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Female Variable Sunbird (*Nectarinia venusta*) on inflorescence of *Aloe lateritia* var. *graminicola.*

Contents.

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Haworthia lockwoodii. Arch. Fl. Pl . Afr. 20:t.792[1940].

Vegetative propagation by sectioning rosettes.

A research paper based on sub-tropical E. Indian climate.

Soumen Aditya, India.

Introduction. *Haworthia lockwoodii*, Section *Archnoideae* sub section *limpidae.* This is indeed a rare species, with onion like qualities, having many thin leaves growing in a compact, ball-shaped rosette, and tending to dry back from the tips, which enclose the inner part of the rosette in a paper like sheet. The leaves are about 6 cm long and 2-3 cm wide, pointed at the apex, but with an almost rounded outline, with very fine small teeth on the margins; there is, too, an almost indiscernible keel.

John Pilbeam, U.K, stated "it is one of the few haworthias I have lost, through over watering I am sure, although it grew well for over a year for me". I was too "kind" when watering this species. I think you probably have to be cruel with seemingly sparse water to be kind. The plant will then flourish. It is an experience for me to have such a very difficult-to-cultivate *Haworthia* in our sub-tropical climate, East India.

The "Archnoidea" group is one of my favourites for haworthias. The difficulty of propagation attracts and challenges me. Plants do not so easily offset nor flower regularly and set seed. In 2005, Dr. J.S. Sarkaria gave me two cloning plants. He told me they were one of his favourites. Unfortunately his illness did not permit him to maintain them properly, which was compounded by his glass house deteriorating. At that time, I was able to assist him from time to time when he was not able to give the plants the attention they needed to survive. I was also a lucky beneficiary, as he was able to assist me with advise and he unconditionally gave me two clones of *Haworthia lockwoodii* along with very big *Haworthia reinwardtii* var. *kafferdriftensis*, *Haworthia springbokvlakensis*, *Haworthia semiviva* and a very nice clone of *Haworthia comptoniana* (now *H. emelyae*. var. *comptoniana*).

At that time he had five very mature *H. lockwoodii*. He gave me many tips for growing them properly in our Kolkata climate, on how he once propagated a plant by sectioning it into four quarters, and how he produced offsets from axils of cut leaves. He published an article in NCSSI-Chandigrah, Annual Souvenir, 1998 and illustrated it with his photographs. His pencil sketch illustrations showed me how to propagate plants by vegetative means in the absence of a tissue culture laboratory. In my mind many babies were produced and lived to produce many more babies in future generations!!!

Propagation. Plants refused to offset for a long time with every owner, so I decides to sacrifice my very delicate old plants in mid August 2013, after 8 years in my collection. When they were dormant seemed to be the right time for propagation. At this time our climatic conditions produce very humid, nearly 98% humidity, day temperature up to 34 degrees Centigrade and some days are totally rainy. I felt this time was the very best for soft leaved haworthia propagation; the humid climate seems to prevent dry rot from developing. So I unpotted both plants, cleaned the dry, root systems, washed them with a fungicide based water and dried them for a few hours. I then cut each plants with a sharp knife into two halves through the middle. Cut ends were dusted with rooting hormone powder and fungicide powder. Then I put them in a shady area on newspaper and dried them for 3-5 days.

I used washed, coarse river-sand dried in full sun for 3 days and then filled four-inch earthen pots with it. Each half plant was potted separately in the dry mix. Only the root areas were covered with sand. The pots were then left to dry another 10 days in a shady, airy place. After 10 days, in the early morning, I sprayed them with cold, sterilized water by hand spray gun, but only twice a week. The half plants rooted after a few weeks. During November 2013, I noticed a few small offset on each of the halves. Each had two to three offsets. The growth rate is very slow for the species, so I apply natural Auxin, which is made by me from grass tip extract. First, collect 3-5 inches of fresh grass tips, and make a paste; 10 grams of paste are diluted in 50 ml of sterilized water. Spray twice a week with the water, but, for the best results with the hormone, spray the same time every day. The hormone is very helpful to promote the propagation of many difficult-to-propagate haworthias. I was lucky enough, to have the four halves survive successfully and during September last year they produced for the 2nd time many offsets. I pulled off each pup when they were just 1 inch in diameter and dusted them in the root area with the hormone and fungicide mixed. They were dried for one week. Thereafter they were given the same treatment as the mother plant for rooting.

I saw in this way that they produced pups two to three times

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Fig. 1. A half, rooted-rosette of *H. lockwoodii* with one small offset.

Fig. 2. A half, rooted-rosette of *H. lockwoodii* with one large offset. Note a just visible, emergent offset adjacent to it.

Fig. 3. Half, rooted-rosette of *H. lockwoodii* with the large offset removed to reveal the emergent offset.

Fig. 4. A half, rooted-rosette, right, with one large offset at left.

A half offset will continue to produce offsets for a number of years. Offset production is encouraged by removing offsets when they have reached a reasonable size for rooting. Some offsets may produce roots before they are removed from the parent half-rosette.

Would you like to be a little more ambitious?

If so, you can cut a large plant into four quarters then proceed as for a half rosette.

Fig. 5. A large offset (right) cut from a half, rooted-rosette (left) of *H. lockwoodii* showing two small emergent offset at the base of the large offset and one very tiny emergent offset at the base

Fig. 6. A half, rooted-rosette of *Haworthia lockwoodii* and a removed offset ready for rooting, which it produced.

Note the just visible emergent offset an the half, rooted-rosette.

When cutting a rosette vertically into two halves or four quarters (three is a bit trickier because of the angle of the cuts) try to get the cuts so that some root is attached to each portion. If you fail, just treat the potion without roots like a cutting. After it has rooted, it will start to grow and then produce offsets.

(Continued from page 2)

continuously in many years. I donated my first rooted pup to my friend Mr. Saikat Dutta. He is a very keen Haworthia grower and successfully grew the pup.

In India, tissue culture is not used on a large scale for propagating Haworthia. I hope that my natural way of propagating clones by division will increase the supply and make many haworthia enthusiast happy.

I regret I was unable to produce this article at an earlier date because I lost the original photographs when my computer crashed.

References:

Haworthia lockwoodii. Archibald, its culture and propagation. Dr. Sarkaria. J.S, NCSSI-souvenir, Chandigrah, 1998.

Haworthia and Astroloba. A collector's guide. Pilbeam JB. Batsford. London.1983.

Photographs:

Soumen Aditya

Nuclear genome sizes of 343 accessions of wild collected Haworthia and Astroloba (Asphodelaceae, Alooideae), compared with the genome sizes of Chortolirion, Gasteria and 83 Aloe species.

B. J. M. Zonneveld

Abstract. For the first time, genome size was determined from a total of 343 wild collected plants from the succulent genera *Haworthia* and *Astroloba* (Asphodelaceae: Alooideae). Genome sizes (2C values) turned out to be rather close, especially within genus *Haworthia* s.s. To improve the accuracy of the results, in the end 2,368 measurements were made. The measured nuclear DNA contents provide a further basis for the separation of *Haworthia* s.l. into three genera. This resulted in 69 recognized species of the new genera *Haworthia*, *Haworthiopsis* and *Tulista*. The 2C values for the largest genus ***Haworthia*** (=*Haworthia* subgenus *Haworthia*) with 45 species varies only from 21.7 to 24.7 pg. An exception is some accessions of *Haworthia nortieri* (var. *agnis*) with up to 27.2 pg. The four varieties of *H. nortieri* are here elevated to species level and placed in a new section *Nortierae* Zonn. The genus *Haworthiopsis* (=*Haworthia* subgenus *Hexangulares*) is clearly divided in two sections, each with 10 species: section *Coarctatae* (25.2–27.6 pg) and *Venosae* (28.9–33.6 pg). The highest value so far for *Haworthia* s.l. has been *H. limifolia* which is hexaploid with 99.8 pg. The third genus *Tulista* (=*Haworthia* subgenus Robustipedunculares) with only four species varies from 35.9 to 37.2 pg. Closely related with *Tulista,* also with respect to genome size, is the genus *Astroloba* (including *Poelnitzia*) with nine species and from 30.4 to 34.0 pg. The results also show that most, but not all, varieties are correctly attributed to the nominate species. A few varieties have been reinstated as species of which two have been renamed in *Haworthiopsis*. Further details are discussed in the main text. The genome sizes were compared with the genome sizes of all species of *Gasteria*, *Chortolirion* and 83 *Aloe* species. *Aloidendron* (=*Aloe* section *Aloidendron*) with 24.5–37.4 pg, comes out as the most basal in the published cladogram for the Alooidae. It leads to the interesting suggestion that the amount of nuclear DNA of the two species in section *Kumara* (=*Aloe* section Kumara) namely *K. plicatilis* (17.6 pg) and *K. haemanthifolia* (16.2 pg) and species in *Aloiampelos* (=*Aloe* section *Macrifoliae*; (21.6 pg) have decreased strongly, which is a rare phenomenon.

Keywords. Genome size. 2C value. Nuclear DNA content. *Alooideae*. *Haworthia*. *Astroloba*. *Chortolirion*. *Gasteria*. *Aloe* p.p. *Haworthiopsis*. *Tulista*.

Introduction

Haworthia Duval and *Astroloba* Uitewaal are herbaceous perennials belonging to the monocotyledons (Asphodelaceae: Alooideae or Xanthorroeaceae). They are mostly endemic to the winter rainfall area of Southern Africa. They are popular with hobbyists and large numbers are sold in garden centres. The attention for the genus *Haworthia* results, as usual when hobbyists are involved, in a plethora of names. This is especially true for this group of plants where each species can vary considerably in morphological characters and also the small indistinct flowers hardly gives some clues. The genus is studied extensively and more than 1,000 different names have been published(Govaerts 2014). Several reviews have been published resulting in different numbers of recognized species. Scott (2001) recognizes 87 species whereas Bayer and Manning (2012) accept about 60 species. Others, often by upgrading varieties of Bayer to species status and describing many new species, recognize about 369 (Breuer 2010) to more than 500 species (Hayashi in Breuer 2010).

Several publications have used DNA sequences for a smaller or larger number of species of the Asphodelaceae (Chase et al. 2000). A fairly extensive number (58) of Alooideae were used by Treutlein et al. (2003) to construct a phylogenetic tree. The main conclusions were that *Haworthia* was divided over two non-sister clades [subgenus *Robustipedunculares* (Uitewaal) M.B.Bayer was not investigated]. Also *Aloe* L. was distributed over several clades. The 'Tree aloes' came out as most basal. Daru et al. 2013 used 172 accessions of the Alooideae to construct their cladogram. *Haworthia* is again shown to be paraphyletic and to comprise three main clades. *Aloe* was paraphyletic too and *Chortolirion* A. Berger was included with the 'True aloes'. The three species of the latter were included in *Aloe* (Grace et al. 2013; Daru et al. 2013). In both cladograms, very surprisingly, *Aloe aristata* Haw. came out close to *Haworthia* subgenus *Robustipedunculares* while *Astroloba* and *Poelnitzia* Uitewaal came out in the same clade.

Based on these results, Rowley (2013) renamed the three subgenera of *Haworthia* s.l. as the genera *Haworthia*, *Haworthiopsis* G.D.Rowley (for *Haworthia* subgenus *Hexangulares* Uitewaal) and *Tulista* [for subgenus *Robustipedunculares*, *Astroloba* (including *Poelnitzia*, following Manning and Smith 2000), and *Aloe aristata*]. This was followed by another generic classification by Manning et al. (2014), who used a more conservative approach and separated *Haworthia* into three genera coinciding with the three subgenera. Although this is a logical consequence of the sequencing results it will likely take a new generation of *Haworthia* enthusiasts before these new names get a foothold. Grace et al. (2013) renamed the segregate *Aloe* clades as the genera *Aloiampelos* Klopper and Gideon F.Sm (for *Aloe* section *Macrifoliae*), *Kumara* Medik. [for *Aloe* section *Kumara* (Medik.) Baker] and *Aloidendron* (A.Berger) Klopper and Gideon F.Sm (for *Aloe* sections *Aloidendron* A.Berger and *Dracoaloe* A.Berger). All this turmoil in name necessitated a completion of the existing genome sizes for the Alooideae by adding the genome sizes (=2C values = nuclear DNA content) for *Haworthia* and *Astroloba*. Although it does not lead to a cladogram, it was shown earlier that genome size is a valuable tool for indicating species relationships (Zonneveld 2009). Genome size differences of 1 picogram (pg) obtained with flow cytometry, amount to a difference of nearly 1,000.000.000 base pairs. This way it can corroborate cladograms that are based on the sequences of just a few 1,000 bases. The amount of nuclear DNA (2C value, for short: genome size) was therefore determined for 343 accessions of *Haworthia*. This is the first time the genome size was determined in *Haworthia* and *Astroloba*. These were compared with earlier obtained genome sizes for all species of *Gasteria* (Zonneveld and Van Jaarsveld 2005), all species of *Chortolirion* (Zonneveld and Fritz 2010) and 83 *Aloe* species (Zonneveld 2002). The genome sizes measured were compatible with the division of *Haworthia* s.l. in three different genera (or subgenera). A new division in sections is proposed with one new section and eight varieties are reinstated as species. Moreover, these data were superimposed on the cladogram of Manning et al. (2014), thus providing some new insights in the classification of the Aloideae.

Materials and methods.

Plant material.

More than 200 wild collected accessions of *Haworthia* s.l. and *Astroloba* were obtained from the collection of M.B.Bayer (South Africa), about 100 accessions from I. Breuer (Germany) and about 50 accessions from C. Grootscholten (The Netherlands). *Aloe haemanthifolia* was obtained from E. Aslander (South Africa). Plants are maintained as live collections by the above mentioned experts. For the correct identification of all material, the valuable opinions, books and articles of M.B.Bayer and I. Breuer were invaluable.

Flow cytometric measurement of DNA 2C value (genome size).

For the isolation of nuclei, about 1 cm² of the skin of the leaves or a few cm of root was chopped together with a piece of *Agave americana* L. 'Aureomarginata', as an internal standard. Chopping was done with a new razor blade in a Petri dish in 0.25 ml nuclei-isolation buffer (Galbraith et al. 1983) to which 0.25 mg RNase/ml was added (Zonneveld and Van Iren 2001). After adding 1.75 ml of propidium iodide solution (50 mg PI/l in isolation buffer), the suspension with nuclei was filtered through a 30 µm nylon filter. The fluorescence of the nuclei was measured half an hour and 1 h after the addition of propidium iodide, using a Partec CA-II flow cytometer. The optical path contained a HBO mercury lamp, filters KG1, BG12, dichroic mirror TK500, filter OG570 and a Leitz 50 x 1 water immersion objective. Data were analysed by means of DPAC software (Partec GmbH). Fresh male human leucocytes (2C = 7.0 pg; 1 pg = 10^{-12}g = 0.978 x 10^9 base pairs) (Doležel et al. 2003) were chosen as primary standard (Tiersch et al. 1989). This yields 2C = 15.9 pg for nuclei of *Agave americana* L. A recent measurement of *Agave americana*, with *Arabidopsis thaliana* (L.) Heynh. with 0.321 pg as a standard, resulted in a very similar value. The 2C DNA content of the sample was calculated as the sample peak mean, divided by the *Agave* peak mean, and multiplied with the amount of DNA of the Agave standard. Most samples were measured 6–7 times, each time with about 5,000 nuclei. From a single leaf of *Haworthia glauca* 35,000 nuclei could be extracted, giving a minimum value for the number present. Most histograms revealed a coefficient of variation of around 3 %. The standard deviation for nuclear DNA content, using all relevant measurements, was about 2 %.

As far as possible the new genus names are used for *Haworthia* subgenus *Haworthia* [*Haworthia* s.s., *Haworthia* subgenus *Hexangulares* (genus *Haworthiopsis*) and *Haworthia* subgenus *Robustipedunculares* (genus *Tulista*, sensu Manning et al. (2014)].

Results and discussion

General

The genus Haworthia s.l. (2n = 14) is divided in about 60 (Bayer and Manning 2012), 369 (Breuer 2010) or more than 500 species (Hayshi in Breuer 2010). Here the more conservative approach of Bayer and Manning (2012) is largely followed. Their classification is mainly based on morphology and biogeography. Bayer studied them extensively in the wild for many years and thus has first-hand knowledge of the genus *Haworthia*. Genome sizes are superimposed on the cladogram of Manning et al. (2014) and compared with earlier determined genome sizes for *Gasteria* Duval, *Chortolirion* and *Aloe* p.p.

As their genome sizes were close, especially in the case of genus *Haworthia* s.s. (*Haworthia* subgenus *Haworthia*), in the end 2,368 measurements were performed amounting to 6–7 measurements on average for each accession. Apart from a peak for the diploid nuclei most histograms also showed smaller peaks that inferred tetraploid and octoploid amounts of DNA per nucleus (Fig. 1).

Remarks on Table 1, pages 13-25.

In Table 1 all 343 accessions of *Haworthia* s.l. and nine species of *Astroloba* that were measured, are arranged alphabetically with their collection number, locality, amount of nuclear DNA (2C value), the average weight for each taxon, the standard deviation and the number of measurements for each accession. In some cases the name is mentioned under which it was received, if deviating from the name in the alphabetical list.

For all the 343 accessions of *Haworthia* the genome size (2C value) varies from 21 to 35 pg if the 18 inferred polyploids are excluded (Table 1). The genome sizes neatly follow the subdivision of the genus *Haworthia* in three subgenera in accordance with Uitewaal (1947), Bayer (1976) and Daru et al. (2013). *Haworthia* (*H.*

subgenus *Haworthia*, section 1–6) with 45 species varies from 21.7 to 24.7 pg, *Haworthiopsis* (*Haworthia* subgenus *Hexangulares*, section 7 and 8) with 20 species

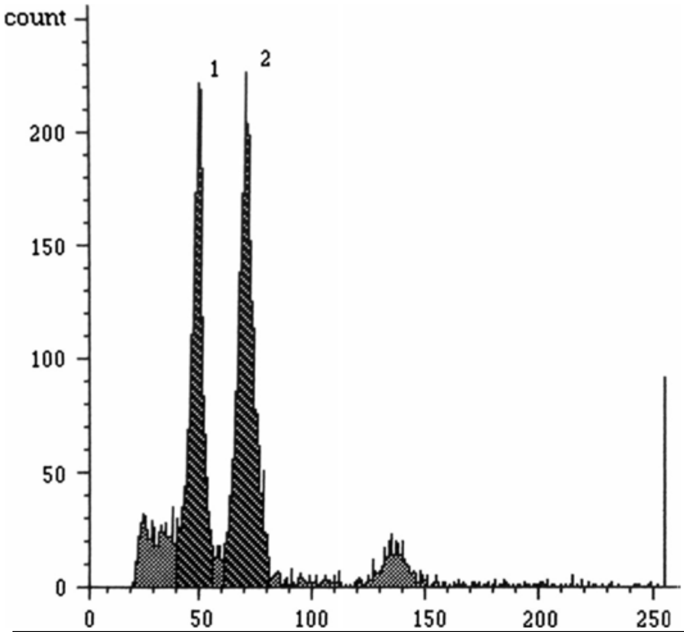

Fig. 1 Histogram of fluorescence intensity of nuclei from tissue of the leaf of *Haworthia marumiana* var. *archeri*. 1 *Agave americana* (standard), 2 *Haworthia marumiana* var. *archeri*

from 25.2 to 33.6 pg and *Tulista* (*Haworthia* subgenus *Robustipedunculares*, section 9) with four species varies from 35.9 to 37.2 pg. The genus *Astroloba* with nine species (if *Poelnitzia* and two nomina nuda are included) varies from 30.4 to 35.9 pg. This range of genome sizes places *Astroloba* close to the genus *Tulista*.

Values within species are mostly very close. An example is *Haworthia attenuata* where 11 accessions varied only from 26.0 to 26.4 pg. In other cases larger differences are found like 23.9 to 25.0 pg for nine accessions of *Haworthia arachnoidea*. There are several explanations possible, but it might have to do with the ease with which nuclei without adhering protoplasm are obtained. However 'cryptic' species cannot be excluded. Brandham and Doherty (1998) published a karyogram showing that *Haworthia* has four long and three short chromosomes. If their arbitrary length was measured, they amount to 17 + 16 + 16 + 16 + 4 + 4 + 3 = 78 mm. If we assume that the loss of a large chromosome would be lethal and choose an average weight of 28 pg for *Haworthia* then loss or gain of a single small chromosome would give a difference of 0.54 to 0.72 pg in 2C value for an aneuploid. This might be solved by further cytological investigations.

Polyploidy.

Diploids in *Haworthia,* as in most Alooideae, have 2n = 2x = 14 chromosomes (Breuer 1999).

Only 18 polyploids are inferred from their genome size among 343 accessions of *Haworthia* (An alternative for the term 'inferred ploidy' is the proposed term 'DNA ploidy' of Suda et al. 2006). Only a single polyploid was found in *Haworthia* s.s. with one triploid and a tetraploid garden form out of 12 accessions of *Haworthia retusa* var. *retusa* (f. *geraldii*). For *Haworthiopsis* both diploid and tetraploid forms are indicated in *Haworthia coarctata* and *Haworthia reinwardtii* var. *reinwardtii*. In *Haworthia glauca* var. *herrei* 25.2 and 61.7 pg were measured, suggesting that the latter is a pentaploid. All three accessions of *Haworthia tesselata* were polyploid but had 66.6, 69.7 and 72.3 pg. If it is tetraploid, half the value of 69.2 (=34.6) would give the highest value in *Haworthiopsis*. Maybe in this case aneuploidy is involved as Breuer (1999) reported 14, 21, 28, 29, 35, 40, 42, 56 and 63 chomosomes for *Haworthia tesselata*. From eleven accessions of *Haworthia limifolia* three were inferred to be diploid, five were triploid, two were tetraploid and one was even hexaploid with 99.8 pg. This is the highest 2C value found so far for *Haworthia*. These inferred ploidies did not coincide with the five varieties of *Haworthia limifolia* (Table 1) suggesting that single populations could have several ploidies. Also for one of the nine species of *Astroloba*, *Astroloba spiralis*, tetraploidy can be deduced from the genome size. Five out of six polyploid accessions were from the 20 species of *Haworthiopsis* and only one (*Haworthia retusa*) was from the 45 species of Haworthia s.s. This is in line with the results summarized by Breuer (1999) who also reported most of the polyploids in *Haworthiopsis*. Although only nine out of 343 plants measured were garden forms three turned out to be polyploid namely *Haworthia glauca* var. *herrei* (pentaploid), *Haworthia retusa* var. *retusa* (f. *geraldii*, triploid) and *Haworthia tesselata* (tetraploid). It is possible that polyploids adapt better to greenhouse conditions, but this needs to be investigated further.

Division in sections (Table 2, page 26).

In Table 2 the results are summarized with the species placed in their own genus. The sections, and the species within each section, are more or less arranged according to genome size. If both diploid and polyploid values were found only the first are presented in Table 2. Also the number of different accessions and the number of measurements on which the genome sizes are based is given. A division in sections in *Haworthia* is a fairly arbitrary exercise, but can be helpful in showing relationships. The division in sections presented here starts from the original division in 20 sections of Rowley (Jacobsen 1974) and the 8 sections (further divided in series) of Breuer (1998). This division in sections is here now furthered by basing it also on new data: their place in the cladogram of Manning et al. (2014) and their genome sizes (Table 2). Genus *Haworthia* s.s. then contains section 4 *Haworthia* (including *Setatae*, *Limpidae* and *Obtusatae*), section 1 *Fusiformis* F.W.Barker, section 2 *Fenestratae* Poelln. (strongly expanded), section 3 *Retusae* Haw. (including *Reticulatae*, *Subregularis* and *Muticae*), section 5 *Loratae* (Salm-Dyck) A.Berger and section 6 *Nortierae* Zonn sect. nov. Genus *Haworthiopsis* is divided in two sections: section *Coarctatae* A.Berger (including *Parviflorae*, *Tortuosa*, *Triquetrae* and *Trifariae*) and section *Venosae* Berg. (including *Scabrae*, *Limifoliae* and *Tesselatae*) and for genus *Tulista*, the section *Margaritiferae* Haw. (including *Marginatae*). Sections *Tortuosae*, *Rigidae* and *Planifoliae* are omitted as likely based on hybrids. Hardly any differences were found for the genome sizes of the species in section 3, 4 and 5. Genome sizes do not support the separate status of these three sections.

A new section *Nortierae* is added for the four peculiar species that were named as varieties of *Haworthia nortieri* by Bayer and Manning (2012).

Description: they differ in genome size with 24.5 pg for *Haworthia pehlemanniae* Scott, 25.3 pg for *Haworthia globosiflora* GG Smith, 26.5 pg for *Haworthia nortieri* GG Smith and 27.2 pg for *Haworthia agnis* Battista from the other species of genus *Haworthia* s.s. Leaves have swollen leaf tips that are only slightly recurved and possess translucent dots. Apart from the genome sizes, these four species are said to differ strongly in flower shape. They are essentially species from the Sandstone Mountains of the Western Cape. Type: *Haworthia nortieri* G.G. Sm. (Smith 1676/a in NBG from near Doorn River bridge, 45 km NW of Clanwilliam, South Africa).

Genera and species (Table 2).

The 2C values for the largest genus *Haworthia* with 45 species varies only from 21.7 to 24.7 pg. This low variation with a factor 1.1 for such a large number of species is unusual as regularly a factor 1.5 to 3 is found for the genome sizes between species in other genera (Zonneveld and Van Jaarsveld 2005; Zonneveld 2001, 2009). This suggests that species of this genus are strongly related and have recently diversified and perhaps more species should be reduced to varieties. (This seems to contradict the earlier remark that there could be more 'cryptic' species, but both could be true).

The lowest amounts of nuclear DNA were found for the species *Haworthia blackburniae* and *Haworthia wittebergensis* with 21.7 and 22.5 pg respectively. Both have similar grassy leaves, very thick contractile roots and a woody vascular structure found further only in *Haworthiopsis*. On this account they are placed here in the same section 1 *Fusiformis*. This deviates from the placement of *Haworthia blackburniae* and *Haworthia wittebergensis* in different clades (Manning et al. 2014). A second group of eight species with low 2C values from 21.9–23.2 pg is composed by reinstating varieties as species that deviated by a lower genome size of about1 pg from the other varieties of the species. This, surprisingly, nearly fully coincides with one of the clades in Manning et al. (2014).

Haworthia marumiana var. *reddii* (36 measurements for 5 accessions) deviated 1.3 pg from the other *Haworthia marumiana* varieties (63 measurements for 9 accessions). Its original name *Haworthia reddii* C.L.Scott is retained here. The same is true for *Haworthia monticola* var. *asema* [now *Haworthia asema* (M.B.Bayer) M. Hayashi] that differed 0.9 pg and *Haworthia pulchella* var. *globifera* [now *Haworthia globifera* (M.B.Bayer) M. Hayashi] that differed 1 pg. It is important to bear in mind that 1 pg equates to a billion bases! Following the latest revision of Bayer and Manning (2012) *Haworthia atrofusca*, *Haworthia beukmannii*, *Haworthia consanguinea*, *Haworthia heidelbergensis*, *Haworthia magnifica*, *Haworthia maraisii*, *Haworthia meiringii*, *Haworthia notabilis*, *Haworthia paradoxa*, *Haworthia scabra*, *Haworthia splendens*, *Haworthia toonensis* and *Haworthia triebneriana* are all now varieties of *Haworthia mirabilis*. *Haworthia mirabilis* var. *paradoxa* differs with 1.1 pg from the other varieties of *H. mirabilis*. However, in the cladogram (Manning et al. 2014) it comes out as sister to *Haworthia mirabilis*, therefore it is retained here as a variety. For *H. cooperi*, the so-called 'gracilis'-forms are included in the nominate species as they are indistinguishable in genome size of the other forms of *H. cooperi* and intermediates occur frequently (Bayer pers. communication 2004). The same is true for *Haworthia chloracantha* var. *subglauca* that deviates with 0.8 pg from the other varieties of *Haworthia chloracantha*. Although the placement of the species within *Haworthia* s.s. is not contradicted by their 2C value, it must be pointed out that all their genome sizes are unusually close indeed.

The genome sizes of the 'varieties' of *Haworthia nort*ieri differ considerably in their amount of DNA. Four varieties have been described based on their morphological and geographical differences. They are all very difficult to grow in culture and might therefore be missing from the cladogram. Genome size range from 24.2 pg for var. *pehlemanniae* (including var. *devriesii*), 25.3 pg for var. *globosiflora*, 26.3 pg for var. *nortieri* to 27.2 for var. *agnis*. All four varieties have been named earlier as species (*H. pehlemanniae*, *H. globosiflora*, *H. nortieri*, and *H. agnis*). As this is corroborated by their differences in genome size, *H. nortieri* is divided here into four species and placed in a separate section (Nortierae Zonn.).

Genome size in genus *Haworthiopsis* with 20 species varies from 25.2 to 33.6 pg. *Haworthiopsis* can be clearly divided in two sections, each with 10 species: section *Coarctatae* (with 25.2–27.6 pg) and section *Venosae* (with 28.9–33.6 pg). This was first noted by Hayashi (2001) and is largely in accordance with the cladogram of Manning et al. (2014) and this is partly followed by Rowley (2013). Two species deviate: *H. bruynsii* that, despite its 29.3 pg falls in the *Coarctatae* clade with about 26 pg. The reverse is true for *Haworthia attenuata* that, with 26.3 pg (based on 12 accessions), falls in the *Venosae* clade with an average of 30 pg. No explanation comes to mind apart from the obvious ones like wrong sampling. *Haworthiopsis venosa* of section *Venosae* is now split into four species (Bayer and Manning 2012): *Hawortrhiopsi venosa*, *Haworthiopsis granulata*, *Haworthiopsis woolleyi* and *Haworthiopsis tesselata*. The first three show only small differences in genome size with 29.9, 28.9, 29.6 pg but *Haworthiopsis tesselata*, at least the three accessions measured, had 69.2 pg on average, inferring tetraploidy. The placement of *H. koelmaniorum* var. *mcmurtryi* as the only member of *Haworthiopsis* in *Tulista* (Daru et al. 2013) seems questionable and is not followed here. *Haworthia koelmaniorum* var. *mcmurtryi* has 2 pg less DNA than its nominate species and is here reinstated as a separate species *H. mcmurtryi* C.L.Scott. *Haworthia variabilis* is considered a synonym of *H. viscosa* of section Coarctatae (Bayer and Manning 2012). However, with 29.1 instead of 26.4 pg for *H. viscosa*, *H. variabilis* does not belong to *H. viscosa* and must even be placed in the different section *Venosae*. The genome size of the third genus *Tulista* with only four species, varies from 35.9 to 37.2 pg. They were found to have a bright orange-yellow leaf exudate present also in some *Aloe* species. Closely related with *Tulista* (Manning et al. 2014), also with respect to genome size is the genus *Astroloba* (including *Poellnitzia*, Manning and Smith 2000) with nine species and from 30.4 to 34.0 pg. These nine species do not have the yellow exudate present in members of *Tulista.* They include two nomina nuda: *Aloe smutsiana* and *Aloe hallii* that were mentioned in a thesis of Roberts Reynecke (1965) but never validly published. These are included to record their genome sizes and so far no synonymy seem to have been suggested. *Astroloba bullulata* Uitewaal has been included. It is supposed to be the hybrid *Astroloba aspera* x *Haworthia pumila*, but that does not fit the genome size. *Astroloba bullulata*, *A. smutsiana*, *A. corrugata* and *A. halli* are very similar in genome size with 30.4–30.8 pg and might represent a single species.

Comparison of genome sizes with the cladogram of Manning et al. (2014)

In Fig. 2, page 25, the genome sizes for *Haworthia* s.l. and *Astroloba* are compared with the summarized cladogram of Manning et al. (2014). This is based on their earlier published cladogram with three plastid genes (matK, rbcLa, trnHpsbA) (Daru et al. 2013) and one nuclear gene (ITS1), with one extra plastid gene added: trnL. These are also compared with the new names of *Haworthia* (Rowley 2013) and *Aloe* (Grace et al. 2013). Combining the results of these two publications, Manning et al. (2014) recognize eight genera for *Haworthia* s.l. and *Aloe* s.l. and add two more genera, *Aristaloe* Boatwr. and J.C.Manning and *Gonialoe* (Baker) Boatwr. and J.C.Manning while maintaining *Gasteria* and *Astroloba.* Additionally, the range of the earlier measured genome sizes for *Gasteria* (Zonneveld and Van Jaarsveld 2005), *Chortolirion* (Zonneveld and Fritz 2010) and *Aloe* (Zonneveld 2002) are transferred to the same cladogram.

Remarks on *Haworthia* s.l. superimposed on the cladogram.

Genus *Haworthia* s.s. is the most basal with an amount of nuclear DNA of 21.7–24.3 pg. This fits with the fact that it has the lowest amount of DNA of the three new genera of *Haworthia* s.l. Moreover it can hardly be crossed with the genera *Haworthiopsis* and *Tulista* (Cumming 2006) which fall in other clades. In the same clade is the genus *Kumara* (=*Aloe* section *Kumara*) (see below).

Looking at the genome sizes of species of genus *Haworthiopsis*, these can be split in two sections as discussed above. Nine species of *Haworthiopsis* sequenced (except one, *H. bruynsii*) form a subclade and coincide with our section *Coarctatae*. The three sequenced species of section *Venosae* are in the other subclade (except one *H. attenuata*) of *Haworthiopsis*. Both sections belong, according to their genome size, flower shape and place in the cladogram to genus *Haworthiopsis*. Based on the cladogram, *Haworthiopsis* is more closely related to *Gasteria* with 32.8–43.2 pg (Zonneveld and Van Jaarsveld 2005) than to the genus *Tulista*. This is corroborated by the fact that, although *Gasteria* crosses with all three genera, only the hybrids with *Haworthiopsis* are fertile (Cumming 2006). Rowley (2013) has taken this up and placed 16 species in *Haworthiopsis*. Manning et al. (2014) added *H. pungens* to section *Coarctata* and *H. koelmaniorum* into section *Venosae*. *Haworthia variabilis* (not included in the cladogram of Manning et al. 2014) and *H. mcmurtryi* are here also added to the genus *Haworthiopsis* section *Venosae* and the new combination is provided below.

***Haworthiopsis variabilis* (Breuer) Zonn. comb. et stat. nov.**

Basionym: *Haworthia viscosa* var. *variabilis* Breuer in Avonia 21:61(2003).

Synonym: *Haworthia variabilis* (Breuer) Breuer in The genus Haworthia 1:8(2010).

Type: South Africa. NW Joubertina, Breuer 7193 (Research Institute of Evolutionary Biology, Tokyo).

***Haworthiopsis mcmurtryi* (C.L.Scott) Zonn. comb. et stat. nov.**

Basionym: *Haworthia mcmurtryi* Scott in Cact Succ J (Los Angeles) 56–2:69 (1984).

Synonym: *Haworthia koelmaniorum* var. *mcmurtryi* (C.L.Scott) M.B.Bayer in Haw Rev.: 181(1999).

Type: South Africa. Transvaal, Loskop, SW Dam, McMurtry 5247(PRE).

The genus *Tulista* with four species has from 35.9 to 37.2 pg, and falls in the same clade as *Astroloba* with nine species from 30.4 to 35.9 pg. This is not incongruent with the genome sizes. It must be remarked that *Astroloba* (*Poellnitzia*) *rubiflora* deviates from the other *Astroloba* by the low sucrose content of its nectar (5 % versus more than 60 % for the other species, Smith et al. 2002), it has the highest amount of nuclear DNA of the *Astroloba* and especially the shape of the flower tube and its orange red colour deviates. *Aloe aristata* and *Haworthia koelmaniorum* are included in the same clade. *Aloe aristata* comes out in the same place in the cladogram of Treutlein et al. (2003). This further suggests that it is closer to *Tulista* than to *Aloe*, despite its aloe-like, large reddish flowers. However, the placing here of *H. koelmaniorum* var. *mcmurtryi* seems unlikely. Based on flower and capsule shape it was placed in *Haworthiopsis* and the genome size of 30.3 pg supports this placement. Retaining of *H. koelmaniorum* in Haworthiopsis despite its different placement in the cladogram was also proposed by Manning et al. (2014).

Hybridity.

Cumming (2005, 2006) has performed extensive hybridizations between all genera of the *Alooideae*. The relevant results here are that crosses between *Haworthia* s.s. on one side and the genera *Haworthiopsis*, *Tulista* and *Astroloba* on the other side, are nearly impossible. Moreover, *Astroloba* crosses fairly easily with *Haworthiopsis* and *Tulista*. This confirms that *Haworthia* s.s. is not closely related to the other two genera and *Astroloba*. It also questions the inclusion of *Chortolirion* in *Aloe* since *Chortolirion* does not seem to cross with *Aloe*, but does so freely with *Gasteria* and *Haworthiopsis*. This seems not to fit with its placement in the cladogram.

Sugar chemistry.

Smith et al. (2002) investigated nectar sugar composition in some Alooideae. They concluded it to be a conservative character that reflects taxonomic affinities rather than pollinator types. They however, did not treat the subgenera of *Haworthia* s.l. separately. If this is done (Cumming 2006) *Haworthiopsis* turns out to have three times as much sucrose as glucose contrary to *Haworthia* s.s., where both are more or less equal. This again shows that there is a marked discontinuity between *Haworthiopsis* and *Haworthia* s.s.

Remarks on *Aloe* superimposed on the cladogram.

Three groups have been considered as basal in *Aloe*. *Aloe* section *Macrifoliae*, with seven species and the small genome size of 21.5 and 21.7 pg for two taxa was considered on morphological grounds (Brandham and Carter 1990; Adams et al. 2000) to be the most basal. *Aloe* section *Kumara*, with *Aloe plicatilis* (L.) Burm.f. sequenced, has 17.6 pg of nuclear DNA. *Aloe haemanthifolia* A.Berger and Marloth [of section *Haemanthifoliae* (A.Berger) Glen and D. S. Hardy], with 16.2 pg, has an even lower amount of nuclear DNA. Both are the lowest of all 83 aloes of which the nuclear DNA was measured (Zonneveld 2002). These taxa were, therefore, considered to be the most basal by Zonneveld (2002) based on this comparatively very low amount of nuclear DNA. *Aloe haemanthifolia* has a stemless, fan-like rosette while *A. plicatilis*, equally with fanlike rosettes, has a stem of up to 2 m.

Aloe haemanthifolia and *A. plicatilis* are usually placed in separate sections (Jacobsen 1974). Their similar DNA content, similar distichous growth form and growing area (i.e. the high rainfall area in the Western Cape mountains), suggest that they may be closely related. Their basal nature is further shown by the simple raceme and the absence of marginal teeth from their strap-like leaves (Zonneveld2002). It would support the view of Holland (1978) who claims that the ancestral aloes originated in the highlands of South Africa.

In the cladogram presented by Manning et al. (2014) the group of the 'Tree aloes' (excluding *A. plicatilis*) comes out as most basal. As they are also basal in the more limited cladogram of Treutlein et al. (2003) based on rbcL, matK and ISSR, it cannot be easily refuted. For these seven 'Tree' species a nuclear DNA content of 24.5–37.4 pg was found (Zonneveld 2002). These genome sizes largely coincide with the genome sizes of the 'True' aloes (27.2–44.4 pg). It would suggest that the amount of nuclear DNA in *A. plicatilis* and *A. haemanthifolia* and in *Aloe* section Macrifoliae has decreased strongly, which is a rare phenomenon. This and the genome sizes seem to argue against considering the 'Tree Aloes' as being the most basal of the Alooideae. A plausible explanation (Zonneveld 2002), at least for the genus *Kumara*, could be that both *K. plicatilis* and *K. haemanthifolia* grow in high rainfall areas in sandy soil, likely very low in nitrogen. That way, any 'saving' on nitrogen-rich DNA would result in a decrease in DNA content, which would be beneficial to the survival of the plants in a nitrogen-deprived habitat (Grime and Mowforth 1982). A similar decrease has been reported for *Hosta longissima* Honda that grows in sphagnum bogs low in nitrogen (Zonneveld and van Iren 2001).

Another Aloe clade is the one that contains the ''True aloe's'', with genome sizes for about 70 aloes of 26.7–44.4 pg (Zonneveld 2002) and the members of *Chortolirion* with 27.2–30.6 pg (Zonneveld and Fritz 2010). *Chortolirion* is closely related to the so-called grass aloes (*A.* section *Leptoaloe* A.Berger) (Craib 2005) with similar amounts of DNA and similar morphology, as was already suggested by Zonneveld in Zonneveld and Fritz (2010). *Chortolirion*, divided for the first time in three species by Zonneveld and Fritz (2010) were renamed as three *Aloe* species by Grace et al. (2013) and improved upon by Klopper et al. (2013; recognizing four species) and Manning et al. (2014).

Rowley (2013) amalgamated *Aloe aristata*, *Astroloba*, *Poelnitzia* and *H. koelmaniorum* with the genus *Tulista* (but omitting *H. minima*). Had Rowley seen the recent publication of Manning et al. (2014), he probably would also have included in his genus *Tulista* the three species of *Aloe* section *Serrulatae* Salm-Dyck with 31.8 and 33.6 pg for two species, as these fall in the same clade. This combination of four genera into a single one is not followed by Manning et al. (2014). A consequence of their more conservative approach is that *Aloe aristata* (now in the genus *Aristaloe*) and three members of *Aloe* of the *Serrulatae* section (now in the genus *Gonialoe*) are each placed in separate genera, despite their close placement in the cladogram to *Tulista* and *Astroloba*. Also *Aloe* section *Macrifolia* (7 taxa), *Aloe* sections *Aloidendron* and *Dracoaloe* (7 taxa) and *Aloe* section *Kumara* (2 taxa) are now placed in the segregate genera Aloiampelos, Aloidendron and Kumara respectively (Grace et al. 2013; Manning et al. 2014). This separates 20 members of species *Aloe* s.l. into five new genera, leaving about 600 other taxa in the genus *Aloe* s.s. However, it can be speculated that more splits might be forthcoming, for instance the grass aloes (*Aloe* section *Leptoaloe*), fleshy fruited or berried aloes (*Aloe* section *Lomatophyllum)* and perhaps the aloes of Madagascar or the Arabian Peninsula. An alternative for the current, conservative approach would be a very broad generic concept that places all Alooidae in one widely circumscribed genus, *Aloe*. However, this would lead to a large number of taxonomic changes causing taxonomic instability and loss of information. It could also have negative consequences for biodiversity conservation and horticulture. So now, instead of five genera we have eleven genera in the Alooidae.

In short, six independent characters are now available for *Haworthia* s.l. These are with their main proponents: morphology (Breuer 1998, 2000; Hayashi 2001), biogeography (Bayer 1999), DNA sequences (Treutlein et al. 2003; Daru et al. 2013; Manning et al. 2014), chemistry (Smith et al. 2002), genome size (Zonneveld this article) and ability to hybridize (Cumming 2006, 2014a, b). Compared with the species recognized by Bayer and Manning (2012), *H. agnis*, *H. asema*, *H. comptoniana*, *H. globifera, H. globosiflora*, *H. mcmurtryi*, *H. pehlemanniae*, *H. reddii* and *H. variabilis* are here considered to be good species adding up to a total of 69 species for *Haworthia* s.l.

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p.p. = pro parte = partly, in part

s.l. = sensu lato = in a broad sense

s.s. = sensu stricto = in a narrow sense.

Table 1 *Haworthia* s.l. and *Astroloba* genome sizes of 343 accessions, arranged alphabetically with their collection number, locality, the average weight for each taxon (species or variety), the standard deviation, section nr and the number of measurements for each accession

Coll. Nr	*Haworthia* s.l. and *Astroloba*	Received as	Section	pg/2C	Average	SD	#Meas.	Origin
CGA4	*Astroloba bullulata* (Jacq.) Uitewaal		10	30.4		0.5	8	Witteberg Valley
MBBsn	*Astroloba smutsiana* nom. nud.		10	30.6		0.5	7	Plathuis
MBBsn	*Astroloba corrugata* N.L.Mey. & Gideon F.Sm.		10	30.7		0.1	8	Montagu
MBB7383	*Astroloba hallii* nom. nud.		10	30.8		0.4	10	E Prince Albert
CGA28	*Astroloba congesta* (Salm-Dyck) Uitewaal		10	31.5		0.3	8	Craddock
MBB7015	*Astroloba foliolosa* (Haw.) Uitewaal		10	31.7		0.4	8	DePlaat
MBB7378	*Astroloba herrei* Uitewaal		10	34.0		0.3	4	S Prince Albert
CGA99	*Astroloba (Poelnitzia) rubriflora* (L.Bolus) Gideon F.Sm. & J.C.Manning		10	35.0		0.8	5	hort.
MBB7001	*Astroloba spiralis* (L.) Uitewaal		10	59.3		0.9	8	Dysseldorp
EA1442	*H. agnis* Battista	*H. nortieri var. agnis*	6	27.0	**27.2**	0.3	8	Karreeberge, Nuwerus
JDV99/12.4	*H. agnis* Battista	*H. nortieri var. agnis*	6	27.1		0.3	8	Karreeberge, Nuwerus
JDV99/12.3	*H. agnis* Battista	*H. nortieri var. agnis*	6	27.3		0.2	8	Karreeberge, Nuwerus
JDV99/12.1	*H. agnis* Battista	*H. nortieri var. agnis*	6	27.3		0.2	8	Karreeberge, Nuwerus
JDV97/72	*H. angustifolia* var. *altissima* M.B.Bayer		5	24.3	**24.7**	0.3	6	Palmietfontein
RIB0007	*H. angustifolia* var. *baylissii* (C.L.Scott) M.B.Bayer		5	24.8		0.3	8	TL, Oudekraal
DMC08213	*H. angustifolia* var. *paucifolia* G.G.Sm.		5	25.0		0.2	4	Kaffirdrift
EAsn	*H. arachnoidea* (L.) Duval var. *arachnoidea*		4	24.7	**24.5**	0.4	8	Inverdoorn
IB6606	*H. arachnoidea* var. *aranea* (A.Berger) M.B.Bayer		4	24.7		0.3	4	near Matjiesdrift
PVB6745	*H. arachnoidea* var. *namaquensis* M.B.Bayer		4	24.9		0.4	8	Kourkamma
RIB0055	*H. arachnoidea* var. *nigricans* (Haw.) M.B.Bayer	*H. C.L.Scottii*	4	25.0		0.2	8	Gamka East
IB7123	*H. arachnoidea* var. *scabrispina* M.B.Bayer	*H. arach. var. gigas*	4	24.3		0.1	4	Middelplaas
JDV92/93	*H. arachnoidea* var. *setata* (Haw.) M.B.Bayer		4	23.9		0.3	14	Prinspoort
DT2445	*H. arachnoidea* var. *setata* (Haw.) M.B.Bayer	*H. aristata*	4	24.2		0.1	4	NE of Grootrivier
MBB6910	*H. arachnoidea* var. *setata* (Haw.) M.B.Bayer	*H. tretyrensis*	4	24.3		0.3	16	N Steytlerville
JDV91/111	*H. arachnoidea* var. *setata* (Haw.) M.B.Bayer		4	24.6		0.2	6	Drielingskloof
RIB0383	*H. asema* (M.B.Bayer) M.Hayashi	*H. bronkhorstii*	2	22.2	**22.3**	0.3	4	Witberg

Coll. Nr	*Haworthia* s.l. and *Astroloba*	Received as	Section	pg/ 2C	Average	SD	#Meas.	Origin
IB6619	*H. asema* (M.B.Bayer) M.Hayashi	*H. asema*	2	22.3		0.4	8	Buffelskloof
PVB7073	*H. asema* (M.B.Bayer) M.Hayashi	*H. monticola var. asema*	2	22.6		0.5	12	Leeurivier
MBB6851	*H. aristata*Haw.	*H. denticulata*	4	23.2	**23.2**	0.3	6	Modderfontein
PVBsn	*H. attenuata* var. *glabrata* (Salm-Dyck) M.B.Bayer		7	26.4	**26.3**	0.4	8	Transkei
MBB6831.b	*H. attenuata* var. *radula* (Jacq.) M.B.Bayer		7	26.0		0.2	8	Halleluja
MBB6831.a	*H. attenuata* var. *radula* (Jacq.) M.B.Bayer		7	26.3		0.4	8	Halleluja
DMC08558	*H. attenuata* var. *radula* (Jacq.) M.B.Bayer		7	26.5		0.3	8	N Hankey
MBB6828	*H. attenuata* (Haw.) Haw.		7	26.5		0.2	8	Sandkraal
MBB7172	*H. attenuata* (Haw.) Haw.		7	26.0		0.5	8	Enon
MBB7172	*H. attenuata* (Haw.) Haw.		7	26.4		0.3	8	Enon
WHGsn	*H. attenuata* 'Big Band'		7	26.4		1.3	4	hort.
WHGsn	*H. attenuata* 'Britteniana'		7	26.3		0.4	2	hort.
TPsn	*H. attenuata* 'Caespitosa'		7	26.2		0.3	8	hort.
WHGsn	*H. attenuata* 'Clariperla'	*H. papillosa*	7	26.0		0.3	2	hort.
IBsn	*H. bayeri* J.D.Venter & S.A.Hammer	*H. Hayashi*	4	22.3	**22.7**	0.2	4	TL., S Uniondale
RIB0071	*H. bayeri* J.D.Venter & S.A.Hammer		4	22.7		0.4	4	Uniondale
JDV91/152	*H. bayeri* J.D.Venter & S.A.Hammer		4	23.0		0.4	6	DeRust
CG1690	*H. blackburniae* W.F.Barker var. *blackburniae*		1	21.9	**21.7**	0.2	6	Rooiberg
CG161	*H. blackburniae* var. *derustensis* M.B.Bayer		1	21.7		0.4	6	W Dysseldorp
PVB sn	*H. blackburniae* var. *graminifolia* (G.G.Sm.) M.B.Bayer		1	21.6		0.1	4	Hartmansberg
CG1537	*H. blackburniae* var. *graminifolia* (G.G.Sm.) M.B.Bayer		1	21.8		0.4	6	W Dysseldorp
MBB6573	*H. bolusii* var. *blackbeardiana* (Poelln.) M.B.Bayer		4	23.2	**23.7**	0.4	6	Highclere
JDV94/60	*H. bolusii* var. *blackbeardiana* (Poelln.) M.B.Bayer		4	23.6		0.5	6	Stonefell
MBB7021	*H. bolusii* Baker var. *bolusii*		4	23.9		0.6	6	Pearston
RIB0087	*H. bolusii* Baker var. *bolusii*	*H. odettae*	4	24.0		0.1	4	Lootskloof
JDV96/61	*H. bolusii* var. *pringlei* (C.L.Scott) M.B.Bayer	*H. decipiens*	4	24.0		0.3	8	Baviaanskranz
JDV91/123	*H. bruynsii* M.B.Bayer		8	29.1	**29.3**	1.2	6	Springbokvlakte
GM258	*H. bruynsii* M.B.Bayer		8	29.5		0.3	4	SE of Kleinpoort
EVJ17620	*H. chloracantha* Haw. var. *chloracantha*		3	23.5	**23.8**	0.5	8	Gouritzpoort
JDV90/74	*H. chloracantha* Haw. var. *chloracantha*		3	23.5		0.3	8	Great Brak

Coll. Nr	*Haworthia* s.l. and *Astroloba*	Received as	Section	pg/2C	Average	SD	#Meas.	Origin
MBB1420	*H. chloracantha* Haw. var. *chloracantha*		3	23.6		0.2	4	Valschriviermond, Gouritz
EvJ17620	*H. chloracantha* Haw. var. *chloracantha*		3	23.8		0.3	10	Gouritzpoort
JDV97/138	*H. chloracantha* Haw. var. *chloracantha*		3	23.8		0.3	6	TL. N Herbertsdale
JDV87/76	*H. chloracantha* Haw. var. *chloracantha*		3	23.9		0.2	8	Cooper Siding
JDV97/136	*H. chloracantha* var. *denticulifera* (Poelln.) M.B.Bayer		3	23.8		0.2	8	NW Herbertsdale
JDV97/136.3	*H. chloracantha* var. *denticulifera* (Poelln.) M.B.Bayer		3	24.3		0.8	8	Herbertsdale
JDV85/164	*H. chloracantha* var. *subglauca* Poelln.		3	22.9	**23.0**	0.3	8	TL. S Great Brak
MBB1425	*H. chloracantha* var. *subglauca* Poelln.		3	23.0		0.2	4	Wolwedans,N Great Brak
JDV85/164.1	*H. chloracantha* var. *subglauca* Poelln.		3	23.1		0.7	14	S Great Brak
DMC06403	*H. coarctata* var. *adelaidensis* (Poelln.) M.B.Bayer		7	25.5	**25.3**	0.5	8	Farm Jaggersdrift
IB6545	*H. coarctata* var. *tenuis* (G.G.Sm.) M.B.Bayer		7	25.4		0.5	8	NEHarvestvale,Bushmans River
JDV90-46	*H. coarctata* (Baker) M.B.Bayer var. *coarctata* f. greenii		7	50.3		0.5	4	Howiesons Poort
CG1133	*H. coarctata* (Baker) M.B.Bayer var. *coarctata* f. greenii		7	50.6		0.4	8	Alicedale
JDV90/8	*H. comptoniana* G.G.Sm.	*H.emelyae v comp.*	3	23.1		0.3	8	Vaalkranz
MBB6776	*H. cooperi* Baker var. *cooperi*		4	23.6	**23.6**	0.3	8	Glen Avon
MBB6560	*H. cooperi* var. *dielsiana* (Poelln.) M.B.Bayer		4	24.0		0.4	8	Eastpoort
	H. cooperi var. *doldii* M.B.Bayer		4	22.9		0.4	8	TL. E London. Ulumna
JDV97/15	*H. cooperi* var. *gordoniana* (Poelln.) M.B.Bayer		4	23.3		0.3	8	N Karedouw
MBB7051	*H. cooperi* var. *gracilis* (Poelln.) M.B.Bayer		4	23.8		0.2	8	TL. Hellspoort
MBB6614	*H. cooperi* var. *gracilis* (Poelln.) M.B.Bayer		4	24.0		0.3	8	TL. Hellspoort
MBB6932	*H. cooperi* var. *isabellae* (Poelln.) M.B.Bayer		4	23.3		0.5	12	Krom River
JDV96/95	*H. cooperi* var. *isabellae* (Poelln.) M.B.Bayer		4	23.9		0.3	8	Forest Glade
PVB7128	*H. cooperi* var. *isabellae* (Poelln.) M.B.Bayer		4	24.0		0.5	10	Holrivier. Baviaanskloof
JDV91/105	*H. cooperi* var. *leightonii* (G.G.Sm.l) M.B.Bayer		4	23.1		0.2	8	TL. Kaisers Beach

Coll. Nr	*Haworthia* s.l. and *Astroloba*	Received as	Section	pg/2C	Average	SD	#Meas.	Origin
JDV91/97	*H. cooperi* var. *leightonii* (G.G.Sm.l) M.B.Bayer	*H. davidii*	4	22.8		0.3	8	E Chalumna
MBB6832	*H. cooperi* var. *minima* (M.B.Bayer) M.B.Bayer	*H. coop. v tenera*	4	23.2		0.2	10	Plutosvale, Grahamstown
CG2698	*H. cooperi* var. *minima* (M.B.Bayer) M.B.Bayer	*H. coop. v tenera*	4	23.4		0.2	12	Grahamstown
JDV90/55	*H. cooperi* var. *picturata* (M.B.Bayer) M.B.Bayer		4	24.1		0.3	8	Andrieskraal
JDV90/40	*H. cooperi* var. *pilifera* (Baker) M.B.Bayer		4	23.8		0.5	10	Perseverance
MBB7017	*H. cooperi* var. *puberula* nom. nud.		4	24.0		0.2	8	Klipfontein
PVBsn	*H. cooperi* var. *truncata* (H.Jacobsen) M.B.Bayer		4	23.6		0.2	8	Bolo Reserve
IB6550	*H. cooperi* var. *venusta* (C.L.Scott) M.B.Bayer		4	23.4		0.4	4	8 km NW of Kasouga
MBB6600	*H. cooperi* var. *viridis* (M.B.Bayer) M.B.Bayer		4	23.5		0.3	12	TL, Perdepoort
MBB6925	*H.cooperi* var. *viridis* (M.B.Bayer) M.B.Bayer		4	24.1		0.4	8	Kloksepad
MBB6916	*H. cooperi* var. *viridis* (M.B.Bayer) M.B.Bayer		4	24.5		0.3	7	Kloksedam
MBB6590	*H. cymbiformis* (*Haw.*) *Duval* var. *cymbiformis*		4	23.0	**23.1**	0.2	10	The tower, Ft Beaufort
JDV93/60	*H.cymbiformis* var. *incurvula* (Poelln.) M.B.Bayer		4	23.1		0.2	6	TL, Plutosvale
RIB0153	*H.cymbiformis* var. *ramosa* (G.G.Sm.l) M.B.Bayer		4	23.3		0.3	8	TL, Wooldridge
EvJ16690	*H.cymbiformis* var. *setulifera* (Poelln.) M.B.Bayer	*H. cym. var. obesa*	4	22.8		0.2	8	Quolora
JDV91/91	*H.cymbiformis* var. *setulifera* (Poelln.) M.B.Bayer		4	23.1		0.3	8	Rainbow Valey,E London
MBB6895	*H. cymbiformis* var. *obtusa* (Haw.) Baker		4	23.7	**23.8**	0.2	8	Thornkloof
MBB6850	*H. cymbiformis* var. *obtusa* (Haw.) Baker		4	23.8		0.4	8	Swartwaterpoort
MBB6847	*H. cymbiformis* var. *obtusa* (Haw.) Baker		4	23.8		0.2	8	S Alicedale
MBB6848	*H. cymbiformis* var. *obtusa* (Haw.) Baker		4	23.8		0.4	8	NW Alicedale
JDV93/45	*H. cymbiformis* var. *obtusa* (Haw.) Baker		4	24.0		0.3	8	Kagasmond
JDV90/103	*H. decipiens* var. *cyanea* M.B.Bayer		4	24.1	**23.9**	0.3	8	Merveville
MBB7025	*H. decipiens* var. *cyanea* M.B.Bayer		4	24.3		0.3	8	Trakaskuilen
MBB7375	*H. decipiens* Poelln. var. *decipiens*		4	23.2		0.3	8	Scholzkloof
PD2231	*H. decipiens* Poelln. var. *decipiens*		4	23.4		0.2	8	Bucklands

Coll. Nr	*Haworthia* s.l. and *Astroloba*	Received as	Section	pg/ 2C	Average	SD	#Meas.	Origin
JDV96/75	*H. decipiens* Poelln. var. *decipiens*		4	24.1		0.3	8	Die Bordjie
MBB6589	*H.decipiens* var. *minor* M.B.Bayer		4	24.7		0.3	8	Dorschfontein
IBsn	*H.decipiens* var. *virella* M.B.Bayer		4	24.1		0.3	8	hort.
IB6575	*H. decipiens* var. *virella* M.B.Bayer	*H. jansenvillensis*	4	23.8		0.2	7	N Klipplaat
IBsn	*H. decipiens* var. *virella* M.B.Bayer	*H. azurea*	4	23.5		0.3	4	Sapkamma, C. Grootpoort
IBsn	*H. decipiens* var. *xiphiophylla* (Baker) M.B.Bayer	*H. xiphiophylla*	4	23.8		0.3	8	Coega Kop
GM267	*H. emelyae* Poelln. var. *emelyae*	*H. picta var.janvlokii*	5	23.8	**23.8**	0.5	4	Perdeberg, Kammanassie Dam
JDV90/33.4	*H. emelyae* Poelln. var. *emelyae*		5	23.2		0.4	12	N Sandkraal
RIB0183	*H. emelyae* Poelln. var. *emelyae*	*H. breueri*	5	23.4		0.5	8	Sandkraal
RIB0426	*H. emelyae* Poelln. var. *emelyae*	*H. picta var. tricolor*	5	23.7		0.5	4	Rooiberg Pass
JDV90/10	*H. emelyae* Poelln. var. *emelyae*	*H. picta*	5	24.4		0.2	4	Witklip
RIB0181	*H. emelyae* var. *major* (G.G.Sm.) M.B.Bayer	*H. wimii*	5	24.1		0.2	4	TL, Garcia's Pass
JDV87/ 162.2	*H. emelyae* var. *multifolia* M.B.Bayer		5	23.8		0.4	12	TL, Riversdale,springfont.
CG2796	*H. fasciata* (Willd.) Haw.		7	26.1	**26.2**	0.6	8	Patensie Road
MBB6806	*H. fasciata* (Willd.) Haw.		7	26.3		0.4	8	Loerie
JDV92/31.1	*H. floribunda* Poelln.		5	24.1	**24.2**	0.5	6	Dassieklip
MBB1417	*H. floribunda* Poelln.		5	24.2		0.1	4	Melkhoutfontein, Gouritz
JDVs.n.	*H. floribunda* Poelln.	*H. chloracantha*	5	24.7		0.3	12	N Albertinia
VDV040	*H. floribunda* var. *dentata* M.B.Bayer	*H. dentata*	5	24.1		0.2	8	NWN Vleesbaai
JDVs.n.	*H. floribunda* var. *floribunda* Poelln.		5	24.4		0.2	8	TL, NE Heidelberg
JDV91/3	*H. floribunda* var. *major* M.B.Bayer		5	23.8		0.2	4	TL, S of Swellendam
LAV26114	*H. glauca Baker* var. *glauca*		7	25.1	**25.2**	0.3	7	Kleinpoort
CG2130	*H. glauca* var. *herrei* (Poelln.) M.B.Bayer		7	25.3		0.4	8	NW Willowmore
TPsn	*H. glauca* var. *herrei* (Poelln.) M.B.Bayer		7	61.7	pentaploid	0.6	4	hort.
MBBsn	*H. globifera* (M.B.Bayer) M.Hayashi		2	22.7	**22.7**	0.4	16	Plathuis
EA1301.2	*H. globosiflora* G.G.Sm.	*H. nortierii var. globosifera*	6	25.0	**25.3**	0.4	7	Botterkloof
EA1301	*H. globosiflora* G.G.Sm.	*H. nortierii var. globosifera*	6	25.2		0.3	6	Botterkloof
EA1301.1	*H. globosiflora* G.G.Sm.	*H. nortierii var. globosifera*	6	25.4		0.2	6	Botterkloof
MBB6505.2	*H. globosiflora* G.G.Sm.	*H. nortieri v nortieri*	6	25.4		0.2	8	Dwarsriver

Coll. Nr	*Haworthia* s.l. and *Astroloba*	Received as	Section	pg/ 2C	Average	SD	#Meas.	Origin
JDV97/84	*H. globosiflora* G.G.Sm.	*H. arachnoidea?*	6	25.5		0.5	8	Kanetvlei
RIB0562	*H. granulata* Marloth		8	28.5	**28.9**	0.2	4	TL, entrance Verlatenkloof
MBB7131	*H. granulata* Marloth		8	28.9		0.5	10	Elandsberg
CG2427	*H. granulata* Marloth		8	29.3		0.5	10	Farm Malieslook, Verlatenkloof
MBB6970.1	*H. herbacea* var. *flaccida* M.B.Bayer		3	24.1	**24.0**	0.4	6	TL, Worcester,Rooiberg
MBB6680.1	*H. herbacea* (Mill.) Stearn var. *herbacea*		3	23.7		0.1	6	Koningriverberg
JDV97/46	*H. herbacea* (Mill.) Stearn var. *herbacea*	*H. herb. v paynii*	3	24.5		0.3	8	Klipbergdam, NW Napier
JDV94/36	*H. herbacea* var. *lupula* M.B.Bayer	*H. lupula*	3	23.6		0.3	4	Villiersdorp
JDV97/37.3	*H. herbacea* var. *lupula* M.B.Bayer		3	24.1		0.3	6	TL, Wolfkloof Robertson
EA1211	*H. kingiana* Poelln.		9	36.5	**36.7**	0.6	8	Great Brak
CG2712	*H. kingiana* Poelln.		9	36.8		0.6	10	Great Brak
CG1441	*H. koelmaniorum* Oberm.& D.S.Hardy var. *koelmaniorum*		8	31.5	**32.2**	0.6	8	TL, Groblersdal
RIB0266	*H. koelmaniorum* Oberm.& D.S.Hardy var. *koelmaniorum*		8	32.8		0.4	4	TL, Groblersdal
MBB5652	*H. limifolia* var. *gigantea* M.B.Bayer		8	33.7	**33.4**	0.5	4	TL, Nongoma
RIB0291	*H. limifolia* var. *ubomboensis* I.Verd. & G.G.Sm.		8	33.8		0.4	7	Ubombo Mountains
632	*H. limifolia* Marloth var. *limifolia*		8	33.9		0.6	4	Pongola
298	*H. limifolia* var. *gigantea* M.B.Bayer		8	46.1		0.7	4	Nongoma
MBB7141	*H. limifolia* Marloth var. *limifolia*		8	49.2		0.6	6	Rymers Creek
MBB6752	*H. limifolia* var. *glaucophylla* M.B.Bayer		8	49.9		0.5	4	Three Sisters
11791	*H. limifolia* Marloth var. *limifolia*		8	50.9		0.1	4	Gollel
477	*H. limifolia* var. *ubomboensis* I.Verd. & G.G.Sm.		8	51.4		0.6	4	Ubombo Range
MBB6746	*H. limifolia* var. *arcana* Gideon F.Smith & N.R.Crouch		8	67.3		1.1	4	Hectorspruit
MBB4805	*H. limifolia* Marloth var. *limifolia*		8	68.5		1.4	4	Umbuluzi
396	*H. limifolia* (var. *striata*) Pilbeam		8	99.8		1.8	4	Hluhluwe
CG2519	*H. lockwoodii* Archibald		4	23.6	**23.2**	0.6	6	TL, Floriskraal Dam, Laingsburg
EHsn.	*H. lockwoodii* Archibald		4	22.8		0.2	8	Ezelfontein
CG1913	*H. longiana* Poelln.		7	26.4	**26.4**	0.4	8	Droogte Kloof, N Patensie

Coll. Nr	*Haworthia* s.l. and *Astroloba*	Received as	Section	pg/ 2C	Average	SD	#Meas.	Origin
JDV88-31	*H. maculata* var. *livida* (M.B.Bayer) M.B.Bayer	*pubescens var. livida*	3	24.1	**23.8**	0.2	4	TL, Worcester,Lemoenpoort
MBB6815	*H. maculata* (Poelln.) M.B.Bayer var. *maculata*		3	23.8		0.4	8	Audensberg
CG0810	*H. marginata* (Lam.) Stearn		9	35.9	**35.1**	0.5	10	Riversdale
ADAsn	*H. marginata* (Lam.) Stearn		9	34.3		0.3	4	hort.
PVBsn	*H. marumiana* var. *archeri* (M.B.Bayer) M.B.Bayer		4	23.0	**23.7**	0.3	10	Klipfontein
RIB0348	H. marumiana var. *batesiana* (Uitewaal) M.B.Bayer		4	23.3		0.2	7	Kamdebooberg
C Craib sn	*H. marumiana* Uitewaal var. *marumiana*		4	23.5		0.3	8	Andriesberg
OVB3723	*H. marumiana* Uitewaal var. *marumiana*		4	23.6		0.3	8	Gamkakloof
JDV91/108	*H. marumiana* var. *viridis* M.B.Bayer		4	23.6		0.3	8	S Prince Albert
GDM535	*H. marumiana* Uitewaal var. *marumiana*		4	23.9		0.1	8	Kamdeboo
GDM535	*H. marumiana* Uitewaal var. *marumiana*		4	24.0		0.4	8	Kamdeboo
RIB0346	*H. marumiana* var. *archeri* (M.B.Bayer) M.B.Bayer		4	24.0		0.1	4	Laingsburg
MBBsn	*H. marumiana* var. *dimorpha* (M.B.Bayer) M.B.Bayer		4	24.2		0.2	4	TL, Constable Station,Laingsburg
RIB0273	*H. mcmurtryi* C.L.Scott		8	30.3	**30.3**	0.2	4	S of Loskopdam
CG2141	*H. minima* var. *minima* (Aiton) Haw.		9	35.7	**36.4**	1.0	11	5 km NW of Riversdale
A1217	*H. minima* var. *minima* (Aiton) Haw.		9	36.2		0.8	12	Mossel Bay
MBBsn	*H. minima* var. *poellnitziana* (Uitewaal) M.B.Bayer		9	36.9		1.0	11	W Sanddrift, Drew
ISI1572	*H. minima* var. *poellnitziana* (Uitewaal) M.B.Bayer		9	36.8		0.8	8	TL, near Drew
MBB6639-15	*H. mirabilis* var. *sublineata* (Poelln.) M.B.Bayer		3	22.4	**22.7**	0.0	2	S Bredasdorp
MBB6639-5	*H. mirabilis* var. *sublineata* (Poelln.) M.B.Bayer		3	22.5		0.4	8	S Bredasdorp
MBB6639-20	*H. mirabilis* var. *sublineata* (Poelln.) M.B.Bayer		3	22.6		0.5	6	S Bredasdorp
MBB6639-21	*H. mirabilis* var. *sublineata* (Poelln.) M.B.Bayer		3	22.7		0.6	6	S Bredasdorp
MBB6639-41	*H. mirabilis* var. *sublineata* (Poelln.) M.B.Bayer		3	22.8		0.6	6	S Bredasdorp
MBB6639-67	*H. mirabilis* var. *sublineata* (Poelln.) M.B.Bayer		3	23.1		0.3	10	S Bredasdorp
MBB6635-18	*H. mirabilis* var. *badia* (Poelln.) M.B.Bayer		3	23.0	**23.2**	0.3	6	NW Napier
RIB0322	*H. mirabilis* var. *atrofusca* (G.G.Sm.) M.B.Bayer	*H. enigma*	3	22.9		0.2	4	10 km N of Riversdale
JDV90-91	*H. mirabilis* var. *atrofusca* (G.G.Sm.) M.B.Bayer	*H. magn.var. atrofusca*	3	23.5		0.3	4	W of Riversdale

Coll. Nr	*Haworthia* s.l. and *Astroloba*	Received as	Section	pg/ 2C	Average	SD	#Meas.	Origin
JDV88-31	*H. maculata* var. *livida* (M.B.Bayer) M.B.Bayer	*pubescens var. livida*	3	24.1	**23.8**	0.2	4	TL, Worcester,Lemoenpoort
MBB6815	*H. maculata* (Poelln.) M.B.Bayer var. *maculata*		3	23.8		0.4	8	Audensberg
CG0810	*H. marginata* (Lam.) Stearn		9	35.9	**35.1**	0.5	10	Riversdale
ADAsn	*H. marginata* (Lam.) Stearn		9	34.3		0.3	4	hort.
PVBsn	*H. marumiana* var. *archeri* (M.B.Bayer) M.B.Bayer		4	23.0	**23.7**	0.3	10	Klipfontein
RIB0348	H. marumiana var. *batesiana* (Uitewaal) M.B.Bayer		4	23.3		0.2	7	Kamdebooberg
C Craib sn	*H. marumiana* Uitewaal var. *marumiana*		4	23.5		0.3	8	Andriesberg
OVB3723	*H. marumiana* Uitewaal var. *marumiana*		4	23.6		0.3	8	Gamkakloof
JDV91/108	*H. marumiana* var. *viridis* M.B.Bayer		4	23.6		0.3	8	S Prince Albert
GDM535	*H. marumiana* Uitewaal var. *marumiana*		4	23.9		0.1	8	Kamdeboo
GDM535	*H. marumiana* Uitewaal var. *marumiana*		4	24.0		0.4	8	Kamdeboo
RIB0346	*H. marumiana* var. *archeri* (M.B.Bayer) M.B.Bayer		4	24.0		0.1	4	Laingsburg
MBBsn	*H. marumiana* var. *dimorpha* (M.B.Bayer) M.B.Bayer		4	24.2		0.2	4	TL, Constable Station,Laingsburg
RIB0273	*H. mcmurtryi* C.L.Scott		8	30.3	**30.3**	0.2	4	S of Loskopdam
CG2141	*H. minima* var. *minima* (Aiton) Haw.		9	35.7	**36.4**	1.0	11	5 km NW of Riversdale
A1217	*H. minima* var. *minima* (Aiton) Haw.		9	36.2		0.8	12	Mossel Bay
MBBsn	*H. minima* var. *poellnitziana* (Uitewaal) M.B.Bayer		9	36.9		1.0	11	W Sanddrift, Drew
ISI1572	*H. minima* var. *poellnitziana* (Uitewaal) M.B.Bayer		9	36.8		0.8	8	TL, near Drew
MBB6639-15	*H. mirabilis* var. *sublineata* (Poelln.) M.B.Bayer		3	22.4	**22.7**	0.0	2	S Bredasdorp
MBB6639-5	*H. mirabilis* var. *sublineata* (Poelln.) M.B.Bayer		3	22.5		0.4	8	S Bredasdorp
MBB6639-20	*H. mirabilis* var. *sublineata* (Poelln.) M.B.Bayer		3	22.6		0.5	6	S Bredasdorp
MBB6639-21	*H. mirabilis* var. *sublineata* (Poelln.) M.B.Bayer		3	22.7		0.6	6	S Bredasdorp
MBB6639-41	*H. mirabilis* var. *sublineata* (Poelln.) M.B.Bayer		3	22.8		0.6	6	S Bredasdorp
MBB6639-67	*H. mirabilis* var. *sublineata* (Poelln.) M.B.Bayer		3	23.1		0.3	10	S Bredasdorp
MBB6635-18	*H. mirabilis* var. *badia* (Poelln.) M.B.Bayer		3	23.0	**23.2**	0.3	6	NW Napier
RIB0322	*H. mirabilis* var. *atrofusca* (G.G.Sm.) M.B.Bayer	*H. enigma*	3	22.9		0.2	4	10 km N of Riversdale
JDV90-91	*H. mirabilis* var. *atrofusca* (G.G.Sm.) M.B.Bayer	*H. magn.var. atrofusca*	3	23.5		0.3	4	W of Riversdale

Coll. Nr	*Haworthia* s.l. and *Astroloba*	Received as	Section	pg/ 2C	Average	SD	#Meas.	Origin
RIB0388	*H. mucronata* var. *inconfluens* (Poelln.) M.B.Bayer		4	24.2		0.4	7	S of Ladi
JDV90/5	*H. mucronata* var. *morrisiae* (Poelln.) Poelln.		4	23.9		0.3	10	Oudtshoorn
IB6600	*H. mucronata* var. *morrisiae* (Poelln.) Poelln.		4	24.6		0.3	4	Steildrift,sw Oudtshoorn
IB7171	*H. mucronata* Haw. var. *mucronata*	*H. tradouwensis*	4	24.3		0.2	4	Stone Heaven
JDV98/14	*H. mucronata* var. *rycroftiana* M.B.Bayer		4	23.4		0.2	8	N.Calitzdorp
RIB0254	*H. mucronata* var. *rycroftiana* M.B.Bayer	*H. integra*	4	24.9		0.3	10	TL. W Gouritz River Bridge
IBsn	*H. mutica* Haw.	*H. otzenii*	3	23.4	**23.4**	0.0	2	hort.
MBB6641.1	*H. mutica* Haw.		3	23.4		0.2	6	Hasiesdrift
RIB0397	*H. mutica* Haw.		3	23.5		0.4	4	Riversonderend
IB7121	*H. nigra* var. *diversifolia* (Poelln.) Uitewaal		7	28.3	**27.5994**	0.3	4	Waaikraal
MBB6945	*H. nigra* Baker var. *nigra*		7	27.0		0.3	10	DePlaat
MBB7386	*H. nigra* Baker var. *nigra*		7	27.5		0.4	12	Beaufort West
MBBsn	*H. nortieri* G.G.Sm.	*H. agnis*	6	26.0	**26.3**	0.1	4	NE Vanrhynsdorp
JDV87/71	*H. nortieri* G.G.Sm.		6	26.2		0.3	8	Vanrhyns Pass
JDV96/71.3	*H. nortieri* G.G.Sm.		6	26.8		0.3	4	Vanrhyns Pass
MBB61.58	*H. nortieri* G.G.Sm.		6	26.1		0.4	7	Sneeukop
MBB6518.2	*H. nortieri* G.G.Sm.		6	26.1		0.2	8	Sneeukop
JDV96/7	*H. nortieri* G.G.Sm.		6	26.2		0.3	6	Wolkberg
MBB6505	*H. nortieri* G.G.Sm.		6	26.3		0.4	14	Wolkberg
PVB6146.3	*H. nortieri* G.G.Sm.		6	26.3		0.4	4	Komkans
PVB6146	*H. nortieri* G.G.Sm.		6	26.3		0.3	8	Komkans
PVB6146.2	*H. nortieri* G.G.Sm.		6	26.6		0.1	4	Komkans
PVB6167.2	*H. nortieri* G.G.Sm.		6	26.4		0.2	4	Steenkamskop
PVB6167.1	*H. nortieri* G.G.Sm.		6	26.5		0.1	4	Steenkamskop
PVB6167.3	*H. nortieri* G.G.Sm.		6	26.5		0.4	4	Steenkamskop
JDV94/61	*H. outeniquensis* M.B.Bayer		2	23.0	**23.2**	0.1	6	Molen River
JDV92/9	*H. outeniquensis* M.B.Bayer		2	23.3		0.4	8	Herold
IB6605	*H. outeniquensis* M.B.Bayer	*H. helmiae*	2	23.2		0.3	4	Herold
JDV94/75.2	*H. parksiana* Poelln.		3	23.4	**23.4**	0.4	6	Dumbie Dykes
MBB7382	*H. pehlemanniae* C.L.Scott	*H. devriesii*	6	24.3	**24.5**	0.2	8	TL. N Prince Albert
JDV91/47	*H. pehlemanniae* C.L.Scott	*H. nortieri var. pehlemanniae*	6	24.4		0.4	9	TL. W Laingsburg
CG1822	*H. pehlemanniae* C.L.Scott	*H. nortieri var. pehlemanniae*	6	25.2		0.3	2	Matjies fontein
CG2026	*H. pehlemanniae* C.L.Scott	*H. nortieri var. nortieri*	6	24.0		0.4	7	Pakhuis pass
JDV96/56.1	*H. pehlemanniae* C.L.Scott	*H. nortieri var. nortieri*	6	24.2		0.3	4	Opdieberg
JDV96/56.6	*H. pehlemanniae* C.L.Scott	*H. nortieri var. nortieri*	6	24.5		0.5	4	Opdieberg
EA1441	*H. pehlemanniae* C.L.Scott	*H. nortieri var. nortieri*	6	23.9		0.2	8	Trawal SE

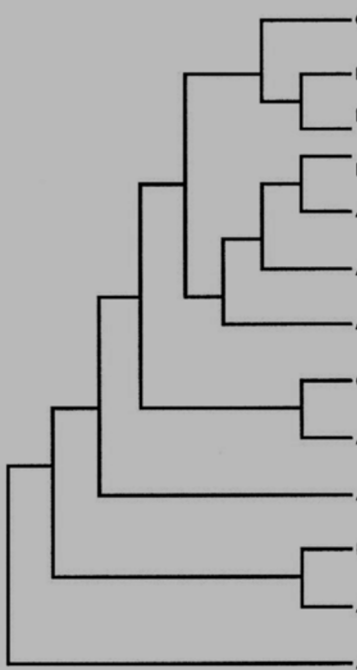
Coll. Nr	*Haworthia* s.l. and *Astroloba*	Received as	Section	pg/ 2C	Average	SD	#Meas.	Origin
EA1441.6	*H. pehlemanniae* C.L.Scott	*H. nortieri var. nortieri*	6	24.1		0.2	4	Trawal
EA1441.5	*H. pehlemanniae* C.L.Scott	*H. nortieri var. nortieri*	6	24.4		0.5	4	Trawal
EA1441.2	*H. pehlemanniae* C.L.Scott	*H. nortieri var. nortieri*	6	24.4		0.1	4	Trawal
EA667/1	*H. pehlemanniae* C.L.Scott	*H. nortieri var. nortieri*	6	24.5		0.4	8	Bulshoek
EA828.3	*H. pehlemanniae* C.L.Scott	*H. nortieri var. nortieri*	6	24.7		0.1	6	Hex River Pass
EA828.2	*H. pehlemanniae* C.L.Scott	*H. nortieri var. nortieri*	6	24.8		0.5	8	Hex River Pass
EA828.1	*H. pehlemanniae* C.L.Scott	*H. nortieri var. nortieri*	6	25.0		0.4	6	Hex River Pass
JDV88/31	*H. pubescens* M.B.Bayer		5	24.5	**24.5**	0.3	6	TL, Sandberg, Worcester
MBBsn	*H. pulchella* M.B.Bayer		4	23.9	**23.9**	0.3	14	Soutkop
CG0242	*H. pumila* (L.) Duval	*H. maxima/ margaritifera*	9	36.4	**37.2**	1.4	8	Mowers Station
CG0639	*H. pumila* (L.) Duval	*H. maxima*	9	37.2		0.7	12	hort.
MBB7096	*H. pumila* (L.) Duval	*H. maxima*	9	37.3		1.0	6	Koningsrivier
TPsn	*H. pumila* (L.) Duval	*H. maxima*	9	37.8		0.4	6	Worchester
JDV97/103	*H. pungens* M.B.Bayer		7	25.7	**25.7**	0.4	4	Joubertina
RIB0316	*H. pygmaea* var. *acuminata* (M.B.Bayer) M.B.Bayer	*H. acuminata*	5	23.6	**23.6**	0.2	8	TL, N of Gouritzmond
JDV85/19.2	*H. pygmaea* var. *argenteo-maculosa* (G.G.Sm.) M.B.Bayer		5	23.3		0.4	6	TL, Dumbie Dykes, Mossel Bay
JDV91-38	*H. pygmaea* var. *argenteo-maculosa* (G.G.Sm.) M.B.Bayer		5	23.5		0.4	11	Humor
GGS5489	*H.pygmaea* var. *dekenahii* (G.G.Sm.) M.B.Bayer	*H. dekenahii*	5	23.1		0.1	4	TL, Draaihoek, N of Albertinia
DP94-01	*H. pygmaea* var. *esterhuizenii* (M.Hayashi) M.B.Bayer	*H. esterhuizenii*	5	23.7		0.3	8	TL, E of Albertinia
RIB0433	*H. pygmaea* Poelln.		5	24.2		0.3	4	TL, NW of Great Brakrivier
JDV93/113	*H. reddii* C.L.Scott	*H. cym. var. reddii*	2	22.6	**22.4**	0.2	8	TL, Waterdown Dam
MBB6843	*H. reddii* C.L.Scott	*H. cym. var. reddii*	2	22.2		0.5	10	Inverbolo
MBB6843	*H. reddii* C.L.Scott	*H. cym. var. reddii*	2	22.4		0.2	8	Inverbolo
PVBsn	*H. reddii* C.L.Scott	*H. cym. var. reddii*	2	22.4		0.4	8	Inverbolo
TPsn	*H. reddii* C.L.Scott	*H. cym. var. reddii*	2	22.3		0.3	2	hort.
JIL148	*H. reinwardtii* var. *brevicula* G.G.Sm		7	25.5	**25.5**	0.4	7	W Kaffirdrift to Kapp River
DMC08230	*H. reinwardtii* f. *zebrina* (G.G.Sm.) M.B.Bayer		7	25.8		0.4	12	TL, E Kaffirdrift Police Station

Coll. Nr	*Haworthia* s.l. and *Astroloba*	Received as	Section	pg/ 2C	Average	SD	#Meas.	Origin
CG2630	*H. reinwardtii* f. *chalumnensis* (G.G.Sm.) M.B.Bayer		7	25.5		0.2	8	TL, Chalumna River
CG1139	*H. reinwardtii* (Salm-Dyck) Haw. var. *reinwardtii*		7	50.6		0.6	8	Vanwijksvlei
RIB0461	*H. reticulata* var. *hurlingii* (Poelln.) M.B.Bayer		3	23.9	**23.8**	0.3	8	Bonnievale
JDV90-28	*H. reticulata* var. *attenuata* M.B.Bayer		3	23.7		0.2	8	TL, S of Bonnievale
MBB6857	*H. reticulata* (Haw.) Haw. var. *reticulata*		3	23.8		0.3	6	Rooiberg
MBB6957	*H. reticulata* (Haw.) Haw. var. *reticulata*		3	23.8		0.3	8	Rooiberg, Roberson
RIB0464	*H. reticulata* var. *subregularis* (Baker) M.B.Bayer		3	23.8		0.2	8	Boskloof
RIB0540	*H. retusa* var. *longibracteata* (G.G.Sm.) M.B.Bayer	*H. turg. var. longibracteata*	3	23.3	**23.3**	0.4	8	N Heidelberg
JDV90-1	*H. retusa* var. *nigra* (M.B.Bayer) M.B.Bayer	*H. chromutica*	3	23.2		0.3	4	Diepkloof
JDV90/75	*H. retusa* (L.) Duval var. *retusa*	*H. retusa f. geraldii*	3	23.0		0.3	8	TL, E Riversdale
JDV87/5e	*H. retusa* (L.) Duval var. *retusa*	*H. retusa f. geraldii*	3	23.1		0.0	4	TL, E Riversdale
JDV87/5d	*H. retusa* (L.) Duval var. *retusa*	*H. retusa f. geraldii*	3	23.2		0.2	4	TL, E Riversdale
JDV86/19	*H. retusa* (L.) Duval var. *retusa*	*H. retusa f. geraldii*	3	23.2		0.4	4	TL, E Riversdale
JDV87/5 g	*H. retusa* (L.) Duval var. *retusa*	*H. retusa f. geraldii*	3	23.3		0.3	4	TL, E Riversdale
JDV87/5c	*H. retusa* (L.) Duval var. *retusa*	*H. retusa f. geraldii*	3	23.3		0.3	4	TL, E Riversdale
JDV87/5b	*H. retusa* (L.) Duval var. *retusa*	*H. retusa f. geraldii*	3	23.4		0.2	4	TL, E Riversdale
JDV87/5.a	*H. retusa* (L.) Duval var. *retusa*	*H. retusa f. geraldii*	3	23.4		0.2	4	TL, E Riversdale
JDV87/5f	*H. retusa* (L.) Duval var. *retusa*	*H. retusa f. geraldii*	3	23.5		0.2	8	TL, E Riversdale
JDV89/21.3	*H. retusa* (L.) Duval var. *retusa*	*H. retusa f. geraldii*	3	23.6		0.3	6	Riversdale School
CGSnn	*H. retusa* (L.) Duval var. *retusa*	*H. retusa f. geraldii*	3	34.3		0.6	10	Riversdale
TPsn	*H. retusa* (L.) Duval var. *retusa*	*H. retusa f. geraldii*	3	47.1		0.4	4	hort.
JDV84-65	*H. rossouwii* var. *calcarea* (M.B.Bayer) M.B.Bayer	*H. calcarea*	3	23.0	**23.4**	0.5	8	De Hoop Nature Reserve
MBB6985	*H. rossouwii* var. *calcarea* (M.B.Bayer) M.B.Bayer		3	23.2		0.3	6	TL, Bredasdorp, De Hoop
MBB6986	*H. rossouwii* var. *minor* (M.B.Bayer) M.B.Bayer	*H. ross v petrophylla*	3	23.5		0.2	6	Karsriver
RIB0558	*H. rossouwii* var. *minor* (M.B.Bayer) M.B.Bayer	*H. petrophila*	3	23.6		0.5	7	Karsriver

Coll. Nr	*Haworthia* s.l. and *Astroloba*	Received as	Section	pg/ 2C	Average	SD	#Meas.	Origin
JDV86/5	*H. rossouwii* var. *minor* (M.B.Bayer) M.B.Bayer	*H. heid. var. minor*	3	23.7		0.4	8	Rooivlei,Bredasdorp
MBB6984	*H. rossouwii* var. *rossouwii* Poelln.		3	23.6		0.4	9	Soutkloof
MBB7255	*H. rossouwii* var. *eliziae* (Breuer) M.B.Bayer	*H. elizeae*	3	23.3		0.4	6	Bromberg
JDV97/121	*H. scabra* Haw.		8	29.6	**29.8**	0.2	4	W DeVlugt
JDV85/145	*H. scabra* var. *morrisiae* (Poelln.) M.B.Bayer		8	30.5		0.4	8	Schoemanspoort
JDV97/3	*H. scabra* Haw. var. *scabra*	*H. tuberculata?*	8	29.1		0.5	8	Saptou
RIB0483	*H. scabra* var. *starkiana* (Poelln.) M.B.Bayer	*H. starkiana*	8	29.5		0.2	4	Groot Kruis
IB6640	*H. scabra* var. *starkiana* (Poelln.) M.B.Bayer	*H. starkiana*	8	30.1		0.5	8	Stonebreaker farm, Schoemanspoort
JDV93/97	*H.semiviva* (Poelln.) M.B.Bayer		4	23.7	**24.3**	0.0	2	Biesiespoort
RIB0496	*H. semiviva* (Poelln.) M.B.Bayer		4	25.0		0.3	8	Beaufort West
MBB4941	*H. sordida* Haw.		7	26.9	**26.9**	0.3	8	Bluecliff
JDV93/21	*H. springbokvlakensis* C.L.Scott		3	23.7	**23.9**	0.4	8	TL. Springbokvlakte
RIB0515	*H. springbokvlakensis* C.L.Scott		3	24.1		0.4	4	TL. Springbokvlakte
JDV80/79	*H. transiens* (Poelln.) M.Hayashi	*H. cymbiformis?*	4	23.1	**23.1**	0.2	6	Prince Alfred Pass
VDV124	*H. truncata* Schonland var. *truncata*	*H. trun. var. minor*	2	21.8	**21.9**	0.4	4	6 km SWS of Dysseldorp
MBB6909	*H. truncata* Schonland var. *truncata*		2	21.9		0.4	6	Dysseldorp
RIB0524	*H. truncata* var. *maughanii* (Poelln.) Halda	*H. maughanii*	2	21.9		0.1	4	TL. Calitzdorp
SAsn	*H. truncata* var. *maughanii* (Poelln.) Halda		2	22.0		0.2	8	S Calitzdorp
IB7180	*H. turgida* var. *suberecta* Poelln.		3	23.7	**23.4**	0.3	8	Brandwag
MBB7227.1	*H. turgida* Haw. var. *turgida*		3	23.2		0.5	10	Witheuwel, Duiwenhoks
MBB6988	*H. variegata* var. *hemicrypta* M.B.Bayer		5	23.4	**23.7**	0.2	10	TL. NE lower Potberg
MBB6888.1	*H. variegata* var. *hemicrypta* M.B.Bayer		5	23.8		0.3	6	TL. NE lower Potberg
MBB6527.2	*H. variegata* var. *hemicrypta* M.B.Bayer		5	24.0		0.4	10	NW Swellendam
MBBsn	*H. variegata* var. *modesta* M.B.Bayer		5	23.1		0.4	14	Potberg Residence
MBB7061	*H. variegata* var. *modesta* M.B.Bayer		5	23.7		0.2	6	TL. SW Kathoek
MBB7101.4	*H. variegata* L.Bolus var. *variegata*		5	24.3		0.3	10	Hoekraal, Riversdale
CG1409	*H. venosa* (Lam.) Haw.		8	29.6	**29.9**	0.1	6	Bontebok Nat Park
JDV94/35	*H. venosa* (Lam.) Haw.		8	29.8		0.6	8	TL. Stellendam
MBB1419	*H. venosa* (Lam.) Haw.			30.3		0.4	6	Valschriviermond, Gouritz

Coll. Nr	*Haworthia* s.l. and *Astroloba*	Received as	Section	pg/ 2C	Average	SD	#Meas.	Origin
CG1686	*H. woolleyi* Poelln.	*H. ven. ssp.* ***woolleyi***	8	29.6	**29.6**	0.2	6	S Kleinpoort, Springbokvlakte
RIB0568	*H. tessellata* Haw.		8	66.6	**69.2**	0.9	8	E Smorenskadu farm
CGS s.n.	*H. tessellata* Haw.		8	68.7		1.3	8	hort.
CG1001	*H. tessellata* Haw.		8	72.3		1.0	8	Scimmelberg, W Steinkopf
MBB7384	*H. viscosa* (L.) Haw.		7	26.4		0.5	8	N Beaufort West
IB7193	*H. variabilis* (Breuer) Breuer	*H. viscosa var.variablis*	8	29.1	**29.1**	0.1	4	Brandekraal
PVB6252	*H. vlokii* M.B.Bayer		2	22.8	**23.0**	0.5	10	Prince Albert
MBB6252	*H. vlokii* M.B.Bayer		2	23.2		0.5	12	E Prince Albert
JDV91/78	*H.wittebergensis* W.F.Barker		1	22.5	**22.5**	0.3	6	Rooinek
IB8928	*H.zantneriana* var. *minor* M.B.Bayer		4	24.2	**23.7**	0.5	4	Waaipoort, NE Steytlerville
MBB7061	*H. zantneriana* var. *zantneriana* Poelln.		2	23.1		0.4	6	Redcliff

In some cases the name is mentioned under which it was received, if deviating from the name in the alphabetical list



Tree of major clades after Manning et al. (2014) — 'Old' division in genera. Haworthia s.l. + new data in bold	Aloe + Haworthia genera according Manning et al.2014	Haworthia genera accord. Rowley 2013	Aloe genera Grace et al. 2013	Range of 2C-values in pg	# species measured
Gasteria[1]	Gasteria	nd	nd	32.8 - 43.2	19
H. subg. Hexangulares sect. Coarctatae	Haworthiopsis	Haworthiopsis	nd	**25.2 - 27.6**	**10**
H. subg. Hexangulares sect. Venosae	Haworthiopsis	Haworthiopsis	nd	**28.9 - 31.5**	**10**
Haw. subg. Robustipedunculatae	Tulista	Tulista	nd	**35.9 - 37.2**	**4**
Aloe variegata,dinteri,sladeniana	Gonialoae	nd(Tulista?)	nd	31.8 + 33.6	2
Aloe aristata[2]	Aristaloe	Tulista	nd	32.4	1
Astroloba (+Poelnitzia)	Astroloba	Tulista	nd	**30.4 - 35.9**	**9**
Chortolirion[3]	Aloe	nd	Aloe	27.2 - 30.6	3
Aloe s.s. (most species)[2]	Aloe	nd	Aloe	26.7 - 44.4	70
Aloe sect. Macrifoliae[2]	Aloiampelos	nd	Aloiampelos	21.5 + 21.7	2
Haworthia subg. Haworthia	Haworthia	Haworthia	nd	**21.7 - 24.7**	**45**
Aloe sect. Haemanthifoliae + Kumara[2]	Kumara	nd	Kumara	16.2 + 17.6	2
Aloe sect. Aloidendron + Dracoaloe[2]	Aloidendron	nd	Aloidendron	24.5 - 37.4	7

2C-values for Aloe, Gasteria and Chortolirion from:
1: Zonneveld and van Jaarsveld (2005)
2: Zonneveld (2002)
3: Zonneveld and Fritz (2010)

Fig. 2 Cladogram (adapted from Manning et al. 2014) with genome sizes of all genera of the Alooideae, the number of species on which these were based and the proposed genera by Grace et al. (2013), Rowley (2013) and Manning et al. (2014). *1* Zonneveld and Van Jaarsveld (2005); *2* Zonneveld (2002); *3* Zonneveld and Fritz (2010)

Table 2 Summary of the results of Table 1 with the species of *Haworthia* s.l. and *Astroloba* placed in their new genera and sections

	Sect.	pg/2C	#Clones	#Meas
Haworthia **s.s.** (Subgenus *Haworthia*)				
Section 1 *Fusiformis* F.W.Barker				
H. blackburniae	1	21.7	4	22
H. wittebergensis	1	22.5	1	6
Section 2 *Fenestratae* Poelln.				
H. truncata	2	21.9	4	22
H. emelyae	2	22.3	3	24
H. reddii	2	22.4	5	36
H. globifera	2	22.7	1	12
Section 1 *Fusiformis* F.W.Barker				
H. vlokii	2	23.0	2	22
H. zantneriana	2	23.1	1	6
H. comptoniana	2	23.1	1	8
H. outeniquensis	2	23.2	2	14
Section 3 *Retusae* Haw.				
H. mirabilis	3	23.2	26	119
H. monticola	3	23.2	4	30
H. retusa	3	23.3	14	76
H. mutica	3	23.4	4	16
H. parksiana	3	23.4	1	6
H. rossouwii	3	23.4	7	50
H. turgida	3	23.4	3	26
H. maculata	3	23.8	2	12
H. reticulata	3	23.8	5	38
H. springbokvlakensis	3	23.9	2	12
H. herbacea	3	24.0	5	30
H. pubescens	3	24.3	2	10
H. mirabilis var. *paradoxa*	3	24.3	1	7
Section 4 *Haworthia*				
H. bayeri	4	22.7	3	14
H. cymbiformis	4	23.1	6	46
H. transiens	4	23.1	1	6
H. lockwoodii	4	23.2	2	14
H. aristata	4	23.2	1	6
H. cooperi	4	23.6	10	68
H. marumiana	4	23.7	9	65
H. bolusii	4	23.7	5	30
H. bolusii	4	23.7	5	30
H. cooperi (*gracilis* forms)	4	23.8	11	103
H. cymbiformis var. *obtusa*	4	23.8	5	40
H. pulchella	4	23.8	1	10
H. decipiens	4	23.9	10	75
H. zantneriana var. *minor*	4	24.2	1	4
H. mucronata	4	24.3	9	57
H. arachnoidea	4	24.4	11	68
Section 5 *Loratae* (Salm-Dyck) A.Berger				
H. chloracantha	5	23.6	11	82
H. pygmaea	5	23.7	6	41
H. variegata	5	23.7	6	56
H. emelyae	5	23.8	7	48
H. floribunda	5	24.1	5	30
H. angustifolia	5	24.7	3	18
Section 6 *Nortierae* Zonn.				
H. pehlemanniae	6	24.5	14	82
H. globosiflora	6	25.3	5	35
H. nortieri	6	26.5	13	79
H. agnis	6	27.2	4	32
Haworthiopsis (Subg. *Hexangulares*)				
Section 7 *Coarctatae* A.Berger				
H. glauca	7	25.2	3	19
H. coarctata	7	25.3	5	30
H. reinwardtii	7	25.5	5	35
H. pungens	7	25.7	1	4
H. fasciata	7	26.2	2	16
H. attenuata	7	26.3	12	72
H. longiana	7	26.4	1	8
H. viscosa	7	26.4	2	16
H. sordida	7	26.9	1	8
H. nigra	7	27.6	3	26
Section 8 *Venosae* A.Berger				
H. granulata	8	28.9	3	24
H. variabilis	8	29.1	1	4
H. bruynsii	8	29.3	2	10
H. venosa	8	29.3	3	20
H. woolleyi	8	29.6	1	6
H. scabra	8	29.8	5	32
H. mcmurtryi	8	30.3	2	12
H. koelmaniorum	8	32.2	1	4
H. limifolia	8	33.6	11	49
H. tesselata	8	69.2	3	24
Tulista (Subg. Robustipedunculares)				
T. marginata	9	35.9	1	44
T. minima	9	36.1	5	18
T. kingiana	9	36.7	2	32
T. pumila	9	37.2	4	
Astroloba				
A. bullulata	10	30.4	1	8
A. smutsiana	10	30.6	1	4
A. corrugata	10	30.7	1	8
A. hallii	10	30.8	1	8
A. congesta	10	31.5	1	7
A. foliolosa	10	31.7	1	10
A. herrei	10	34.0	1	8
A. spiralis	10	59.3	1	8
A. rubriflora	10	35.0	0.8	5

The sections and the species within the sections are more or less arranged according to genome size (2*C* value). Polyploid values are here excluded. Also the number of different clones measured is given. Species are attributed to genera sensu Manning et al. (2014)

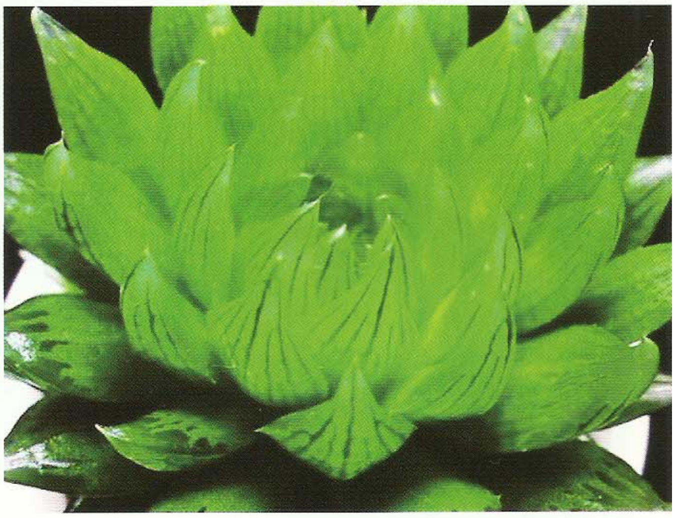
Haworthia Study No. 30

is enclosed for all who have ordered a copy;
for those who have not, a copy of page 16 is below to let you see what you are missing.

① **‘花紫’ A. ’Hana Murasaki’ A.** Ø=5 cm. A, B とも‘ドドソン紫’(OB-1)の赤斑。(旧‘紫オブト赤斑’)
Red variegation of ‘Dodson Murasaki’. By Hayashi

② **‘花紫’ B. ’Hana Murasaki’ B.** Ø=5 cm. A, B とも無毛丸頭濃緑葉に鮮明赤～黄斑。林選抜命名。
Reddish variegation on very round tip with no awn.

③ **‘水宝玉’ ’Suihōgyoku’** Ø＝8 cm 馬地氏育成命名。‘水晶オブト’実生。窓の透明度が非常に高い傑作。
‘Suishō Obto’ Seedling. Nice translucent, blue window. Breeder/Author : Ms Umaji



④ **‘桜水晶’ ’Sakura Suishō’** Ø＝13cm 馬地氏栽培。‘エメラルド LED’に似るが無鋸歯でより美麗。
本誌 26 号 7 頁は特徴不鮮明なので再掲載した。(育成者不明)
Close to ‘Emerald LED’, but no marginal teeth.

⑤ *H. tomei* (透明) Ø=8 cm 北村氏栽培品。
Joubertina 地方には *H. diaphana* など窓の非常に透明な種があるが、それらの中でも最透明の一つ。
One of most transparent species in Joubertina area.

⑥ **‘氷刀’ ’Hyōtō’** Ø＝12 cm 岩田氏育成命名。
H. cooperi (*H. specksii*)。非常に窓の大きな、青みがかった葉色の特異個体。*H. cooperi* の最優品。
Nicest clone of *H. cooperi*. Breeder/Author: Ms. Iwata

A floriferous new *Aloe* cultivar in Kenya

Leonard E. Newton

Kenyatta University, Nairobi, Kenya

The genus *Aloe* is popular in tropical and subtropical gardens and in greenhouses in temperate climates. Over 500 species are known (Carter et al., 2011), ranging from tall trees to very small plants. The smaller-growing species are most popular for greenhouse cultivation, and a number of hybrid cultivars have been produced from them. In South Africa some stunningly beautiful hybrids have been produced from larger-growing species (De Wet, 2013; Thamm, 2013). Very few species are hardy in Britain, though trials with species from higher altitudes in South Africa could be successful.

Aloes are self-incompatible, i.e. a plant will not set seed with its own pollen, with the possible exception of species in the Section *Lomatophyllum* (Lavranos, 1998). They are mostly pollinated by sunbirds (Fig. 1), and as the birds fly from one plant to another the seeds produced in a garden of many species usually give rise to hybrids. For this reason I remove developing fruits as I see them in my Nairobi garden, but occasionally a fruit ripens (a capsule that splits open at maturity) and the winged seeds are scattered, especially if this occurs at a time when I have travelled for some time. Rogue seedlings then appear here and there, and I suspect that this is the origin of the plant described below. Natural hybrids occur occasionally in the wild, but they are relatively rare because different species in one area may have different flowering times (Newton, 1998).

I first noticed this plant in my garden several years ago. In time it suckered to form a dense clump (Fig. 2), and it was rarely out of flower. New inflorescences emerged, from the same or another rosette in the clump, before one inflorescence had finished flowering. Eventually I separated the rosettes in the clump shown in figure 2 and planted them as a spaced-out group. Again, there was an unbroken succession of inflorescences in the whole group (Fig. 3), and the rosettes have also started to sucker at the base. Most of the aloes in my garden flower for a couple of weeks once or twice a year, but this plant is an exception.

From the maculate leaves and flower shape, this plant clearly belongs in the “maculata” group, typified by the South African *Aloe maculata* Allioni. Species of this group growing in my garden are *A. duckeri* Christian, *A. ellenbeckii* A. Berger, *A. lateritia* Engler var. *graminicola* (Reynolds) S. Carter and *A. springatei-neumannii* L.E. Newton, all native to East Africa. The first three of these usually have bright red flowers, as do my plants, though yellow-flowered variants of the second and third are seen occasionally in the wild. *Aloe duckeri* remains as a solitary rosette, eventually forming a stout trunk, whilst *A. ellenbeckii* and *A. lateritia* var. *graminicola* sucker freely. The rosettes of *A. ellenbeckii* are smaller than in the other species. *Aloe springatei-neumannii* has bright yellow flowers, and has solitary rosettes that develop a short trunk with age.

The rogue plant has yellowish orange flowers (Fig. 4), suggesting that it might be a hybrid between a red-flowered plant and a yellow-flowered plant. After flowering prolifically, this plant has not yet set seed and the anthers are mostly rather shrivelled. In pollen stained and examined with a microscope, only 33.7% of the pollen grains were found to be good, again suggesting possible hybrid origin. If it is a hybrid any of these other “maculata” group plants in the garden could have been parents, with *A. lateritia* var. *graminicola* as one most likely candidate. Other yellow-flowered species in the garden, though not members of the “maculata” group, are *A. elata* S. Carter & L.E. Newton, *A. jibisana* L.E. Newton, *A. labworana* (Reynolds) S. Carter and *A. rivae* Baker. The first is a tree about four metres tall, the second has long scrambling stems, the third has numerous small scattered whitish spots on the leaves, and the last has very large rosettes, and these characters do not appear in the suspected hybrid.

As I am uncertain of its origin but it is a very attractive plant, it seems worthwhile describing it as a cultivar. With its suckering habit it is easy to propagate for distribution, and it is an ideal bedding plant in areas where succulents can be grown outdoors. I live on the main campus of Kenyatta University, on the outskirts of Nairobi. In conversation and in some documents the university is usually referred to as “KU” and this abbreviation is used in the cultivar epithet.

Aloe ‘KU Flame’ L.E. Newton, new cultivar. Similar to *Aloe lateritia* var. *graminicola* in growth habit, but with yellowish-orange flowers produced almost continuously on a large clump. Perianth yellow-orange (23A) at base, becoming darker orange (24A) towards mouth, where the lobes have a narrow yellow (7A) margin. (Colours as in RHS Colour Chart, 1966.)

My garden is at an altitude of about 5500 feet above sea level, and is 80 km south of the Equator. Temperatures range from about 11ºC in the cold months (July, August) to over 30ºC in the hottest months (January, February). I do not water the garden — the plants survive on rainfall. There are two wet seasons each year, though their date of starting and their persistence vary from year to year. The “long rains” are from about late March to early June, and the “short rains” are from late October or early November to mid-December. In temperate climates this new cultivar would require greenhouse conditions, where it would benefit most from being in a soil bed rather than confined to a pot.

References

Carter, S., Lavranos, J.J., Newton, L.E. & Walker, C.C. (2011) Aloes: The Definitive Guide. Royal Botanic Gardens, Kew.

De Wet, A. (2013) Aloe cultivars, landscaping and care of aloes in gardens. Aloe 50: 82–84.

Fig. 1. Female Variable Sunbird (*Nectarinia venusta*) on inflorescence of *Aloe lateritia* var. *graminicola.*

Fig. 2. Clump of *Aloe* 'KU Flame'.

Lavranos, J.J. (1998). Neues aus der Gattung Aloe in Madagaskar. Kakteen und andere Sukkulenten 49: 157–164.

Newton, L.E. ("1995", publ. 1998) Natural hybrids in the genus Aloe (Aloaceae) in East Africa. Journal of East African Natural History 84: cover + 141–145.

Thamm, L. (2013) Important aspects of the Aloe Cultivar programme. Aloe 50: 85–86.

Photographs: Leonard E. Newton.

Fig. 3. A group of *Aloe* 'KU Flame', planted after breaking up the clump shown in figure 2. Young emerging inflorescences can be seen.

Fig. 4. Flowers of *Aloe* 'KU Flame'.

The International Cultivar Registration Authority for Haworthia (including Haworthiopsis & Tulista), Astroloba and Chortolirion is the Haworthia Society of Japan.

Registrar: Dr. M. Hayashi, info@haworthia.net

Representative for western countries: Harry Mays, alsterworthia@freenetname.co.uk

Both the Japanese Haworthia Society and Alsterworthia International are willing to publish new cultivars in Haworthia Study (Japanese) and in Alsterworthia International (English) respectively, provided they comply with the International Code of Nomenclature for Cultivated Plants.

Please send descriptions and colour photos to Dr. Hayashi or Harry Mays as appropriate. Electronic copies are acceptable.

Further information will be supplied on request.

Soumen Aditya….

…. has produced a number of new Haworthia cultivars.

Details will be published in the November journal.

In the meantime…..

….Haworthia 'Bela-Rani-Atasi' n.n.