae-Coreopsidinae*. In: Sherff, EE & Alexander, EJ (eds) *North American Flora*. Ser. 2, Pt. 2. New York Botanical Gardens, New York
- Thompson & Morgan (1885, 1902, 1942) Seed catalogues
- Whitson, J, John, R & Williams, HS (eds) (1914) *Luther Burbank, his Methods and Discoveries and their Practical Application*. Vol. 4. Luther Burbank Press, New York
- Wilkinson, T, Wetten, A & Fay, MF (1998) Cryopreservation of *Cosmos atrosanguineus* shoot tips by a modified encapsulation/dehydration method. *Cryo-Letters* 19: 293–302
- Wilkinson, T, Wetten, A, Prychid, C & Fay, MF (2003) Suitability of cryopreservation for the long term storage of rare and endangered plant species – a case history for *Cosmos atrosanguineus*. *Ann. Bot.* 91: 65–74