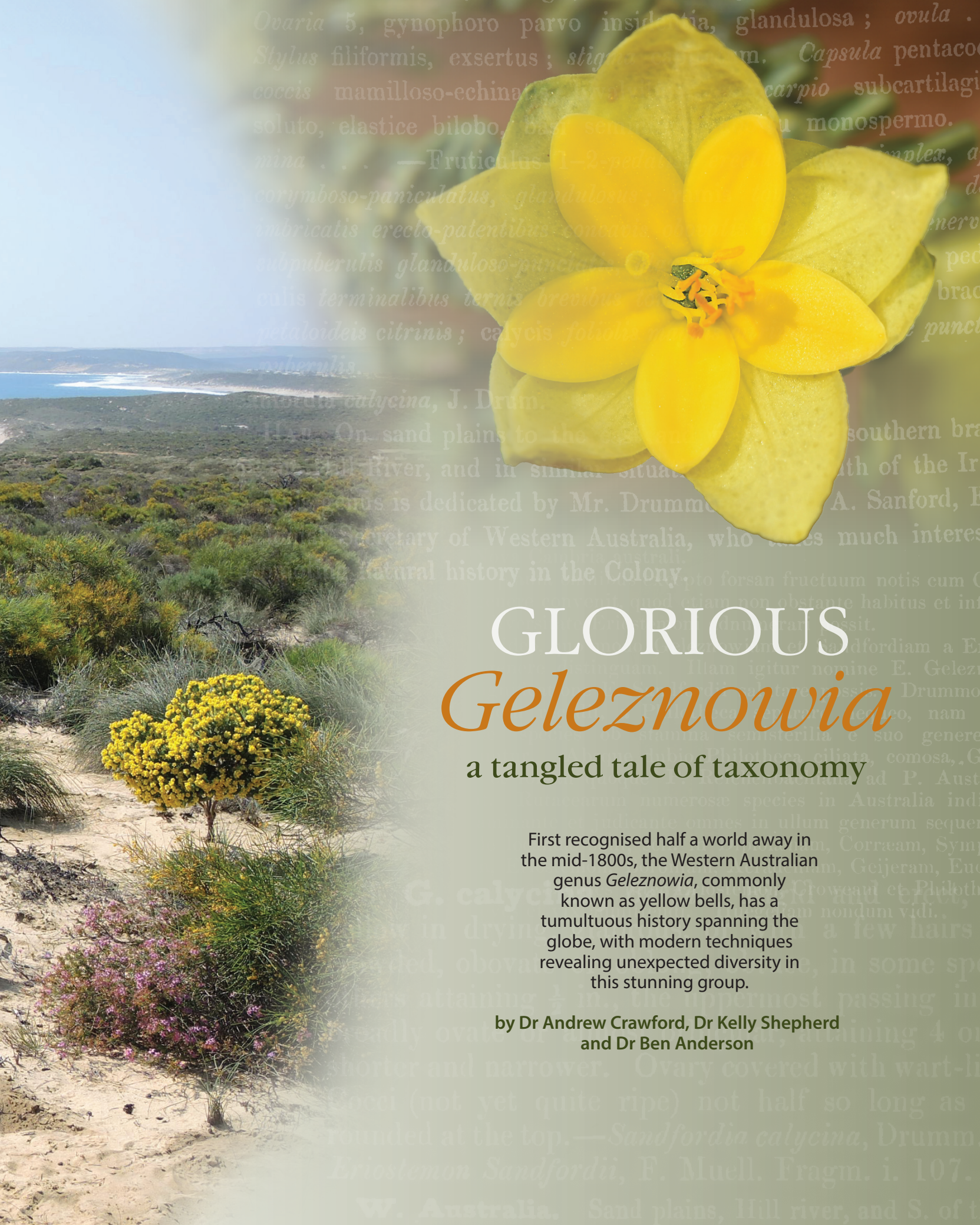






GLORIOUS *Geleznovia* a tangled tale of taxonomy

First recognised half a world away in the mid-1800s, the Western Australian genus *Geleznovia*, commonly known as yellow bells, has a tumultuous history spanning the globe, with modern techniques revealing unexpected diversity in this stunning group.

by Dr Andrew Crawford, Dr Kelly Shepherd
and Dr Ben Anderson



Taxonomy is the science of naming, describing, and classifying organisms. Historically, botanists relied on morphological features alone to determine relationships, assuming plants that appear more similar are more closely related.

For the most part this is correct, but not always. With the development of sophisticated methods to examine plant DNA, scientists can now test their ideas about plant relationships. Molecular data can corroborate what we already understand, highlight unexpected relatedness between groups that appear quite distinct at first glance, or even reveal hidden diversity that was previously overlooked.

Resolving the taxonomy of a group of closely-related species is not always easy, even with newer DNA tools. The genus *Geleznovia*, commonly known as yellow

bells, is a case in point. This genus has a long and tangled history hidden behind its name, presenting a complex taxonomic problem spanning 174 years.

BACK IN TIME

In 1849, Nicolai Turczaninow, a Ukrainian-Russian botanist, recognised *Geleznovia* as a new genus in the Rutaceae family. This genus was named after the Russian botanist Nikolai Zheleznov (1816–1877) using the German spelling of his name, Geleznov.

Turczaninow recognised just a single species, *Geleznovia verrucosa*, from a single dried herbarium specimen collected in Western Australia in 1845 by the botanist James Drummond. Drummond was among the first colonists to arrive with Captain James Stirling to establish the Swan River Colony in 1829. Over the years he supplemented his income by selling plant specimens and seeds to herbaria across Europe, some of which were eventually obtained by Turczaninow. Drummond's precious specimen is called a holotype, as it is the reference specimen for the name *Geleznovia verrucosa*. In modern times, the holotype resided in the National Herbarium of Ukraine in Kiev; however, due to the current war with Russia it was evacuated along with other critical specimens to another location for safe keeping.

Turczaninow's original description of *Geleznovia verrucosa* was written in Latin and published in a journal based in Moscow. As was often the case, this early publication was not seen by other taxonomists. Consequently, in 1855 an Irish botanist, William Harvey, named another new genus comprising a single species *Sanfordia calycina*, again

from material originating from James Drummond.

Sir Ferdinand von Mueller, the then-director of the Royal Botanic Gardens, Melbourne, did not agree with the taxonomy of Turczaninow and Harvey, and declared in his book *Fragmenta Phytographiae Australiae* published in 1859, "I do not see how *Geleznovia* and *Sanfordia* can be distinguished from the genus *Eriostemon*" (note that he spelled *Sanfordia* incorrectly when he did this, just to add to the confusion). *Eriostemon* was a genus within the Rutaceae family that had first been described in 1798, prior to either *Geleznovia* or *Sanfordia*, hence this name had precedence, meaning that *Geleznovia verrucosa* became *Eriostemon geleznovii* and *Sanfordia calycina* became *Eriostemon sanfordii*.

Only four years later in 1863, George Bentham, a botanist based at the Kew Royal Botanic Gardens in London, published the first volume of his *Flora Australiensis* series, and he concluded that *Geleznovia* should be reinstated as a genus distinct from *Eriostemon*. *Eriostemon geleznovii* reverted to its original name of *Geleznovia verrucosa*, while *Eriostemon sanfordii* was given the new name *Geleznovia calycina*.

In addition to these two previously recognised species, *Geleznovia macrocarpa* was also recognised as distinct based on a fragmentary specimen, as Bentham thought it had larger flowers.

RENEWED INTEREST

For the next 90 years there were no changes to the naming of *Geleznovia*. Then, in 1954 Blackall and Grieve's seminal work on the identification of the flora of south-western Australia, *How to Know*

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Main *Geleznovia amabilis* growing south of Kalbarri.

Photo – Kelly Shepherd/DBCA

Top far right *Geleznovia verrucosa*.

Photo – Fred and Jean Hort

Background far right from top Extract from William Harvey's letters in *Hooker's Journal of Botany and Kew Garden* (1855); Extract from Sir Ferdinand von Mueller's book *Fragmenta Phytographiae Australiae* (1859); Extract from George Bentham's book *Flora Australiensis* (1863).

Above *Geleznovia narcissoides* flowers are reminiscent of daffodils.

Above right Ben Anderson photographing *Geleznovia eximia*.

Photos – Kelly Shepherd/DBCA

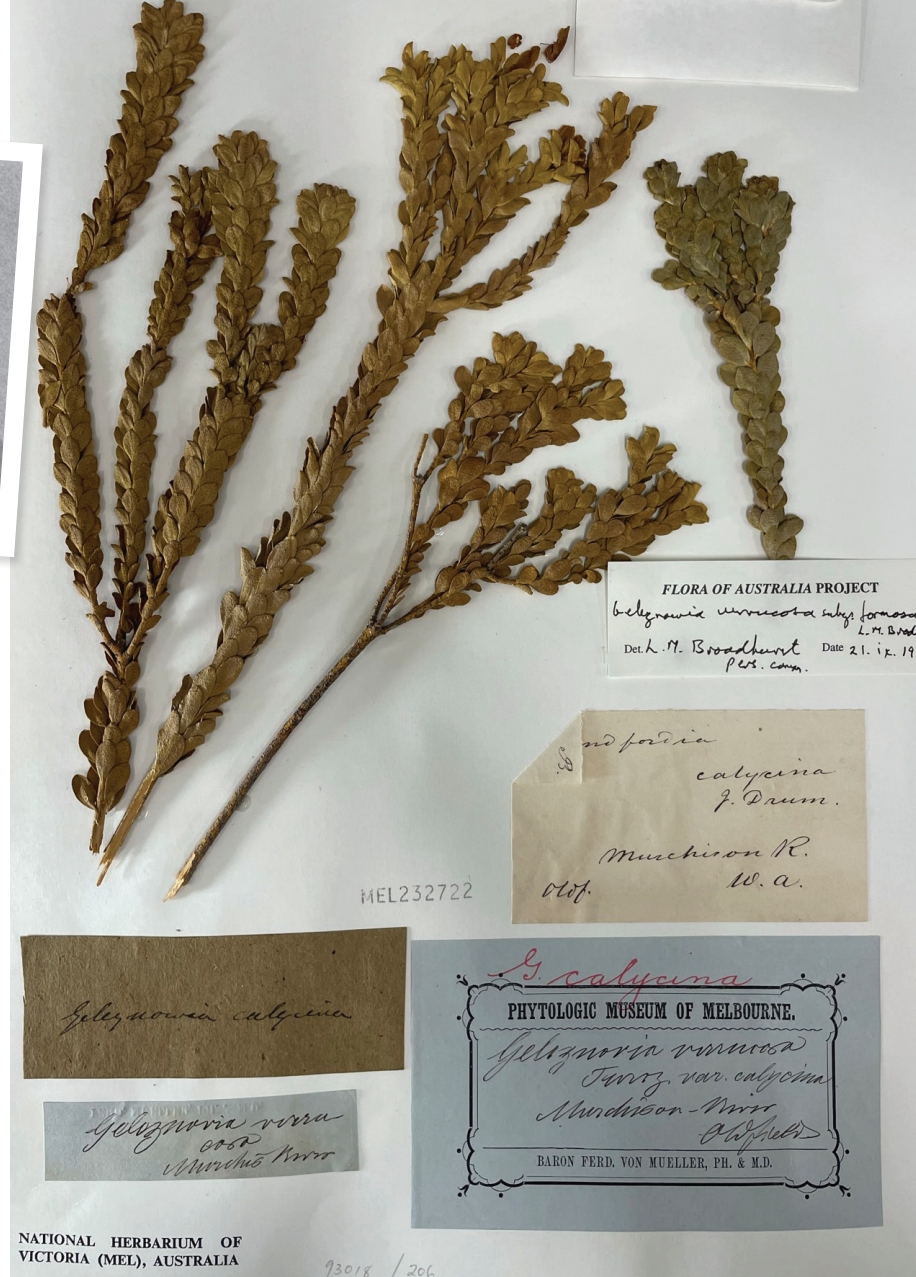


“Turczaninow recognised just a single species, *Geleznovia verrucosa*, from a single dried herbarium specimen collected in Western Australia in 1845 by the botanist James Drummond.”

Western Australian Wildflowers, was published. In this book there is no reference to *Geleznovia macrocarpa*, and although *Geleznovia calycina* is listed as a species, it is noted as being “... only a small form of *G. verrucosa*”. By 1981, when Green’s *Census of the vascular plants of Western Australia* was published, only *Geleznovia verrucosa* was recognised as distinct.

The late 1990s saw a renewed interest in the taxonomy of *Geleznovia*. Yellow bells, due to their stunning floral display, were a popular target for wildflower pickers supplying cut flowers for the floriculture industry. Despite only one species of *Geleznovia* being recognised at this time, the pickers and sellers of the yellow bells recognised that there were several forms of *Geleznovia*, known by colloquial names such as ‘daffodil’, ‘tinged’ and ‘mini’.

Identifying these forms was important to the industry, for example the form known as ‘daffodil’ was more valued due to its large showy flowers. Two scientific studies on *Geleznovia* started around this time. The first was a PhD study by Linda Broadhurst at Curtin University examining the morphology and genetics of the species, and the second was a floriculture project headed by Dr Julie Plummer at the



University of Western Australia (UWA) seeking to determine whether *Geleznovia* could be established in cultivation as a cut flower crop.

Linda Broadhurst concluded, with support from the genetic techniques of the day, that two subspecies of *Geleznovia verrucosa* merited taxonomic recognition, and a third form was suggested to be a hybrid. Meanwhile, the floricultural project recognised six distinctive floricultural forms.

Unfortunately, no further work was undertaken to try and resolve the complexity evident within this group and by 2013 when Paul Wilson published his treatment of the genus in *Flora of Australia*, only the single species *Geleznovia verrucosa*

Above A scan of *Geleznovia* specimen collected by A.F. Oldfield.
Photo – National Herbarium of Victoria

Inset above far left Botanist James Drummond collected *Geleznovia* specimens in 1845 from Western Australia.
Photo – Ewen Mackenzie

Inset above left Botanist Nicolai Turczaninow recognised *Geleznovia* as a new genus in 1849.

was recognised. Although Wilson did note that due to the variation seen in its leaves, hairs and flowers, there may be several unrecognised subspecies. After the completion of the floricultural project at UWA, one of the project participants,

Timeline of taxonomy of *Geleznovia*

Botanist	Taxonomy
1849 Nicolai Turczaninow	<i>Geleznovia verrucosa</i>
1855 William Harvey	<i>Sanfordia calycina</i>
1859 Sir Ferdinand von Mueller	<i>Eriostemon geleznovii</i> <i>Eriostemon sanfordii</i>
1863 George Bentham	<i>Geleznovia macrocarpa</i> <i>Geleznovia verrucosa</i> <i>Geleznovia calycina</i>
1954 W.E. Blackall and B.J. Grieve	<i>Geleznovia verrucosa</i> <i>Geleznovia calycina</i>
1981 J.W. Green	<i>Geleznovia verrucosa</i>
2000 G. Paczkowska and A.R. Chapman	<i>Geleznovia verrucosa</i> subsp. <i>verrucosa</i> ms <i>Geleznovia verrucosa</i> subsp. <i>formosa</i> ms
2007 Western Australia Herbarium	<i>Geleznovia verrucosa</i> subsp. <i>Kalbarri</i>
2013 Paul Wilson	<i>Geleznovia verrucosa</i>
2013 Western Australia Herbarium	<i>Geleznovia</i> sp. <i>Binnu</i> <i>Geleznovia verrucosa</i> <i>Geleznovia</i> sp. <i>Marchagee</i> <i>Geleznovia</i> sp. <i>Red Bluff</i>
Colloquial names assigned	Daffodil White peak Tinged Broad's Mini Kalbarri
2020 Kelly Shepherd and Andrew Crawford	? <i>Geleznovia amabilis</i>
2023	<i>Geleznovia narcissoides</i> <i>Geleznovia eximia</i> <i>Geleznovia calycina</i> <i>Geleznovia uberiflora</i> <i>Geleznovia verrucosa</i> <i>Geleznovia occulata</i> <i>Geleznovia amabilis</i>



Top *Geleznovia amabilis*.

Left *Geleznovia occulata*.

Inset from far left
Tinged (*Geleznovia calycina*);
White peak (*Geleznovia eximia*).
Photos – Kelly Shepherd/DBCA

Tinged (*Geleznovia uberiflora*).
Photo – Andrew Crawford/DBCA



Andrew Crawford, moved to a job based at the Western Australian Herbarium. He continued to collect specimens of *Geleznovia* and lodge them at the herbarium, adding to the knowledge about the distribution and variation of the species.

Subsequently, a thorough inspection of all the WA Herbarium collections of *Geleznovia* by resident taxonomist Kelly Shepherd led to three additional putative species being identified, which corresponded to some of the floricultural forms that had previously been identified. These were allocated the informal phrase names: *Geleznovia* sp. Binnu (K.A. Shepherd & J. Wege KS 1301), *Geleznovia* sp. Marchagee (A. Crawford ADC 1353) and *Geleznovia* sp. Red Bluff (A. Crawford ADC 597).

In 2020, *Geleznovia* sp. Red Bluff was formally named and described as *Geleznovia amabilis*. It was recognised as a species of conservation concern, as it is currently only known from a few populations around Kalbarri. The specific epithet (the second part of its binomial Latin name) means ‘worthy of love’, an appropriate choice given its striking flowers.

EMPLOYING GENOMICS

Even though some progress had been made, it was clear that further help was needed to untangle the rest of this complex. The group was investigated as part of the national Genomics for Australian Plants conservation genomics project (genomicsforaustralianplants.com/geleznovia-verrucosa-conservation). In the spring of 2020, while the COVID-19 pandemic swept around the world and many were in lockdown, Kelly Shepherd and Carol Wilkins were able to undertake

fieldwork, sampling populations across the various forms previously recognised in *Geleznovia*. The samples were sequenced and then analysed by Ben Anderson and Rachel Binks using modern genomic techniques.

The molecular results corroborated initial ideas but also pointed to some unexpected relationships. So, after a long and complicated journey that started with a single species, a combination of traditional taxonomy and modern genetics has now resulted in the recognition of seven species in the genus. This includes *Geleznovia verrucosa*, *Geleznovia amabilis*, and four new species, as well as the reinstatement of *Geleznovia calycina*, a species previously described in 1855 by Harvey (under the genus *Sanfordia*). Two of the new species revealed by the genetic results, *Geleznovia occulta* and *Geleznovia eximia*, are very rare in the wild, with the latter currently only known from three plants within one population.

Some of these species corresponded to the horticultural forms or phrase named species that had previously been identified. For example, *Geleznovia* sp. Binnu (the ‘daffodil form’) was named *Geleznovia narcissoides*; a name based on the daffodil genus *Narcissus* with the addition of *-oides* meaning “like”, alluding to this species having showy flowers that are reminiscent of a double-headed daffodil.

To further complicate matters, when scanned images became available of the holotype of *Geleznovia verrucosa* held in the National Herbarium of Ukraine, it became clear that the phrase-named *Geleznovia* sp. Marchagee represented true *Geleznovia verrucosa*, while most specimens named as *verrucosa* were either

Geleznovia calycina or the new species *Geleznovia uberiflora*.

Over the long and complicated history since yellow bells were first described, the number of names and concepts have varied (see timeline on page 46). This may also not be the final word, as there may yet be more diversity to be discovered. The UWA horticultural study mentioned another unrecognised ‘form 5’ that has not been seen in the wild since then, and no specimens are available for study. While we have come a long way in clarifying what names go with which species and how they are related to each other, there may yet be another chapter to be written about these stunning plants.

Top left Card showing dissected fresh flowers of *Geleznovia amabilis*.

Photo – Kelly Shepherd/DBCA

Above Kelly Shepherd providing updated determinations to *Geleznovia* specimens.

Photo – Andrew Crawford/DBCA

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