

# CLIVIA



8



Interspecific 'Pansy' Breeder: Yashikasu Nakamura, Grower: Laurens Rijke and Photographer: Helen Marriott  
(*C. miniata* x *C. caulescens*) x *C. miniata* 'Aurea'

Front cover: *Clivia miniata*, Breeder, Grower and Photographer: Mick Dower  
JW5 X Transkei pink 2

Back cover: *Clivia miniata*, 'Cameron Peach'

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# CLIVIA

## 8



Photo: Mick Dower

*Clivia miniata* — Winner Best Photograph Section of the Photographic Competition

### Editors

Claude Felbert

John van der Linde

Roger Dixon

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# Editorial

A reviewer of CLIVIA 7 wrote, “It has always been a source of amazement to me that 6 species of plants in one genus can produce so much diversity and so much enthusiasm amongst people.....A variety of subjects regarding *Clivia* are dealt with, in fact so thoroughly that one wonders where the subject matter is going to come from for CLIVIA 8.”

Well, the subject matter has come forth yet again - from authors in Australia, Netherlands, New Zealand, the United Kingdom and South Africa. It is as diverse as the backgrounds of the authors. These include a businessman, a farmer who breeds cattle as well as *Clivia*, a mechanical engineer, a geneticist, a professor of architecture, a police forensic scientist, an associate professor in Japanese studies, a biologist and practical full-time plantsmen. Needless to say, in every case *Clivia* are their passion. The “enthusiasm amongst people” referred to by that reviewer is also reflected in the attendance at the Clivia Society’s 2006 International Clivia Conference. This is the fourth to be held since the founding of the Clivia Club, the predecessor of the Clivia Society, in 1992. The enthusiasts have come from around the world - including for the first time China. Eight of the articles in this yearbook are based on Conference presentations; the rest were submitted in response to invitations from the Editors, who are nevertheless also always happy to be ‘surprised’ by articles submitted from out of the blue.

The combination of diversity of material, enthusiastic *Clivia* lovers and digital cameras is a powerful one. Indeed, what will first stand out to anyone simply leafing through this

book is the increased number and quality of the photographs. Breeding efforts around the world are now producing many more beautiful and unusual plants, and more keen photographers are sending us better pictures. We particularly thanks entrants in the 2006 Clivia Society Photographic competition and congratulate the winners whose entries are featured in this yearbook.

Yoshikazu Nakamura is a giant among *Clivia* breeders, and who has not heard his name? Many enthusiasts around the world have plants bred by him, or grown from seed from his plants. He has led the way and we have so much for which to thank him. It is only fitting therefore that a ‘Tribute to Nakamura’ should appear as the lead article in this issue. Helen Marriott has written a thoroughly researched



Photo: courtesy Helen Marriott

A Nakamura Multitepal with variegated foliage

and magnificently illustrated 'landmark' article, based largely on her personal contacts with Nakamura during her regular business visits to Japan.

Hein Grebe has written on the most primitive of the *Clivia* species, *C. mirabilis*, found at the extreme western end of the known distribution of the genus *Clivia*. Jaco Truter and his co-authors tell us about plants from the extreme opposite end of the known range. Is *C. x nimbicola* a naturally occurring hybrid between *C. miniata* and *C. caulescens*, as the authors suggest, or is it an intermediate stage in an ongoing process of speciation? Are there *Clivia* species yet to be discovered? There are many intriguing questions that will be answered in years to come. DNA and other research into *Clivia* is proceeding apace. Johan Spies touches on some initial results in his article on the genetic aspects of *Clivia* breeding. We expect to publish further results as soon as next year, results which will throw light on the origin of the genus and its evolution, and which will go a long way to explaining the variation that is found among the species today.

Many *Clivia* enthusiasts are particularly attracted to variegated leaved plants and are always eager to know more about them, and to see photographs of them. Ben Zonneveld has explained the theoretical background to variegation in *Clivia* and Roger Dixon follows this up with a practical demonstration of some of the types of leaf variegation and introduces us to the names that they have been given by the Japanese.

A legendary breeder of Cape *Gladioli* in the mid-1900s named the essential attributes of the successful plant breeder as: **a keen eye, a hard heart, and a hot incinerator**. Sean

Chubb tells us how he ruthlessly selects as he goes about breeding for colour. His article is an object lesson for all of us who complain about lack of space, yet are reluctant to discard plants! Keith Hammett also deals with flower colour in his report on *Clivia* flower pigment analyses commissioned by the Clivia Club of New Zealand. We thank them and Keith for making the results of this research available to the wider *Clivia* community.

Tony Barnes tells us about *Clivia* in New Zealand, and about the people who breed them. John Craigie is an Australian businessman cum *Clivia* and *Agapanthus* breeder. He writes about how he and his wife run a nursery operation under the most arduous of climatic conditions. Aart van Voorst gives us an update on the ongoing work that he is doing in the Netherlands on polyploid *Clivia*.

Keith Hammett gave us this haiku for CLIVIA 6:  
Art is exploration  
To breed a flower is Art.

A further aspect is the recording of *Clivia* for posterity, as related by Roger Fisher in his article on *Clivia* as depicted by botanical artists over the years. We understand that, in the 19<sup>th</sup> century, before the days of colour photography, many very beautiful hand-coloured lithographs of *Clivia* were published in Europe, particularly in Belgium and Germany, and in obscure and long-obsolete British gardening journals. They lie there, waiting to be discovered. We appeal to any readers who may have access to such old pictures to let the Clivia Society know about them. If they are in good condition, and subject to any copyright requirements, we will happily republish them, with or without any accompanying article, for today's wider audience.

We began this Editorial by referring to digital photography, the modern form of depicting *Clivia* for the record. Ian Coates has not only been growing *Clivia* since the 1960s, but is a professional photographer of note. He has done pioneering work on ultraviolet photography of *Clivia*, which gives us an idea of how flowers might look to their potential pollinators. He has contributed two “Here’s how to do it” articles to this Yearbook, one on normal photography of *Clivia*, and the other on UV photography. Ian has also been one of the judges of the Photographic Competition.

We end with a tribute to the late Sir Peter Smithers, the breeder and grower of “Vico

Yellow”, the now-famous *Clivia* that Nakamura has used so much in his breeding. He was one of the founding members of the Clivia Club, along with other international “greats”, many of whom have also passed on. He remained a member of the Clivia Society until his death at the age of 92. This is what he wrote some time ago:

“It would be nice to end life surrounded by the beauty which is my garden...As long as memory lasts my garden will remain with me, like my own past life, a delightful dream which once I dreamed here on this mountainside.”

The Editors, August 2006



Photo: Claude Félbert

*Clivia miniata* ‘Vico Gold.’ First flowering of a plant sent to the SANBI by Sir Peter Smithers



# Nakamura's Contribution to *Clivia* Breeding

Helen Marriott, Australia



Yoshikazu Nakamura showing off the new sign for his *Clivia* Breeding Plantation

## Introduction

One of the most influential individuals in the international *Clivia* community is undoubtedly the Japanese breeder **Yoshikazu Nakamura**, whose interest in *Clivia* spans approximately 30 years. Nakamura's residence and nursery/greenhouses, known as the *Clivia* Breeding Plantation, are located several hours south-east of Tokyo in Chiba prefecture and are home to an eclectic collection of rare *Clivia* which have been gathered from around the world. Yoshikazu Nakamura's father, Chu, was an eminent horticulturalist specializing in rice. Chu Nakamura lived at a time when rice cultivation was very important in Japan, and he developed new cultivation methods and made other discoveries, for which he received many awards. After this he specialised in flowering plants such as *Amaryllis*, *Dahlia*, *Hibiscus*, *Narcissus* and *Erythrina*.

Centring upon one main greenhouse and supplemented by other houses, Yoshikazu Nakamura's collection of *Clivia* continues to evolve and to be influenced by *Clivia* breeding trends in Japan and overseas. By avidly collecting different plants from within Japan

and from abroad during the 1980s and 1990s, Nakamura has assembled a wide range of *Clivia* from which he has produced many distinctive hybrids. He has actively cultivated such hybrids over a long period of time and from them has produced new types of *Clivia* which had not existed hitherto. These plants have been sought after by overseas enthusiasts in various countries, including South Africa, with the result that there are now collections of Nakamura hybrids in many countries around the world.

Nakamura joined the *Clivia* Club, the predecessor body to the *Clivia* Society, as one of its very first members and his major contribution to *Clivia* has been recognised with the awarding of Honorary membership. All the Yearbooks to date display photos of his plants and numerous *Clivia* pictures posted to the Yahoo *Clivia*-enthusiast group have some Nakamura breeding in their background.



A Nakamura *miniata* multitepal

Quite a few facts about Nakamura's formative years have already been well documented in *Clivia* Club/Society literature, including his mentorship by Isamu Miyake,



a renowned nurseryman and bulb and rhizome specialist who lives close to Nakamura. (Miyake, in fact, had earlier been trained by Yoshikazu Nakamura's father, Chu Nakamura.) In addition, his acquisition of Shuuichi Hirao's collection of *Clivia* upon the sudden death of the latter at the age of 68 years, has been frequently reported. This event occurred in 1988. Similarly well-known is the fact that Hirao's collection included a *C. miniata* 'Vico Yellow' plant (received from the late Sir Peter Smithers) which Nakamura has subsequently used extensively in his breeding programme.

### Features of Nakamura's *Clivia* growing

During the past two decades, Nakamura's contribution to *Clivia* breeding has been diverse. From my own layperson's perspective, a number of interrelated features can be identified with respect to his development of *Clivia*.

From the outset and until the present, **Nakamura has aimed to source and to utilise all available *Clivia* resources**, even in the early period when this was not easy. For instance, in the Royal Horticultural Society's publication of 1992 he notes:

"I make a point of obtaining every new cultivar or variant possible and trying out every conceivable breeding technique. I

am not aiming at mass cultivation but am committed to continuous observation.... The more I study the breeding of *Clivia* the more pleasure I find in promoting their strong points and caring for their development" (*The Garden*, August 1992, p.371).

Nakamura's interest in *Clivia* led him to China approximately 20 years ago, first to Shanghai, and returning on four subsequent occasions to Changchun, Dalian, Harbin, Dandong or Guangzhou (cf. Nakamura 1999). Other overseas trips were to Australia in 1992 and 1993, and then to South Africa in 1994 and 1998, where he attended the first two international *Clivia* conferences, giving an introduction of his own breeding on the first occasion. His visits to *Clivia* habitats remain amongst his most precious memories. Of course, overseas visits also provided opportunities for him to augment his *Clivia* collection.

In the early period of his *Clivia* growing, Nakamura received from Miyake several seed from yellow plants, which were quite rare at the time, in addition to *C. caulescens*, both plants originating from Hirao. Historically, then, Nakamura's access to *C. miniata* 'Vico Yellow' at the end of the 1980s was important for him. His subsequent receipt of yellow *Clivia* plants/offsets and seeds from Cynthia Giddy have also been



*Clivia miniata* 'Ghost'



A peach hybrid

documented, at a time when seeds from yellow-flowered plants were not readily obtainable (Clivia Society Newsletter, 2005a, p. 9); in turn, Giddy's admiration for Nakamura's breeding is also known (Clivia Club, 1998c, p.14).

Hirao's *Clivia* collection, noted above, provided a boost to Nakamura's expanding collection, even though he discovered that many of the 200 plants were 'ordinary' *Clivia*. Hirao was an eminent researcher on the carotenoids in fish skin and was employed throughout his career by the Japanese Ministry of Agriculture, Forestry and Fisheries, rising to its chairman. He was also highly respected within the Japanese horticulture community and was especially known for his hybridization of *Iris kaempferi*, though he played major roles in a variety of plant societies as he possessed interest and expertise in a wide range of plant species. On an overseas visit to South Africa, he visited Gordon McNeil's farm and took back to Japan some *Clivia* plants from there. Even though his main interests centred upon other plants, especially the irises, he published several seminal articles on the genus *Clivia* which were important references for Nakamura. The first of these appeared in a 1980 special issue on *Clivia* in *Garden Life* (in Japanese) where Hirao wrote on breeding *Clivia*. Another important article appeared in a special issue of the 1985 *Engei Bunka* (Journal of the Japan Horticultural Society), which featured *C. miniata* 'Vico Yellow' on its cover. Hirao was obviously a very influential and a highly liked individual whose drawings of plants and philosophical views, apart from his other contributions to science and horticulture, were appreciated by many, including Nakamura. Taking over Hirao's collection of *Clivia* resulted in Nakamura's confirmation that his own life's mission was to develop this genus. He describes this purchase as a boost in his early period of growing and breeding *Clivia* and is grateful for the influence of both Hirao and Miyake.

Over the past decade or more, among the many acquisitions of Nakamura have been an offset of *C. miniata* 'Vico Gold', received directly from the late Sir Peter Smithers in April 1993, green-centred yellow *C. miniata* (group 2) from Toshio Koike, Light of Buddha variegate seeds and seedlings from China, peach *C. miniata* from South Africa (Sean Chubb) and the USA, and many others. These days he still continues to receive certain important plants, seeds or pollen from South Africa in particular, but sometimes also from other countries. In this way, Nakamura is able to utilize original plants from the habitat as well as cultivars from a range of breeders in different countries, produce new hybrids and then further disseminate such material.



Interspecific 'Ester' *C. miniata* x *C. caulescens*

Around mid-May, 2005, Nakamura was pleased to take receipt of his order of *C. mirabilis* from the South African National Biodiversity Institute (SANBI) and commented, "I will enjoy observing them to see their characteristics". He also started to plan what crosses he would produce in the future.

It appears that one of Nakamura's pleasurable activities around February, the month when Japanese retail outlets stock flowering *Clivia* plants, is to seek out interesting flowers from local florists and nurseries. Some recent acquisitions will be mentioned below.

The early establishment of Nakamura's collection and results of his breeding deserve recognition. By 1992, the same year that the *Clivia* Club was launched, Nakamura had already built up a diverse collection, as evidenced by the photos in *The Garden*, mentioned above. Keith Hammett's report of a visit to Nakamura in 1993 is also testament to the diversity of his collection (Hammett 1994). Hammett was impressed with the variety of leaf forms, ranging from narrow to broad, different forms of variegation as well as specimens of *C. nobilis* and *C. caulescens*. He claims that Nakamura's collection was very broad based, with all the species that were known at the time, and stood in contrast to many other collections which were primarily of *C. miniata*.

Interrelated to the above is the fact that Nakamura engaged in important networking with overseas individuals, despite his lack of English or Chinese competence. As one example, Ken Smith, in Australia, initiated contact with Nakamura in late 1990 and thereafter they corresponded and sent each other seed, articles, notes and photographs. Among the many friendships he treasures are Chinese *Clivia* specialists such as Zhu Yongqing, Shi Guo Guang, Guo Wenchang and Zhao Yutang, while from South Africa, Nick Primich, the late Cynthia Giddy, James and Connie Abel, and John Winter have been important contacts for him, among others. Nakamura has always been happy to receive overseas visitors to his nursery, and displays eagerness to hear about overseas developments in *Clivia* (see Malan 2003). Sometimes, Nakamura and his overseas contacts have been able to use translations and interpretations to facilitate their communication but of course this has not always been possible. Nakamura feels sincerely apologetic towards the many

people who have interacted with him and expresses his appreciation to them all. He says himself that in the early years, "It was difficult for me to buy even a single seed from overseas". Although Nakamura no longer travels overseas due to his health, he values his ongoing connections, through *Clivia* plants, with many individuals in South Africa, China, Australia and elsewhere.

Through networking with key individuals of the international *Clivia* community Nakamura was able to expand his own collection and, in turn, supply overseas *Clivia* growers and groups/organisations, including the *Clivia* Club/Society, with seeds or plants/seedlings, as well as photos, posters and other *Clivia* memorabilia. At least for a short period in the early years of the *Clivia* Club, Nakamura sent seeds in return for having some of the newsletters translated into Japanese and these seed were distributed among various Club members. In this way he seemed to provide an important early boost to *Clivia* breeding among enthusiasts in South Africa.

Nakamura has shared his breeding and growing experiences when the opportunities allowed in Japanese, English and Chinese, and throughout has promoted the 'international' character of *Clivia* growing. The early newsletters or yearbooks of the *Clivia* Club/Society contain short articles written by himself and, more recently by Shigetaka Sasaki, whose own *Clivia* collection is built around Nakamura plants. They have both described important aspects of Nakamura's breeding. Illustrated articles on *Clivia* that have been published by Nakamura in Japan and China frequently include photos not only of his own hybrids, but also those taken on his earlier trips to South Africa and Australia.

Koopowitz (2002, p.176) aptly describes Nakamura as an 'international ambassador' for *Clivia*,

"... exposing and introducing Japanese *Clivia* in their myriad forms, flower colors, and plant shapes to other growers around the world. He has also sold and shared seed – spreading enthusiasm and good will for *Clivia* around the world."

In addition to introducing Japanese trends in *Clivia* breeding to other countries, Nakamura has also shared *Clivia* plants from various parts of the world, including Japan, with others through his new hybrids. Nakamura possesses a vision whereby other Japanese breeders and enthusiasts can benefit from greater contact with South Africa and he also believes that Chinese breeders, whose interest

tends to be focused upon the foliage, will also benefit from greater international contact, particularly if this leads to increased attention to flower form and to the diversity available within the genus.

As noted by Koopowitz and others, Nakamura has disseminated the results of his breeding outcomes within Japan and overseas. He has repeatedly claimed not to have aimed to develop *Clivia* for the commercial market, even though this has been his single specialisation, but rather to satisfy himself through his own breeding efforts. Unlike some other breeders, he has not focused upon a single main line of breeding, preferring instead to explore the diversity that *Clivia* breeding offers. In addition to selling from his nursery or at



Nakamura's '17 Day Delight' – Thought to be an F2 *C. miniata* x *C. caulescens*  
This outstanding interspecific confirms the potential of the *Clivia* gene pool

the wholesale market in Tokyo, Nakamura has offered a mail order service to Japanese customers for about 20 years and commenced in mid-2005 a Japanese website introducing this service.

With the aim of stimulating interest in China in different kinds of *Clivia*, in 1997 Nakamura contributed 10,000 yellow hybrids to the city of Dalian, for which the mayor of the city expressed his great appreciation. Retrospectively, Nakamura does not know whether his gift was appreciated or not, since the yellow long-leafed *Clivia* were not familiar to Chinese *Clivia* growers at the time.

Overseas customers were able to order seed from Nakamura for a period through intermediaries or occasionally, directly, up until about 2004. A few international visitors have been able to purchase plants directly from Nakamura while other visitors to his nursery or contacts he met when abroad report on receiving gifts of plants from him. As a sole nursery operator, Nakamura only rarely sent plant orders overseas. David Bearlin from Australia, however, managed in 2000 to import from Nakamura some *akebono* and *fukurin* variegates, in addition to *C. miniata* 'Vico Yellow' tissue cultured (meristems) and other plants that are now found in various Australian collections.

Some of Nakamura's *Clivia* as well as those of others (including Sasaki) were displayed at two leading Tokyo nurseries in 2005 and 2006 as part of a 'Clivia Fair' (*Clivia Society Newsletter*, 2005c, pp. 22-23) which was organised as a means of raising the public's awareness of *Clivia* plants. Recently, Nakamura reports that interest in *Clivia* in Japan seems to be increasing.

### **Some characteristics of Nakamura's *Clivia* breeding**

A principal objective of Nakamura's breeding has been the improvement of flower form and to this end he has frequently utilised *C. miniata* 'Vico Yellow' in many crossings. When 'Vico Yellow' flowered for him this year, Nakamura stated:

"Even though I was impressed with 'Vico Yellow' 20 years ago, it's still an impressive flower. I think I will feel the same way in another 20 years."

After his plant's first flowering in 1984, Hirao, himself, identified *C. miniata* 'Vico Yellow' as being an important plant for breeders to use and to further develop. At the time, 'Vico Yellow' was the largest yellow flower that Nakamura had ever seen; moreover, it had a good flower form, with reflexed tepals, and a kind of frill or wave that he has subsequently found excellent for breeding purposes to create distinctive *Clivia*. Its thick, strong and long peduncle as well as long pedicels are also seen as important in supporting the inflorescence. Nakamura is well aware that now many other superior cultivars similar to 'Vico Yellow' are being used in breeding, but historically, he has maximized use of this particular cultivar.

From among his *C. miniata* 'Vico Yellow' hybrids, Nakamura has selected those with big yellow flowers that have a good flower form and named them 'best yellow'. 'Chiba Yellow' and 'Chiba Orange' are hybrids that have arisen from crosses of 'Vico Yellow' and surpass the parent plant in terms of the size of the flower and their excellent form with reflexed tepals. Waved and rolled petalled flowers have been other forms to arise from crosses using this cultivar (see *CLIVIA* 3, pp. 24-29, photos 30-33).



Nakamura has also made frequent use of the cross (orange *C. miniata* x yellow *C. miniata*) x *C. miniata* 'Vico Yellow', with excellent cultivars resulting. *C. miniata* 'Chiba Lily' is one of these crosses, with an unusual flower shape and measuring 13 to 14 cm in diameter. *C. miniata* 'Chiba Gold' is another exceptional hybrid that is a deep yellow colour and which exhibits a fine shape with reflexed petals. Nakamura continues to use the cross of (orange *C. miniata* x yellow *C. miniata*) x 'Vico Yellow' in his breeding so we can look forward to more exciting results hereafter.



A 'Vico Yellow' Hybrid

*C. miniata* 'Vico Yellow' has also been used by Nakamura in his development of *akebono* variegates in particular, and more recently with his Light of Buddha variegates of Chinese origin. From time to time, he has also used 'Vico Yellow' in his breeding of interspecific hybrids.

In late April, 2006, Nakamura received news that he felt vindicated his own long-term commitment to *C. miniata* 'Vico Yellow'. One of his customers who had earlier obtained 'Vico Yellow' hybrid seed from him had used it as the basis of his own breeding with *daruma* and has produced a variegated *daruma* which has the frilled tepal of 'Vico Yellow' and the broad tepal of 'Vico Gold' but which apparently surpasses both of them.

Nakamura states:

"I have spread 'Vico' genes throughout the country and hoped that it would produce some beneficial results one day so I'm really thrilled that this has come about and admire the enthusiast who has produced this plant over a long period of time. I had thought that Japan was behind other countries in developing the *Clivia* flower but actually a small proportion of enthusiasts are producing some wonderful flowers. I expect that we will see a continuation of beautiful flowers appear in different parts of Japan. 'Vico Yellow' has raised the level of my own breeding as well as that of Japanese *Clivia* breeding. So I feel that I have achieved my responsibility for having received this plant."

An early recommendation of Nakamura was that breeders should backcross with a like type. Using yellow *C. miniata* as an example in interspecific hybridisation, he suggested such combinations as (yellow *C. miniata* x *C. caulescens*) x yellow *C. miniata* or (yellow *C. miniata* x *C. gardenii*) x yellow *C. miniata* (*Clivia* Club 1994b, p.7).

His own crosses of orange and yellow *C. miniata* have produced his well-known striped tepalled-plant (sometimes referred to as 'veined petal'), which first flowered about 10 years ago, among others (see CLIVIA 3, 2000, pp.28 photo 37). Nakamura is always interested in new possibilities and in the past has experimented with cobalt 60, producing for example, 'Chiba zakura' (see CLIVIA 3, p.27 photo 35). A rare bicolour is another outcome of his breeding (see CLIVIA 3, p. 71, photo 111).

In recent years Nakamura has been working with peach, particularly *C. miniata* 'Chubb Peach' and, like others, he has been



crossing the peach with other superior flowers, including *C. miniata* 'Vico Yellow' or its hybrids, *C. miniata* 'Vico Gold' and others. He has undertaken numerous crosses of (orange *C. miniata* x yellow *C. miniata*) x peach, as well as (variegated orange *C. miniata* x yellow *C. miniata*) x peach over the past couple of years and from these expects a percentage of peach variegates. Although peach-coloured *Clivia* are not yet well known in Japan, Nakamura expects them to be popular among enthusiasts, given that peach carries more variation than does yellow.

Nakamura's development of *Clivia* flower forms can also be found in his growing of multitepals with consistent eight tepals or more (see CLIVIA 2, p.33, photo 22; CLIVIA 3, cover & p. 1, photo 1; CLIVIA 5, p.89, no. 134). While he says that others in Japan were involved in the breeding of multitepals, *akebono* variegates and interspecifics earlier than himself, he has



Nakamura's preferred style of multitepal with its regular arrangement of tepals

certainly helped to improve and spread these varieties of *Clivia* to overseas communities. Given the strong tendency for the multitepal characteristic to be inherited, he reports that multitepals have been grown in various parts of Japan for quite a long while. He admits, however, that good multitepals are still quite scarce. The plant owned by Ian Brown that

produces the spectacular double flower (see CLIVIA 3 cover and inside page) arose from Nakamura's breeding. Nakamura himself personally prefers a regular arrangement of tepals in multitepaled-plants, rather than the more irregular forms that also occur and which are sometimes favoured by others (see CLIVIA 7, p.31).

One of Nakamura's special discoveries at local nurseries or flower shops during the 2006 flowering season was a broad-leaved *daruma* with a multitepal tendency for 1980 yen (about R110). He also found several yellow multitepals for 3000 yen (approximately R170). He himself has been working towards breeding yellow multitepals, though he also dreams of growing pink, peach or green multitepals in the future. In addition, this year an acquaintance purchased for him a multitepal, variegated *daruma* with an excellent large flower which he already treasures highly.

Another principal characteristic of Nakamura's breeding is his full use of different species and combinations of characteristics. Perhaps the most exciting outcomes of Nakamura's breeding are now being witnessed in relation to his breeding of interspecifics. Interspecific hybrids where 'Day Dream' has been used as the pollen parent, have been blooming in various places, but it is the parent 'Day Dream' that is a magnificent hybrid itself. Bred from (orange *C. miniata* x yellow *C. miniata*) x (*C. caulescens* x yellow *C. miniata*) about 15 years ago, 'Day Dream' has been featured in various publications (cf. CLIVIA 2, p.41, photo 29; CLIVIA 3, p.27). Nakamura reports that he did not make many instances of this cross at the time, yet this flower emerged from them.

Also arising from a cross of *C. miniata* x *C. caulescens* (probably F2) is a personal favourite of Nakamura called 'Tricolor', which flowered



Laurens Rijke's 'Clementina'

about 10 years ago and which he now uses as an emblem on his website.

Laurens Rijke in Melbourne, Australia, recently flowered a fine specimen which has since been called 'Clementina', which appears to be an F<sub>2</sub> *C. miniata* x *C. caulescens* (see CLIVIA 7, inside cover & p.30). Similar to 'Tricolor' with yellow/cream, orange and green as the main colours, it is a superb but unusual interspecific due to its spherical umbel, which obviously comes from its *C. miniata* parentage.

Rijke is in the midst of flowering a large number of Nakamura's interspecific hybrids and many exceptional flowers have already appeared. Apart from 'Clementina', others which he has named in 2005 and 2006 include 'Gay Delight', 'Aquilegia', 'Ester' and many more. These are from *C. miniata* x *C. caulescens* crosses and frequently flower twice a year. Rijke himself has used a Nakamura *C. miniata* x *C. caulescens* and crossed it with *C. miniata* 'Aurea' (the Australian cultivar) to produce 'Pansy', which is notable for its broad and shapely tepals. Also from the same



Another *C. miniata* x *C. caulescens* Interspecific from Nakamura

cross are 'Patsy' and 'Primrose'.

Nakamura has been breeding interspecific hybrids for about 15 years now, starting with a *C. nobilis* that was a seedling in the Hirao collection (in a pot with a South African-looking label referring to its serrated edge). He subsequently ordered a lot of *C. nobilis* from South Africa in the early 1990s and has since produced some interesting *C. miniata* x *C. nobilis* hybrids, such as *C. miniata* 'Vico Yellow' x *C. nobilis* (see CLIVIA 7, p.46).

In 1993 Nakamura recommended breeding with *Clivia* species, noting the desirable features of green-tipped flowers and long and slender leaves in the case of *C. gardenii*, which, when crossed with variegated *C. miniata*, result in attractive leaves and improved fertility and growth rate (Clivia Club, 1993, p.6). F<sub>1</sub> orange *C. miniata* x yellow *C. miniata* have often been used as the pod (mother) parent to cross with *C. gardenii*, producing interspecifics which he generically names as 'Candoll' (CLIVIA 3, p.27). One of his named *C. miniata* x *C. gardenii* hybrids is 'Moonchild', which arose about five years ago. 'Moonchild' is yellow and orange on the outside of the flower, and yellow, aging to gold, inside. While some *C. miniata* x *C. gardenii* hybrids have erect tubular flowers and others are pendulous, the flowers of 'Moonchild' sit horizontally.



'Moonchild' with its flowers that sit horizontally

A *C. miniata* x *C. gardenii* (probably F<sub>2</sub>) that recently flowered for Rijke has strong green colouring both on the outside and inside of the flower. Nakamura is attracted to the green colour that is found in many interspecifics and hopes one day to find a flower with a green picotee edge. Peach coloured interspecifics involving *C. miniata* x *C. gardenii* crosses have arisen on several occasions, without the use of a peach parent (see CLIVIA 7, p.88, photos 6-7).

By using *C. caulescens*, *C. gardenii*, *C. nobilis* and *C. x crytanthiflora*, Nakamura has produced a wide range of interspecific hybrids. He has frequently selfed his F<sub>1</sub> plants, the purpose being to stabilize the characteristics of the plant and to bring out the recessive traits or genes of the parents. He notes that by cross-pollinating an F<sub>1</sub> interspecific with another parent, we are only using one-half of the plant's special characteristics. His aim in the breeding of interspecifics is to come close to a *C. miniata* with its thick peduncle but to retain some of the characteristics of the non-*miniata* parent. The frequent emergence of green in the interspecifics is possibly due to his employment of selfing. Although Nakamura himself highly evaluates the outcome of his breeding with *C. miniata* 'Vico Yellow', the extraordinary variation found in his superb

interspecific hybrids is possibly unparalleled at present, especially with regard to his F<sub>1</sub> and F<sub>2</sub> *C. miniata* x *C. caulescens* crosses.

Interspecifics still remain relatively unknown to the Japanese market and hence to stimulate interest, last year Nakamura gave out two year-old seedlings of *C. miniata* x *C. 'Day Dream'* to



'Day Dream' and 'Patsy' ((*C. miniata* x *C. caulescens*) x 'Aurea') show the potential for different flower shapes between interspecific crosses



his domestic customers as gifts. Through this strategy, he hopes that they might become interested in interspecifics as well as in *Clivia* with narrow leaves. Earlier, Miyake had taken over some of Nakamura's mature F<sub>1</sub> *C. miniata* x *C. caulescens* plants with the purpose of producing seedlings to sell throughout Japan and thus also increasing interest in this variety.

*Clivia* plants from Nakamura exhibit much diversity in their combination of features. Thus we find variegated interspecifics with striata-type variegation, *C. miniata akebono* variegate x *C. nobilis*, *C. nobilis* x *C. miniata daruma*, variegated 'Ghost', 'Ghost' multitepal, variegated *daruma* and others. Nakamura's own preference seems to be plants that contain multiple features rather than a single main characteristic.

Although Nakamura has always positioned himself as being primarily interested in the development of flower forms, he has also worked extensively with variegated leaf forms as well as displaying an interest in the whole plant form. Indeed, it appears to be largely because of his Japanese heritage that many of us now have access to growing numbers of different types of variegates alongside of increasing knowledge of these forms. In 1994 Nakamura introduced to the Clivia Club the different types of variegates that were found in Japan up until that time (Clivia Club 1994c, p.5), with a more detailed set of drawings in a 1998 newsletter (Clivia Club 1998a, pp.14-16). Some of the variegate seed that he sent to the Club in 1993 and 1994 (ibid) may have formed the beginnings of some South African enthusiasts' addition of variegates to their growing collections. While variegates from China are also now increasingly making their

way overseas, Nakamura has worked with variegated leaves, in conjunction with the aim of improving the flower form.

Nakamura claimed in 1994 to be interested in the hybridization of variegated *C. miniata* crosses with *C. gardenii*, *C. caulescens* and *C. nobilis* (Clivia Club, 1994b, p.9), yet on a visit to his glasshouse, it is the *akebono* and *fukurin* variegates which form conspicuous groups here and there and which constitute a spectacular sight. Many of the *akebono* variegates have long, beautiful leaves, but there are also others with shorter, broader leaves.

According to Nakamura, in an earlier period in the Japanese breeding of *akebono* variegation, the variegation pattern often disappeared permanently but that this is no longer the case. The plants owned by Nakamura, which have been crossed with good parents, are fine collections of this variety. Indeed, he is very proud of his specimens of yellow *akebono*. These *C. miniata akebono* variegate x *C. miniata* 'Vico Yellow' have resulted in big flowers with a good shape and also large leaves. Nakamura's use of *C. miniata* 'Vico Yellow' in the breeding of a yellow *akebono*, which was first flowered by Connie and James Abel in 2000, followed by his own first bloom in 2002, is one of a number of crosses undertaken during the past decade (see Abel 2004). Each year Nakamura has had more maiden blooms, and shortly hopes to obtain peach or other pastel colours from his crosses of (orange *C. miniata akebono* variegate x yellow *C. miniata*) x yellow *C. miniata*. He reports on obtaining a whitish flower on one 'Vico Yellow' *akebono* cross this year. Nakamura is now using his parent *akebono* plants to produce various crosses, the latest one being (F1 *C. miniata akebono* x *C. miniata* 'Vico Yellow') x *C. miniata* 'Chubb Peach'. A few crosses have also been made with *C. gardenii* in recent times.



A yellow variegated *Clivia miniata*

Although the *akebono* variegation is automatically transmitted 100% through the pod parent, Nakamura has indicated that *akebono* seedlings are not necessarily easy to raise, especially during the first six months due to their lack of chlorophyll. Furthermore, the growth of these plants tends to be slow and hence they have not become widespread. Based on their own experience, Connie and James Abel advise on delaying the sowing of *akebono* seed until around early to mid-summer when the new leaves will emerge green due to the seasonal characteristic of the *akebono* banding. Even though Nakamura first saw a nursery advertisement for *akebono* plants 25 to 30 years ago (which were too expensive for him to purchase), these plants remain rare in Japan, despite the beauty of their foliage. He himself has now been growing them for about 20 years.

In recent years Nakamura has built up a collection of Chinese Light of Buddha variegates (which he refers to as Chinese *akebono* or *akebono negishi*-type), believing these to be stronger and easier to grow than are the Japanese *akebono* plants, since they have some chlorophyll distributed throughout their leaves (and do not seem to have seasonal variation, as does the Japanese *akebono*). He believes Light of Buddha plants could easily be planted in the open ground in Australia or

other in countries where *Clivia* can be grown in gardens (in addition to container culture). His Light of Buddha plants first flowered for him in 2005 and again in 2006, when they were pollinated with *C. miniata* ‘Vico Yellow’, a new Belgian hybrid strain that flowers in two years, *hime daruma* and *C. gardenii*. His aim is thus to improve the flower size and form but also to produce interspecific hybrids and other combinations. In particular, he wants to produce yellow Light of Buddha *Clivia* in the F<sub>2</sub>s, since he is unaware of the existence of these plants elsewhere. Multitepals and other species will be used in future hybridization.

A plant that takes pride of place in Nakamura’s collection is a slightly broadleaved fukurin – albomarginated variegate (leaves with a green centre and broad lateral white/cream stripes on both sides) which sits in a decorative Chinese pot. Given that *fukurin* or margin variegation cannot be reproduced from seed (occurring only spontaneously in seed or in offsets, and hardly ever with the *daruma* strain) this variety is also rare. *Fukurin* are often said to possess poor quality flowers, with superior flower forms being rather rare, since these cannot be purposefully bred. The *fukurin* of Nakamura that was photographed for *The Garden* article in 1992 was of exceptional quality and exceedingly rare. Nakamura also



Akebono variegation



‘Light of Buddha’ seedlings





Nakamura's 'Itofukurin'

owns a plant with a very thin white margin, which has been called 'Itofukurin' ('string-like').

In order to increase *fukurin* vegetatively, Nakamura and others sometimes employ a cutting method. Here, vertical cuts are made at the base of the plant, in order to stimulate the production of offsets. While this method can be used with any kind of *Clivia*, it is a particularly useful technique to increase *fukurin* more quickly. In the case of *fukurin*, they should be made along the green part of the leaf which contains the chlorophyll.

Another type of variegation that is being grown by Nakamura and some other Japanese growers is the *negishi*-type variegation, which was originally bred from crossing *striata* variegates (See CLIVIA 5, pp.53-54). Even allowing for variation amongst the *negishi* type of plants, these are characterised by a lime green leaf, with thin (or broken) stripes running down the leaf. Nakamura recommends more growing of this variety, since the plants are as strong as other green-leafed plants.

While interest in the flower obviously predominates for Nakamura, his interest in other plant characteristics is also evident. In 2004, Nakamura contributed the photos on *Clivia* foliage and plant forms for a Japanese garden magazine (*Shizen to yasei ran* The Wild Orchid Journal, 2004), showing the range of variation that he features in his own collection.

Although Nakamura frequently laments the focus of the majority of Japanese *Clivia* breeders upon short, broad-leafed plants - which in Japan are equivalent to the *daruma* strain - these seem to accord with the Japanese public's desire to buy small plants for the requisite container culture. Nakamura, nevertheless, also seems to have some interest in well-formed *daruma*, which have 100 or so year's history of development in Japan. Similarly, his interest also extends to very small Japanese and Chinese miniature *Clivia* plants.

### Conclusion

Nakamura's single-focused commitment to and vision for the genus *Clivia* can be confirmed by many people. He is delighted with the developments that are taking place in the growing and breeding of *Clivia* in various countries but recently reflected on his own contribution as follows:

"Whenever an unimaginable beautiful flower emerges from a 'Vico Yellow' hybrid, I realise the true value of 'Vico Yellow'.... However, I still haven't produced an original flower that will benefit a lot of people as does 'Chubb Peach' or 'Vico Yellow'. But maybe one day the *Clivia* will respond to me."

As we reflect upon the great diversity in Nakamura's breeding, the special Japanese perspective that he has shared abroad, and the way in which he has promoted *Clivia* breeding and growing, there is no way in which we could find his contribution lacking. I think we owe him our heartfelt thanks for his tremendous advancement of *Clivia* around the world.

### Acknowledgements

Numerous people have assisted with the compilation of this article, especially Yoshikazu Nakamura.

**Photographs** are courtesy of Helen Marriott and Yoshikazu Nakamura.



# Clivia Mirabilis in the Western Cape

## Hein Grebe, South Africa

Naturally-occurring *Clivia* in the Western Cape, growing in an area where you find an abundance of wild flower bulbs, are seriously endangered. Fossil discoveries show that the dry areas of the Western Cape and Namaqualand were once rich in flora and fauna. But with continued climatic change over the millennia many of those flora and fauna could not adapt to survive the long dry summers of the Western Cape. *C. mirabilis* now barely survives, truly a relict of a long lost world.



*Clivia mirabilis* survives in austere conditions

Only a few isolated populations, hiding in small pockets of mountainous forest of less than one hectare, have managed to cling onto a precarious existence. I am inviting you to visit some of these populations to give you an idea of the conditions under which they survive and how their numbers are dwindling each year. I first wrote about these populations on private farm land in my article, “In search of *Clivia mirabilis*” in CLIVIA 7.

Most of the pictures in this article were taken on a farm in the mountains outside Vanrhynsdorp. This town lies some 50 km to

the south-west of Nieuwoudtville, the nearest town to the Oorlogskloof Nature Reserve in the Northern Cape Province, where another population of *C. mirabilis* was discovered in 2002. John Rourke wrote about these plants, and the naming of the new species, in his article, “The miraculous clivia” in CLIVIA 4. Oorlogskloof is now closed to the public.

On the farm to which I have access the plant habitat changes from semi-desert to grassland and mountain forest as you go up the steep route to the farmhouse. From there it is a further drive on 4wd terrain to a river, and then a couple of km by foot all along a riverbank before the *C. mirabilis* suddenly and miraculously appear before you. Some grow in the open, some near the river, while others are partially sheltered in trees and many grow between rocks.

Those that grow in the open are the most vulnerable. They are open to attacked by the sun’s scorching rays, insects and wild animals that chew on anything green during the hot dry summers when the only green plants around are the *mirabilis*.



*Clivia mirabilis* in the wild is not easily accessible

It does not take long to notice that the continued weather change has had an adverse effect on the trees that are there and which protect the *C. mirabilis*. Year after year more and more trees and bigger shrubs die, leaving the *C. mirabilis* more exposed and unprotected and in even greater danger from fire, as many of them are surrounded by dry wood.



Despite the harsh climate we see that *mirabilis* can produce striking and beautiful blooms



The only relief during the long summer months comes from short thunderstorms that bring clouds and rain to this region. During autumn, fogs rolling in from the Atlantic provide moisture and cool the plants down for a few hours before the sun's rays attack them again. During these long hot months *mirabilis* is in a struggle for survival against the forces of nature. Some plants lose all their leaves due

to the scorching sun; others get uprooted by frustrated baboons and porcupines looking for food. Few seedlings, if any, make it to adulthood.

By July everything changes into the colourful wonderland that has made Namaqualand famous. Everything is green, and flowers of all colours and shapes are everywhere in abundance. In July, August and early September the *C. mirabilis* companion bulbs such as *Zantedeschia* and *Eucomis* are in flower. As soon as the winter rains cease, those *mirabilis* plants that have managed to



recover from the dreadful summer months with sufficient energy stored in their system begin to push flowers. It is seldom that a *mirabilis* will flower in two consecutive years. This can be seen from the fact that any green flower stalks of the previous year are still intact. Most *mirabilis* flower within a very short period of around 4 weeks. Out of season flowers are unheard of. The earliest flowers are usually seen in mid-September and the last in the last week of October. Those flowers that bloom late have a short life due to the heat. It is not uncommon to measure 30° C at midday in the middle of winter - after freezing nights! - and 40° C and more in the shade in November.

The flower colours are amazing and are usually the hard-to-find colours on the colour chart; neon-like colours such as red, orange-red, orange, watermelon, papaya, salmon pink, etc. The lightest shade is a type of yellow blush and the inside of the flowers is peach. The pollen quickly dries out due to the heat and dry air. Small ant-like insects move up and down the tubular flowers. Occasional flying insects that look like a cross between a fly and a bee also visit a flower here and there. Sunbirds are believed to be the main pollinators. From the scratch marks on the flower petals one can speculate that wind may also play a role in the pollination process. Only 30% of the flowering plants will end up with seeds, and then with only one or two seeds per plant. It looks as though some plants abort the seed-forming process by not feeding the flower stalk, which shrivels up after a couple of weeks.

The seed-forming process is much quicker than that of the other *Clivia* species and *mirabilis* seed is ripe by the end of February. Little of the seed known to be set is eventually found. It appears that some creatures, which no one has yet seen, remove the seeds and carry them away. In 2005, after two days' search of three populations fewer than 50 seeds could be found after a thunderstorm. In 2006, ripe seeds disappeared just as mysteriously from a *mirabilis* plant in a garden.



*Clivia nobilis* to compare with *mirabilis*

The leaves of *C. mirabilis* come in various lengths and widths. On some the median stripe is missing while on others it is more prominent and almost white. A few plants discovered this year have more than one stripe. In 2004 I discovered a *C. mirabilis* plant with *nobilis*-like notched leaves.

After this discovery I spent hours with my *nobilis* plants at home when they were in flower to take photos and to compare the two species. There are so many differences that it is actually amazing. Scientific research has shown that the difference in genetic make-up between these two different *Clivia* species is greater than the difference between man and ape. Does this mean that there might be another elusive *Clivia* species or two, intermediate between *mirabilis* and *nobilis*, waiting to be found – if they have not already become extinct? In my view, the breeding possibilities with *mirabilis* are endless.

From nature it looks as though *mirabilis* is very slow-growing, like the surrounding succulent and desert plants. It could thus be better to use it as a pollen parent. The problem is the limited number of flowering plants, most of which produce almost useless dry pollen. In 2005, I mixed this dry pollen with sugar water and placed it on the stigmas



*Clivia mirabilis* – note the differences from *nobilis*

of 15 flowering *C. miniata* plants. Of these 15 plants only seven produced seed heads. Some of these seven produced only one or two seedpods each. It will be interesting to see the difference in the seedlings. I am hoping to create new colours with these crosses in the second generation. Hopefully the neon-like colours and inside peach of the *mirabilis* will play a role.

Although the *C. mirabilis* seed looks similar to that of *C. miniata*, *C. caulescens* and *C. gardenii*, a long thin radicle grows and appears similar to that of *C. nobilis*. At the end of the radicle a tubular root is formed and later a small leaf. During the dry summer months the small plants become dormant and new leaves only appear after the winter rain. My guesstimate is that it can take up to 10 years for a *mirabilis* to flower in the wild.

The future of *C. mirabilis* in the wild looks bleak. Plants seldom produce offsets and from my observations I cannot see that small plants make it to adulthood. On many occasions I have seen plants uprooted or destroyed in the wild. Luckily the farmer has shown an interest in protecting this rare species on his property. He has built a shade house where he nurses damaged plants and where he grows young plants from seed.

Many enthusiasts now have *mirabilis* seedlings grown at Kirstenbosch from seeds collected from the population at Oorlogskloof. With others showing an interest in growing plants from seed that I have been able to distribute, collected from the other populations on private land, the future of *C. mirabilis* under domestication – in contrast to the plants in the wild - fortunately seems assured.



Above : *Clivia mirabilis* with notched leaves similar to *nobilis*

Left : Green tipped *mirabilis* flowers and a very dark peduncle

Photographs by Hein Grebe



# Clivia × nimbicola – a Stunning Beauty from the Bearded Man

J.T. Truter, Z.H. Swanevelder & T.N. Pearton, South Africa

The Amaryllid genus *Clivia*, an endemic to Southern Africa, consists of six described species. Many of the species and cultivars are extensively grown worldwide, making this group of considerable horticultural importance.

Man-made hybrids between the different *Clivia* species are currently enjoying great popularity in breeding programs, mainly because of the beautiful progeny they produce—though the first hybrids were made as early as 1856 (*C. nobilis* and *C. miniata*). Various references to putative natural hybrids between *C. miniata* and *C. nobilis*; *C. miniata* and *C. gardenii* and *C. miniata* and *C. caulescens*, have been recorded in literature in recent years. Rourke (2003) reported on a natural hybrid between *C. miniata* and *C. caulescens* from the Bearded Man Mountain (on the border between Mpumalanga, South Africa and Swaziland) and its subsequent collection and cultivation at Kirstenbosch Botanical Gardens, South Africa. Though these reports exist in literature, no scientific documentation, *i.e.* formal description of a nothotaxon existed till recently. A nothotaxon is a botanical term used to describe a naturally-occurring hybrid

The recognition of naturally occurring hybrids is often regarded as speculative and the existence of such taxa is usually based on circumstantial evidence. Therefore, scientific reports of putative nothotaxa are rare. The following are some criteria that have been suggested as standards to help facilitate the identification (Stewart and

Manning, 1982):

1. The possession of intermediate morphological features
2. Proximity to the putative parents
3. Hybrid fertility, with segregation recognisable in the F<sub>2</sub> progeny
4. Preferably supplemented by the artificial hybridisation of the putative parents

The first, formal description of such a natural hybrid, with the hybrid identity supported by the four criteria stipulated above, has recently been published in *Bothalia*. *Clivia* × *nimbicola* Swanevelder, Truter and van Wyk, is intermediate between *C. caulescens* and *C. miniata* with regards to rhizome, leaves, umbel and flower morphology (See Table 1, for an abridged comparative listing). Flower colour exhibits a range of tonalities, from pastel pinks through to pastel oranges and deep reds, some specimens showing pronounced green tepal apices. Flowering is somewhat erratic, and can occur at various times throughout the year, but mainly from July to December. Some clones even flower twice yearly, the second flush occurring from February to May. The extended flowering period of *C. × nimbicola* is regarded as further evidence in support of the taxon's hybrid origin; bearing in mind that *C. caulescens* flowers October—December and *C. miniata* October—November in this specific locality (Bearded Man Mountain). Furthermore, the hybrid plants carry fertile berries and produce seedlings that grow close to the parent plants, thus inferring the maintenance of the populations by subsequent breeding.

Field observations suggest some introgression (*i.e.* back-crossing) between *C. x nimbicola* and its putative parents. Where populations of *C. x nimbicola* occur close to or amongst *C. caulescens*, backcrossing of the hybrid with *C. caulescens* produces umbels with fewer flowers that are tubular, yet more open than typical *C. caulescens*. Conversely, where the hybrid occurs close to or amongst *C. miniata*, the umbels are less floriferous and the flowers are more funnel-shaped; yet not as open as typical *C. miniata*. It is suggested that from the inferred initial hybrid cross, subsequent generations have resulted from various backcrosses, resulting in a hybrid swarm. Records proving that artificial hybridisation between *C. miniata* and *C. caulescens* can successfully be done, date back to 1945 (*e.g.* 1945/66, R. Marais PRE 37106). Morphologically, the resultant hybrids closely match *C. x nimbicola* in the wild.



Forest-covered Bearded Man Mountain in the distance, the locality of *Clivia x nimbicola*

The holotype of *C. x nimbicola* was collected on the Bearded Man Mountain, near Barberton, South Africa. Located at an altitude of between 1100m and 1300m above sea level, Bearded Man Mountain receives approximately 1200mm of rain per year. In this locality, the new taxon is fairly common (an estimated 50 or more individual plants), occurring in sympatric stands (*i.e.* the

populations are intermingled) of *C. miniata* and *C. caulescens*. At least three separate, well-established populations of *C. x nimbicola* have been recorded for this locality, with stands extending into both South Africa and Swaziland. Judging by plant size and the height of aerial stems, original hybrids can be as old as their putative parents. Toppled plants with long aerial stems freely produce suckers when in contact with the soil. The natural distribution range of *C. x nimbicola* is confined to the Barberton Centre of Endemism (van Wyk & Smith, 2001), the only known region in which the distribution ranges of *C. caulescens* and *C. miniata* overlap (Swanevelde, 2003).



*Clivia caulescens* of the area



In this locality, *C. caulescens* prefer steep cliff faces or steep rocky embankments, while *C. miniata* generally prefer gentler scree embankments or flatter forest habitats. The *C x nimbicola* plants are distributed between and



amongst both parents, occupying both specific habitats found in the Afromontane Forest.

The epithet 'nimbicola' means 'dweller in the mist/cloud' and refers to the mist belt habitat in which this hybrid and its putative parents are found. The new nothospecies is intended to cover all hybrids between *C. miniata* (including all varieties) and *C. caulescens*.

and do not have the characteristic tip die-back of *C. miniata*. The plants sucker readily if exposed to bright light – a sucker can flower in its second year after emerging. Seeds collected from the habitat and those grown in cultivation are not all vigorous, with an equal split between vigorous, average and weak seedlings. The full strength of the best seedlings only becomes evident at the end of the second year of growth. Seedlings do not appear to be as susceptible to fungal attack as either of the parent plants.



A. *Clivia × nimbicola* 'Int1b'. This clone is shown next to a metrestick (10cm divisions) - note the firm leaves with rounded tips and lack of tip die-back, commonly found in both parent species.

B. *Clivia × nimbicola* 'Int1c'. This clone bears a symmetrical, flat-topped umbel – note green tips to tepals. A self-sterile, vigorous grower that sets seed poorly but flowers twice yearly.

C. *Clivia × nimbicola* 'Int5a'. This clone is an example from the Swaziland side – note the full rounded umbel with green tepal tips that fade fairly quickly. It is a larger specimen which flowers in April and sets copious seed.

#### Cultivation of *Clivia × nimbicola*

*Clivia × nimbicola* is typically a vigorous grower, enjoying the strong points of both the *C. miniata* and *C. caulescens* parents. It benefits also in that unlike *C. miniata* from the area, the leaves are very healthy and strong

*C. miniata* accepts *C. × nimbicola* pollen readily but the berries often contain only one or two seeds. Seedlings grown are not on average as strong as *C. × nimbicola* and have shown considerable variety in leaf form. The characteristics of *C. × nimbicola* are clearly evident in all cases.

TABLE 1: ABBREVIATED COMPARISON OF *Clivia* × *nimbicola* WITH ITS PUTATIVE PARENTS, AT THE BEARDED MAN MOUNTAIN, MPUMALANGA

Character	<i>Clivia caulescens</i>	<i>Clivia</i> × <i>nimbicola</i>	<i>Clivia miniata</i>
Aerial stem	Present in mature plants, length age dependent	Present in mature plants, length age dependent but shorter than in <i>C. caulescens</i>	Present in these populations when plants are mature, length age-dependent, usually shorter than in hybrid
Leaf length x width (in mm)	300–600 × 35–45	250–350 × 55–70	450–600 × 35–70
Leaf apex / margin	Obtuse–acute apex with rarely serrated margins	Acute apex that is usually entire, but with occasional serration	Acute apex with margins usually entire
Umbel	Usually compact but, flattened on one side	Loose/open form with ± flat-top	Loose form but almost globose
Flowers	14–40 in number, up to 50, Drooping in orientation, 30–45 mm long with a tubular and curved shape; inner segments slightly spreading	Usually 10–20, but up to 30, orientation ranging from semi-erect to drooping with flowers between 30 and 60 mm long; flowers are trumpet-shaped and curved, with segments open; funnel-shaped and mostly spreading	Only 7–10 in number with a maximum of 15 flowers in an erect orientation. The flowers are 60 to 80 mm long with open, funnel-shaped, ± straight, spreading perianth segments.
Seed	1–4 seeds that are ± 8–10 mm in diameter taking approximately 9 months to mature	1–4 seeds with a diameter of ± 10–15 mm, maturing in 9 months	1–4 seeds with a ± 12–15 mm diameter, taking up to 12 months to mature
Flowering time	October–December	Erratic, mainly July–December and/or February–May	October–November



Examples of the natural variation of *Clivia miniata* found on the Bearded Man Mountain. Colour and flower forms vary significantly

Photographs courtesy of the authors

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# Some Show Photographs



Garden Route Clivia Club: Best on Show - A variegated *Clivia miniata*

Runner-up to best on Show - An apricot *Clivia miniata*







Joburg Clivia Club: Best on Show

KwaZuluNatal Clivia Club: A 'Ndwedwe' gardenii from their Gardenii Show





Cape Clivia Club: Best on Show - Breeder John Winter

Cape Clivia Club: Runner-up to Best on Show - Grower Felicity Weedon



**NOTE: Errata — On page 50 of CLIVIA 7 the picture that appears as the runner-up on the Northern Club Show is incorrect as is the caption. The correct runner-up belonged to Gert Esterhuizen.**



# Genetic Aspects of *Clivia* Breeding

Johan Spies, South Africa

Plant breeding is often described as a combination of art and science. The scientific part involves the use of genetics to predict the outcome of certain crosses. In this paper we are going to take a quick trip through Mendelian inheritance and then focus on various deviations.

I believe every *Clivia* breeder, eagerly awaiting the first flower of a cross, has observed the polytepal picotee with the ideal colour combination. The second flower on the same inflorescence opens - and your breakthrough becomes just another ordinary orange flowered plant with the normal number of sepals! How can the same inflorescence bear a first stunning flower followed by rather ordinary flowers on the rest of the inflorescence? How can the flowers produced in the first year of flowering vary so much from flowers in subsequent years of flowering? Are the same genes not present in all the flowers? Many such deviations are known. Similar deviations include the formation of orange offspring from a self-fertilised Group 2 yellow; a colour deviation in the offshoot of a plant (yellow plant with an orange offshoot or vice versa); a green plant with a variegated offshoot (or vice versa). I think many *Clivia* lovers will be able to add their own stories to this list. Is this a breakdown of our knowledge of genetics, or are we dealing with a plant redefining the laws of nature?

In order to try to explain some of these phenomena, it is necessary to study certain genetic phenomena, especially deviations from the Mendelian laws, and to try to determine whether our deviation could be attributed to

any of these phenomena.

According to Mendelian inheritance, two factors (now called genes) are responsible for the appearance (phenotype) of a trait. The combination of these genes (genotype) determines whether an individual is breeding truly (homozygous) or not (heterozygous - split for a character). The true breeding stock may be subdivided into dominant (phenotype will be the same as for the non true-breeding group) or recessive. Most *Clivia* breeders are familiar with these concepts. Often, however, people try to over-simplify more complex genetic situations to Mendelian inheritance and in this process the true mode of inheritance is lost.

One of the first misconceptions is the word 'dominant'. In genetics dominant means that this is the character that will be expressed in the heterozygous condition. Many people think that it represents the form occurring most in nature, but that is not true. Some



Multitepal flower where all flowers in inflorescence have at least eight tepals. Breeder: Jurie Swart

dominant genes are very rare indeed. The best example may be in humans where the gene for achondroplastic dwarfism is dominant. However, the condition is rarely observed.

The source of variation in any organism is mutation. Mutations are changes occurring in the expression of a gene. Not all mutations are recessive. All variation we observe in *Clivia* originated as mutations at sometime in the past. If the mutation is recessive nothing will be visible in the mutant (the plant where the mutation originated) (Figure 1). Since the mutation is restricted to this original plant, self-fertilization is the only way in which the trait can be observed, and then only in a quarter of the offspring.

keep the frequency of mutations in mind, too many such deviations are found for them all to be attributed to somatic mutations.

Mutations do not only occur in genes. The largest part of the genome consists not of genes, but of portions of DNA often described as junk-DNA. These mutations are often used to do so-called DNA-fingerprinting to identify individual plants. To obtain the results below we used a fingerprinting technique called AFLPs (Amplified Fragment Length Polymorphisms). This technique is sensitive enough to distinguish between different plants and can even be used as parenthood tests for *Clivia*.

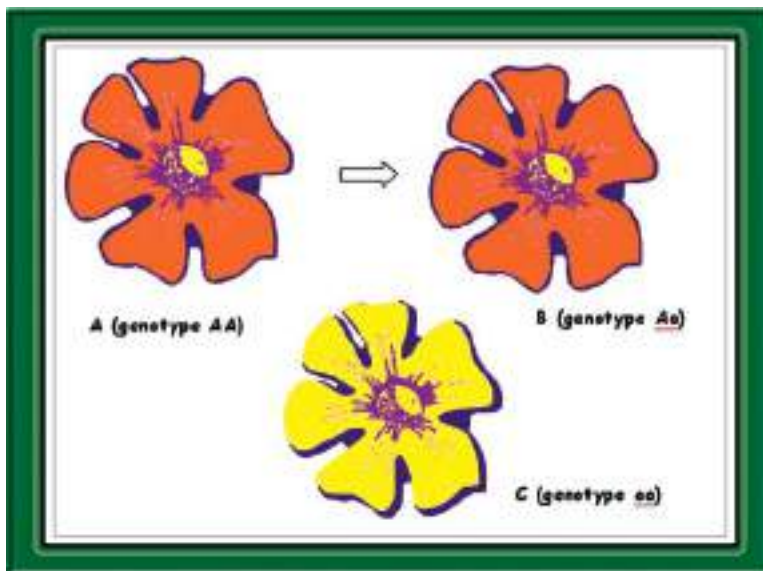


Figure 1. Schematic representation of a mutation. A gene (A: orange) in plant A mutates (arrow) to yellow (a). Since the mutation is recessive, it is not visible in the mutant (B). Self-pollination of the mutant will result in a quarter of the offspring showing the mutation (C). Please note that C is not the mutant plant but one of the progeny of mutant (B).

These mutations not only occur in reproductive cells, but also in somatic cells. This may be the reason why an offshoot may differ from the maternal plant. However, if we

Seventy two *Clivia* specimens, mainly yellow cultivars, were studied as part of Anthia Gagiano's M.Sc. project. This study clearly highlighted several aspects:

- The technique can be used to identify different plants; yet give the same fingerprint to proven clones.
- Parenthood can be determined if a large enough data base exists; i.e. if both parents are included in the data base.
- This study suggests that the mutation to yellow has occurred often: yellow, peach and other colour variants are merely colour mutations that do not reflect phylogenetic relationships.
- Relationships between different plants can be studied (Figure 2).
- Cultivar disputes can be settled; a major problem in the *Clivia* fraternity is the high number of “different clones” bearing the same name. I bought “Cynthia’s Best” / “Giddy’s Best” from at least four different sources; all four are clearly different plants although they carry the same name. The only way to solve this problem is to make it compulsory to include a DNA fingerprint with the registration of each cultivar. Unfortunately this will put a financial burden on each registrant of a cultivar. In the case of cultivars already registered the Clivia Society should be responsible for establishing the database.

Back to deviations from Mendelian inheritance - a factor complicating inheritance is ‘incomplete dominance’. This is where the heterozygous individual has an intermediate trait. The classical example of incomplete dominance occurs in foxgloves where a cross between a red- and a white-flowered plant results in pink-flowered offspring. Self-pollination of the pink will result in  $\frac{1}{4}$  red,  $\frac{1}{2}$  pink and  $\frac{1}{4}$  white in the  $F_2$  generation. This is

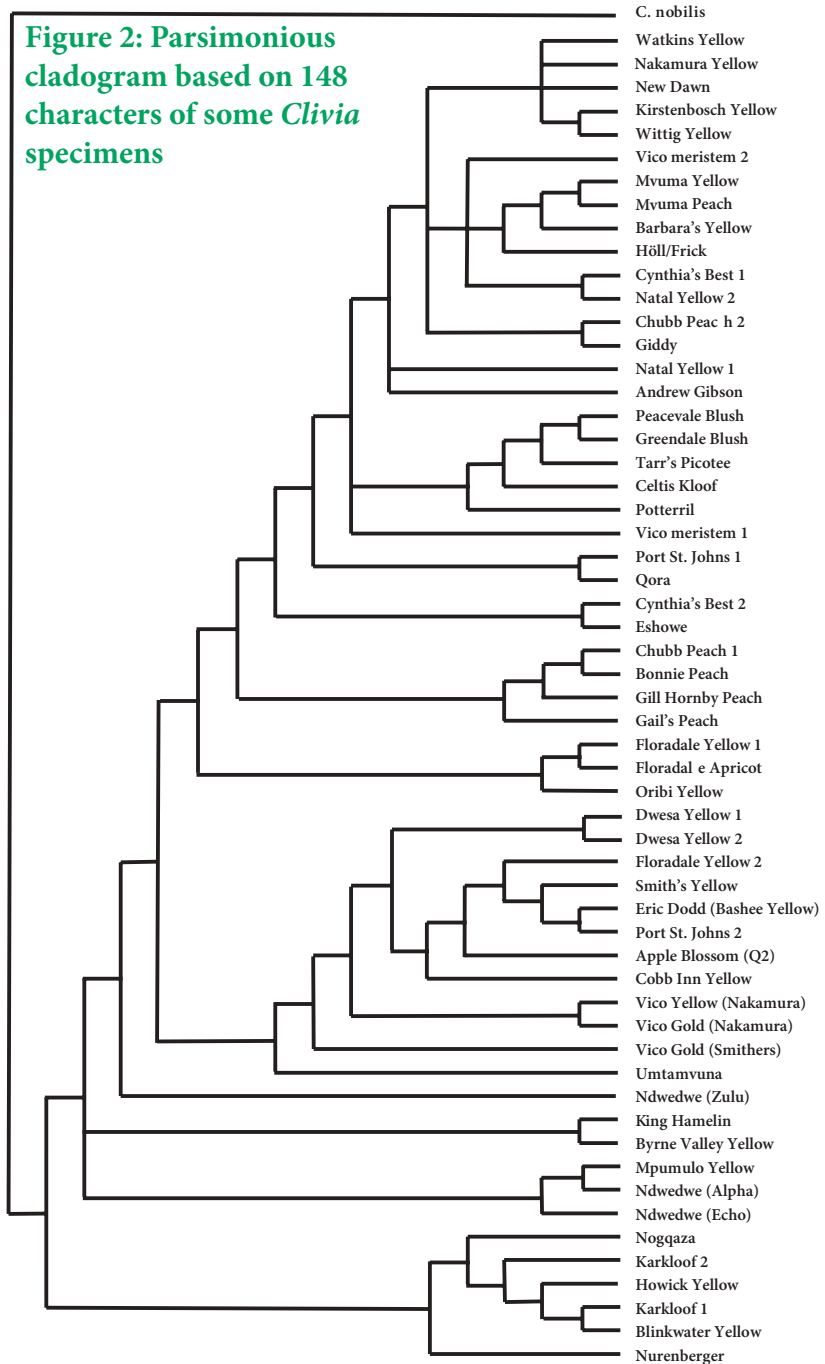
in contrast to ‘co-dominance’ where both genes are dominant and both are equally expressed. An example is blood groups in humans where A and B are equally dominant and result in the AB phenotype.

In addition to all these different types of genes an additional complexity exists: some genes occur in more than two different forms and are called alleles. Alleles often express varying degrees of dominance, for example in coat colour in certain animals, black will be the most dominant form, followed by brown and grey, with white usually being recessive.

Breeding is a “numbers game”. The more offspring produced, the better the chance of getting the “ultimate” plant. If you want to select for a recessive gene, statistically one in four offspring should have the trait. If you select for two recessive genes the figure drops to one in sixteen. This figure can be calculated by using  $1/4^n$ , where n = the number of genes. You really need lots of offspring to get the desired result.

People familiar with Mendelian genetics know that you get a 3:1 ratio if you cross two individuals heterozygous for one gene. If you use two genes the ratio becomes 9:3:3:1 (Table 1-3). Often one gene will influence the working of another gene. This process is known as epistasis. If one gene influences the effect of another gene, these genes will not produce the expected 9:3:3:1 ratio, but variations of this ratio, for example 15:1, 13:3, 12:4, 12:3:1, 9:7, 9:6:1 and 9:4:1. So if you get ratios deviating from the 3:1 ratio expect the presence of two epistatic genes effecting the same trait, rather than one gene with “maternal dominance” or different penetrance levels. Two epistatic genes contributing to the same trait may be confused with a single gene resulting in two

**Figure 2: Parsimonious cladogram based on 148 characters of some *Clivia* specimens**



morphological groups but the results will differ. Thus 94% of the offspring may have a specific trait (15:1) (Table 2), or 81% (13:3), 75% (12:4) or even 56% (9:7).

Table 1	AB	Ab	aB	ab
AB	AABB	AABb	AaBB	AaBb
Ab	AABb	AAbb	AaBb	Aabb
aB	AaBB	AaBb	aaBB	aaBb
ab	AaBb	Aabb	aaBb	aabb

Table 1. Normal 9:3:3:1 ratio observed with two independent genes segregating separately. An example may be when a group 1 and a group 2 yellow were crossed to produce an orange plant. Self-fertilisation of the orange will result in 9 orange (capital A & B present), 3 group 1 yellows (A is dominant and b recessive), 3 group 2 yellows (B is dominant and a recessive) and 1 plant that will be a group 1 & 2 yellow (a & b are recessive). If only colour is used as a criterion this will represent another case of epistasis with 9 orange to 7 yellow.

Table 2	AB	Ab	aB	ab
AB	AABB	AABb	AaBB	AaBb
Ab	AABb	AAbb	AaBb	Aabb
aB	AaBB	AaBb	aaBB	aaBb
ab	AaBb	Aabb	aaBb	aabb

Table 2. Epistatic effect of genes result in a 15:1 ratio where all individuals containing a dominant A and/or B have one phenotype and all without any dominant gene the other phenotype

What is the contribution of the pollen and ovary parents respectively to the genetic constitution of the offspring? The answer is quite easy: each one contributes 50%. Seasoned *Clivia* breeders may have experienced it differently.

Organelles (mitochondria and chloroplasts for example) contain a bit of DNA. The organelles are usually inherited only from the mother and some people reason that this

Table 3	AB	Ab	aB	ab
AB	AABB	AABb	AaBB	AaBb
Ab	AABb	AAbb	AaBb	Aabb
aB	AaBB	AaBb	aaBB	aaBb
ab	AaBb	Aabb	aaBb	aabb

Table 3. The colour of squashes is influenced by epistatic genes and all individuals carrying a dominant A will be white, those with only B being dominant will be yellow, whereas the double recessive will be green

additional contribution from the mother increases her contribution. The majority of genes in these organelles are involved with the functioning of the organelle. Therefore the number of genes influencing the morphology of the individual in these organelles is so low that it will form such a small fraction of one percent that it may be ignored in equating the respective contributions.

## 1. Cytoplasmic inheritance

Very few genes are inherited only through the cytoplasm. Quite often these genes are influenced by the genes in the nucleus. If we take variegation for example, it is obvious that the inheritance of variegation is much more complex than pure cytoplasmic inheritance. Although the major form of inheritance of variegation in *Clivia* is governed by chloroplast genes, it appear as if nuclear genes must be involved in the “turning the chloroplast variegation genes on and off” (variegation in offspring of green plants). This aspect needs further research.

## 2. Genomic imprinting:

A few cases are known where genes will respond differently in an organism depending on whether they are inherited from the father or the mother (*The explanation may be in the way that genes function. The genes are in the nucleus and a special form of messenger RNA (mRNA) is transcribed to transfer the genetic code from*



the nucleus to the cytoplasm where the gene should function. This mRNA is translated in the genetic code and, with the aid of ribosomes and certain enzymes, a protein is coded. It may be that the differences in cytoplasm may cause the different effects of the gene). This has a very rare occurrence in nature and very few examples are known. A possible case may be present in *Clivia*. In crossing a yellow and a peach *Clivia*, Mick Dower observed that the offspring in the reciprocal cross varied. With each cross the offspring had the same colour as the mother. However, the number of offspring were too low to determine whether this is really a case of genomic imprinting in *Clivia*.

### 3. Genotype-environment interaction:

It is a well-known fact the same gene may respond differently in different environments. Sometimes people don't take into account that environments differ with a reciprocal cross. Consider for example a cross between *C. miniata* with *C. nobilis*. One difference between the two species is the size of the seeds. If *C. miniata* is used as ovary parent you get a much larger seed than in the reciprocal cross. Although the two embryos contain the same genetic material, the environment for the seedlings will differ; the seedlings growing from the *C. miniata* mother will receive much more nutrition (larger endosperm), or may receive it for a longer time than the seedlings growing from the smaller *C. nobilis* seeds. To conclusively test the genetic contribution you must move on to the next generation to determine what the real genetic contribution was.

These phenomena may provide reasons why offshoots may differ from the parental plants. The genotypic effect on the cytoplasm may be completed at this stage and the cytoplasm will act differently than in the original parent. The genotype - environment interaction may also

be responsible for different phenotypic effects at different physiological stages of *Clivia*. Much more research is needed to get to the bottom of most of these phenomena.

Just when we think we understand genetics and apply it to our breeding programs, we hear about "leaky genes" that complicate the whole process. To understand what is happening we must look closer at the functioning of genes. Let us divide genes into structural and regulatory genes. Simply put, the structural genes code for the primary structure of the enzyme and the regulatory genes control the quantity of enzyme formed. Often other catalysts are needed for an enzyme to be formed. For example, in humans the genes coding for haemoglobin may be present and functioning. However, in the absence of iron molecules the complete haemoglobin molecule cannot be formed and the person will suffer from anaemia.

Instead of a leaky gene producing a bit of anthocyanin in group 2 yellows, a regulatory gene allowing the formation of a very low quantity of one of the enzymes responsible for the anthocyanin pathway, or even a regulatory gene stimulating the overproduction of anthocyanin repression, may be present. In a similar way the gene "dilute" should be studied. Is it really a gene that is "bleaching" normal colour or is it a regulatory gene influencing normal colour production?

One of the "rules" of inheritance described by Mendel was that genes segregate independently. However, genes may often be linked. This means that they are close together on one chromosome and are inherited together. Thus it is possible that a gene for narrow leaves is linked to the "group 1 yellow" gene and the result will be that group 1 yellows will usually have narrow leaves. The closer the distance between the two linked genes,



Red *C. miniata* and yellow Giddy. Both plants flowering for the first time

some of these genes allows them normal segregation and will not restrict the number of colour schemes too much.

Inherited traits can usually be divided into quantitative or qualitative traits. Qualitative traits are usually present or absent, or else present

the more frequently they will occur together. However, crossing-over between the genes may occur, and that will result in a wide-leaved yellow plant. The chance of the crossing-over is not predictable by Mendelian inheritance and extremely high numbers of offspring need to be obtained to get the desired result.

in a specific form. Such traits are usually governed by a single gene or allele. In contrast, quantitative traits are present in many different forms. These traits are usually associated with many different classes or even a continuum. These traits often include things such as leaf length and width, width of tepals, etc. and are caused by a number of genes: polygenic inheritance. With polygenic inheritance the effect of the genes is usually the result of the additive number of dominant genes present.

In a similar fashion, we must remember that not all genes on a chromosome are inherited as a unit. If the genes are further than 50cM

In certain animals so-called lethal genes have been described. If these genes occur in the homozygous condition the result will be the death of the individual. Does a gene like this exist in *Clivia*? Why are some *Clivia* plants self-sterile? Are they self-incompatible or are lethal genes present? Personally I think that we are just scratching the surface with our current research on *Clivia*. Let us apply our current knowledge to the inheritance of flower colour in *Clivia*.



A first flowering peach *C. miniata*

### Colour inheritance in *Clivia*.

apart, they will be inherited independently. The fact that almost all genes responsible for the anthocyanin pathway are carried on one chromosome in the majority of species, whereas the genes for the carotenoid pathway are on another chromosome, is not limiting to colour production. The distance between

The inheritance of flower colour in *Clivia* is a complicated subject. There is a whole series of biochemical changes needed to form one of the substances needed in the colour scheme, anthocyanin. Each step in the transformation from chalcone to pelargonidin needs a gene to control the process. Any gene failing along this pathway will cause all the subsequent genes to fail.

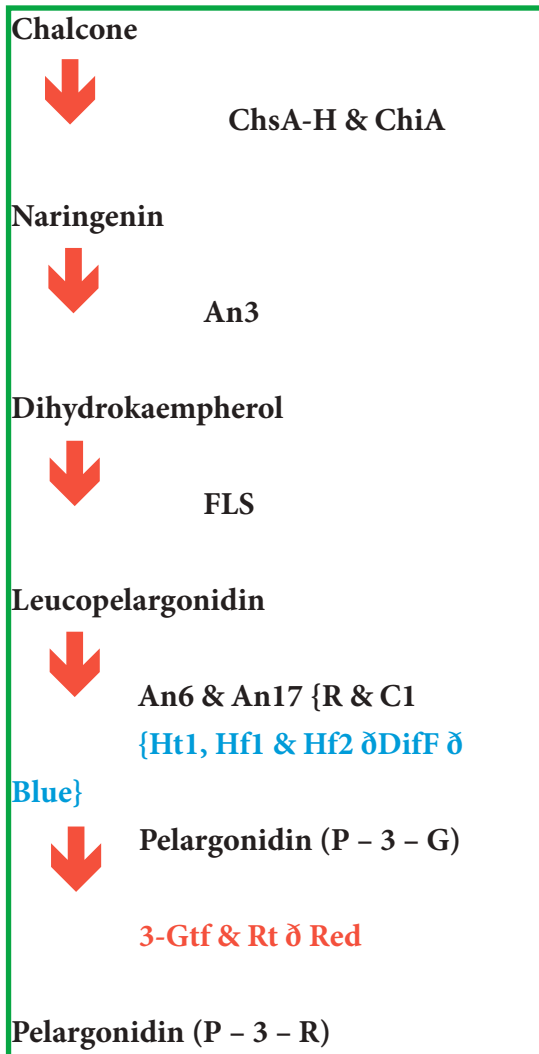


Figure 3. Schematic representation of the different enzymes and the putative genes responsible for their production in the anthocyanin pathway of *Clivia*.

Marius Snyman (a M.Sc. student in my laboratory) is currently studying the different putative genes involved in the anthocyanin pathway. We intend to study the DNA constitution of the different genes and compare them with similar genes in other

plants (especially petunia, maize and rice). Next, we will study the expression of these genes and the factors influencing their expression. Looking at this cascade of the genes, the genotype of an orange *Clivia* is not merely AABB, but may vary from ChsA ChsA ChiA ChiA An3 An3 An6 An6 An17 An17 3-Gtf 3-Gtf Rt Rt (R R C1 C1) to ChsA chsA ChiA chiA An3 an3 An6 an6 An17 an17 3-Gtf 3-gtf Rt rt (R r C1 c1). With all these genes it is quite possible to get (i) different alleles, (ii) linked genes, (iii) different forms of incomplete dominance and co-dominance, (iv) epistatic working of genes, (v) regulatory and structural genes, (vi) different genotypic-environmental interactions, (vii) polygenic inheritance, and (viii) possibly to get some phenomena yet unheard of. Only time will tell us, and the more research put into these studies, the sooner the results.

Irrespective, however, of the outcome of any research, you will still need a good gene pool to get the desired results; you will still have to use your own imagination to determine what combination of traits will result in the most beautiful plant; you will still have to be extremely lucky to get that showstopper!

Photographs in the above are courtesy of Johan Spiess



Photo: Gordon Frazer

# Pigment Surprise

## Keith Hammett, New Zealand

Western science seeks to provide an explanation of phenomena that occur in the world in which we live. In its purest form it works by making observations, postulating suggestions (hypotheses) that might explain the phenomena and then testing these hypotheses by critical experimentation.

An essential part of scientific research has been the notion that findings reported by one group of scientists would be tested independently by other scientists in other places. If the results were seen to be repeatable the hypothesis might become accepted as an explanation. In the nineteenth century scientists referred to these explanations as natural laws.

It is useful to think of a body of knowledge on any subject as a building constructed of bricks. If additions are made to that building, it will change shape. Equally our impression of that building will also differ depending on the viewpoint from which we view that building. By this I mean that scientists trained in one discipline will approach a subject somewhat differently to scientists from other disciplines.

Over time, we have come to realise that as more information on a subject is accumulated, especially as new technologies are developed, our understanding changes. We no longer talk in terms of natural laws or even theories, but refer to our current understanding of a subject as a paradigm.

This recognises that our understanding is likely to change as more information is acquired. As an example, for many centuries mankind thought of the world as being flat,

then, a few centuries ago, enough evidence accumulated for people to accept that it was a sphere. More recently we have come to view that sphere as not being solid, but as a molten ball on which the landmasses float and gradually move around.

Now, hopefully having established a context or perspective we can look at the question of flower colour in *Clivia* and the addition of a few very small pieces of information. Both Harold Koopowitz in his book *Clivias* (2002 Timber Press) and Rudo Lötter in a Power Point presentation have explained and illustrated very well the current paradigm of flower colouration in the genus *Clivia*.

In essence three separate pigment systems interact. These involve both pigment chemistry and the architectural juxtaposition of these pigments. Bear in mind that the current model is based on very limited research. Pigment analyses have been relatively few; little has been done with species other than *C. miniata*, while detailed anatomical/histological studies are even scarcer. Further, no detailed pigment analyses have been carried out in association with any genetic experiments.

Oil soluble carotenoid pigments provide yellow colouration. These pigments are contained in discrete plastids in each cell and tend to occur in deeper cell layers in the tepals (petals and sepals). In contrast, the red anthocyanin pigments are water-soluble, occur in cell vacuoles and are more conspicuous in the epidermal and adjacent surface cell layers.

The third pigment is chlorophyll which, in the leaves, is responsible for photosynthesis.



Nakamura bronze

This occurs to varying degrees in the flowers and is most easily seen in green-throated selections of *C. miniata* and on the tips of the tubes of some of the pendulous species. Like the carotenoid pigments, chlorophyll is contained in plastids, which are consequently known as chloroplasts. The presence of these has a modifying effect on the expression of the other two pigment systems and is most clearly seen in the bronze red flowers of *C. miniata*.

There are two major problems when discussing flower colouration. The first is that most people tend to think back to early childhood when paints were mixed and slopped around with gay abandon to produce interesting aesthetic creations, or perhaps more recently when tinting paints when decorating their homes.

Oil and water do not mix and, as we have discussed, the carotenoid pigments and chlorophyll are contained within the little balloons we call plastids within each cell. In addition if we look at a petal of any flower with a microscope we will find that cells immediately adjacent to each other can be completely different colours. The nature of colour in flowers is therefore particulate.

Now, I guess with the advent of computer and television screens of various types, digital photography and inkjet printers, many more people will be familiar with the concept of pixels or many minute dots being arranged in a way to produce an image. In reality this is not so new as for very many years it has been possible to see with even a low power magnifying glass that pictures in newspapers, whether black and white or colour have been made up of dots.

In the case of flower colour, the colour of individual cells represents pixels, but remember that these are not a single layer as in a newspaper picture, but are three dimensional with light passing through and being reflected from many layers of cells. This is why it is so difficult to match the solid colour of a colour chart with the colour of a flower petal.

The second problem is that Mendelian genetics as taught at many schools around the world gives the impression that major traits like flower colour are controlled by single genes, whereas this is a rare phenomenon. This is made worse in the case of *Clivia*, because in the early 1980s, Japanese scientists showed that yellow *C. miniata* resulted from one of the pairs of genes that contributes to the production of the red anthocyanin pigments having become inoperative. Orange *Clivia* owe their colour to the underlying yellow carotenoid pigments being viewed through the red filter of anthocyanins in the surface cells. When anthocyanin ceases to be produced, only the yellow carotenoid pigments can be seen.

Only in this instance, can yellow colour be thought of as being controlled by the function or malfunction of a single gene or gene pair. It is important not to think in terms of this malfunctioning gene as coding to produce



yellow pigment. Remember also that the concept of Group I and Group II yellows relies on the paradigm of different gene pairs having become inoperative.

### The project

In today's world, science has been remodeled on business lines and the ability to have work carried out depends on the availability of specific skills and equipment and the ability to pay to have the work carried out.

In New Zealand in 2004 we were lucky to have Dr Ken Markham, a scientist with a world reputation in flower pigment chemistry, who although essentially retired still had access to his laboratory. The New Zealand Clivia Club elected to fund a limited number of pigment analyses in the hope of adding some knowledge to our understanding of flower colour in *Clivia* and at the same time to check out existing hypotheses.

We posed a number of questions, namely:

- What is the relationship between red, orange and pastel (dilute orange) coloured blooms?
- What is the relationship between dilute orange and peach colouration?
- What is the relationship between dark yellow and palest cream?
- Can putative Type I and Type II yellows be distinguished on the basis of flower pigment analyses?
- Do pendulous species such as *C. nobilis* and *C. caulescens* have similar pigment profiles to *C. miniata*?
- If so can these parents be detected in interspecific hybrids?

In any research there are always constraints to be overcome. In an ideal world this whole topic would make a very good doctoral study and would take at least three years to accomplish. We needed to cut our coat according to the

cloth and the results presented here can be considered as nothing more than a quick look-see.

### The plants

The plant material used is listed in Tables 1 and 2 and is arranged to match the questions asked. Nakamura Crimson and Nakamura Bronze are selections from a seed mixture from Yoshikazu Nakamura in Japan. 8319/04 is a selection from a seed-line styled *Grandiflora* obtained from Germany. An accession of wild type *C. miniata* has been in New Zealand for over 100 years and this is listed as "Long standing NZ accession". 'Peach Melba' is a pastel selection made from an unspecified batch of seed from Nick Primich in South Africa. 'Tony's Pastel' is a very pale pastel bred and owned by Tony Barnes in New Zealand. It has resulted from making successive crosses between the palest pastels in each generation to yellows.



Nakamura crimson

I imported clonal material of 'Chubb Peach' and 'Natal Yellow' some years ago, through the good offices of James Abel, specifically to undertake work of this kind. 'Alick's Peach' is a selection made and owned by Alick McLeman from a cross between 'Chubb Peach' and a yellow.

Table 2

Species/hybrid	Selection	Colour Type	* Carotenoids		* Anthocyanins		Two Dimensional Paper chromatography ***					
			mg/g of live petal x1000.	mg/g of live petal	Anthocy-1 (P-monoglyc)	Anthocy-2 (P-diglyc)	Anthocy-3 (D-Monoglyc)	HC -1	HC -2	HC -3	Flavones/ols	
NOTES: * Carotenoids expressed as B-carotene equivalents in mg/g of live petal x1000. ** Anthocyanins expressed as pelargonidin-3-glucoside equivalents in mg/g of live petal *** P=pelargonidin-like; D=delphinidin-like; HC=hydroxycinnamic derivatives; + =relative level; p=present; w=weak; -=absent.												
<i>C. miniata</i>	Nakamura Crimson	Dark Red	8.2	1.61	+++	+++	++	p	—	—	—	
<i>C. miniata</i> x <i>C. nobilis</i> ?	Nakamura Bronze	Bronze	5.6	0.88	+++	+++	—	p	—	—	—	
<i>C. miniata</i> var. <i>Grandiflora</i> (sic)	8319/04	Orange	2.9	1.12	+++	++	—	p	—	—	—	
<i>C. miniata</i>	Long standing NZ accession	Pale Orange	3.2	0.35	+	+	w	p	p	—	—	
<i>C. miniata</i>	'Peach Melba'	Pastel	4.2	0.21	+	+	+	p	p	—	—	
<i>C. miniata</i>	Tony's Pastel	Pale Pastel	2.8	0.09	+	+	—	p	p	p	—	
<i>C. miniata</i>	'Chubb Peach'	Peach	4.8	0.07	w	—	—	p	p	—	—	
<i>C. miniata</i>	'Alick's Peach'	Peach	3.8	0.06	—	—	—	p	p	—	—	
<i>C. miniata</i>	'Bly' [Group I]	Deep Yellow	9.6	—	—	—	—	p	p	p	—	
<i>C. miniata</i>	8160/04 [Group I]	Pale Yellow	1.4	—	—	—	—	p	p	—	—	
<i>C. miniata</i>	'Natal Yellow' <sup>w</sup> [Group II]	Mid Yellow	7.2	—	—	—	—	p	p	p	—	
<i>C. nobilis</i>	<i>C. nobilis</i>	Pink	2.8	0.47	w	++	—	p	—	—	—	
<i>C. caulescens</i>	<i>C. caulescens</i>	Orange	1.4	0.09	w	—	—	p	—	—	—	
<i>C. caulescens</i> x <i>C. miniata</i>	864/04	Pale Orange	2.3	0.25	+	++	w	p	p	p	—	
<i>C. miniata</i> x <i>C. nobilis</i> ?	'Armani'	Orange	2.8	0.33	++	—	—	p	p	p	—	

Table 1

Species/hybrid	Selection	Colour Type	Petal Inside	Petal Outside	Sepal Inside	Sepal Outside
<i>C. miniata</i>	Nakamura Crimson	Dark Red	nr	30A	nr	46A
<i>C. miniata</i> x <i>C. nobilis</i> ?	Nakamura Bronze	Bronze	32A, 144C, 155D	34A, 33C, 155D	34B, 145C	34B
<i>C. miniata</i> var. <i>Grandiflora</i> (sic)	8319/04	Orange	30A, 11B, 11D	30B, 11C	30A	30A
<i>C. miniata</i>	Long standing NZ accession	Pale Orange	32B	32B	32B	32B
<i>C. miniata</i>	'Peach Melba'	Pastel	29A, 29C	29B	29A, 29C, 4B	29B
<i>C. miniata</i>	Tony's Pastel	Pale Pastel	29A, 29C, 11D	nr	nr	nr
<i>C. miniata</i>	'Chubb Peach'	Peach	20B, 24D	23C, 24D	20B, 24D	23C, 24D
<i>C. miniata</i>	'Alick's Peach'	Peach	25D, 23D	nr	25D, 23D	nr
<i>C. miniata</i>	'Bly' [Group I]	Deep Yellow	16A, 16D	16A, 16D	16A, 16D	16A, 16D
<i>C. miniata</i>	8160/04 [Group I]	Pale Yellow	11B, 11D	11B, 11D	11B, 11D	11B, 11D
<i>C. miniata</i>	'Natal Yellow' [Group II]	Mid Yellow	14C, 13D	14C, 13D	14C, 13D	14C, 13D
<i>C. nobilis</i>	<i>C. nobilis</i>	Pink	145A, 145C, 36B	144A, 145A, 35B	145C, 35C	144A, 145A, 145C, 35B
<i>C. caulescens</i>	<i>C. caulescens</i>	Orange	146B, 24D	146A, 33C	146B, 24D	146B, 33C
<i>C. caulescens</i> x <i>C. miniata</i>	864/04	Pale Orange	145A, 28C, 11D	33B, 33A	23C, 34C	34B
<i>C. miniata</i> x <i>C. nobilis</i> ?	'Armani'	Orange	29B, 154B	34A, 11D	34A, 154B	34A



'Chubb Peach'

'Bly' is a selection made from a mixed population of plants raised by Peggy Pike here in New Zealand from seed obtained from Jim Holmes in South Africa and other sources with origins outside South Africa. 8160/04 is derived from a cross between pale cream selections from Australia and Japan.



Broad leaf yellow (Bly), grown by Peggy Pike out of mixed seed from Jim Holmes and others

The accession of *C. nobilis* was obtained as a clone from Yoshikazu Nakamura in Japan. It is a pink flowered form. *C. caulescens* came from an accession imported into New Zealand about 25 years ago as seed, directly from South Africa. The *C. caulescens* x *C. miniata* hybrid 864/04 resulted from a cross between that same accession of *C. caulescens* and a pale yellow *C. miniata* derived from the Australian cultivar 'Walter's Yellow'.



A *C. caulescens* x *C. miniata* interspecific

'Armani' came from a population raised from seed sent to me by Nakamura. It was described as "Hybrid Mix" x *C. nobilis*. The presumption is that it is an F1 *C. miniata* x *C. nobilis* hybrid.

### The process

Tepals were removed from fully opened mature, but fresh flowers at a comparable stage of development. It was important to standardise samples, as the colour of tepals is known to change as they age.

There are very few if any *Clivia* where pigment is uniformly distributed across an individual tepal. In most there is an unpigmented area at the base of each tepal that gives each flower throat colour. In a longer-term study it would be desirable to cut out each area of pigmentation and carry out analyses of these individually. Here, as a compromise,

ideograms or simple diagrams were sketched to record colour distribution of each sample. This involved distinguishing between petals and sepals and both inner and outer surfaces of both.

Recordings were made using the Cape Clivia Club chart (CCC) and the Royal Horticultural Society (RHS) colour fan 1966 edition. In many cases the range of colours on the CCC chart was inadequate to make a recording. The colour references are given in Table 1; the ideograms are not presented here.

For the chemical analyses, tepals were organised into samples of comparable weight. Fresh samples were ground and pigments extracted in appropriate solvents. Carotenoid levels were estimated by absorption spectroscopy. Anthocyanin levels were estimated by absorption spectroscopy, and two-dimensional paper chromatography. The chromatograms were examined in visible and ultra-violet light. This latter technique also enabled the tentative identification of anthocyanin types and hydroxycinnamic derivatives. Presence or absence of chlorophyll was not determined and neither was the pH of each sample.

### The results

Results are presented in Table 2. The carotenoid level is presented as an indication of the concentration of all carotenoid pigments in each sample. The overall level of anthocyanins is similarly shown. These data were obtained from absorption spectroscopy. As anthocyanin profiles were similar for all samples, the anthocyanin spectra are not presented here. An indication of specific anthocyanin types as deduced from two-dimensional paper chromatography is given under this heading. The number of pluses gives an indication

of the relative levels of colour derived from these. Similarly, the presence or absence of hydroxycinnamic derivatives, which while colourless in visible light, may influence the expression of the colour produced by anthocyanins is indicated. It is interesting to note that while the flowers of plants in some families owe their yellow colouring to water-soluble flavonoid pigments, these are absent from *Clivia*.

The first six samples represent a progression from the darkest red we had available to the palest dilute available. With the exception of Nakamura Bronze, there is a steady reduction in the level of anthocyanin pigments from the darkest to the palest. At the same time carotenoid pigments are seen to diminish, although in not as orderly a manner as the anthocyanins. The apparent bronze colour of Nakamura Bronze is almost certainly attributable to the presence of chlorophyll; this selection has a distinct green throat.

As might have been expected, the higher the level of pigments that a flower has the darker it will be. Clearly traditional plant breeding strategies of crossing the darkest with the darkest and palest with the palest are most likely to lead to a widening of the colour range within *C. miniata*. The appearance of delphinidin-like anthocyanins in 'Nakamura Crimson' is also encouraging, as the presence of delphinidin, given an appropriate cell pH, leads to a bluer colouration.

Comparison of the analyses of 'Chubb Peach' and 'Alick's Peach' with Tony's Pastel suggests that there is no fundamental difference between what we call a pastel/dilute orange and what we call a peach. It seems simply a matter of reducing the anthocyanin levels to a point where they are still present, but have



Chart 2

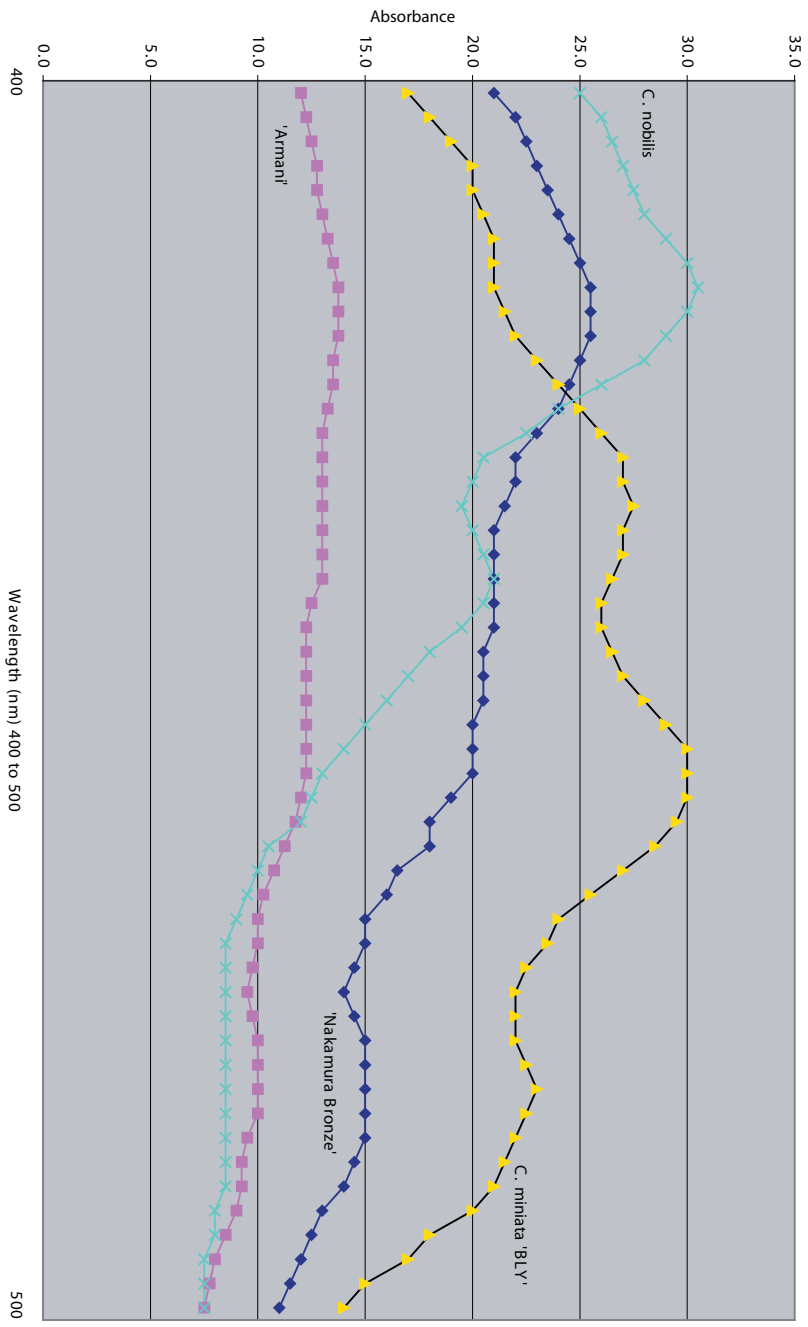
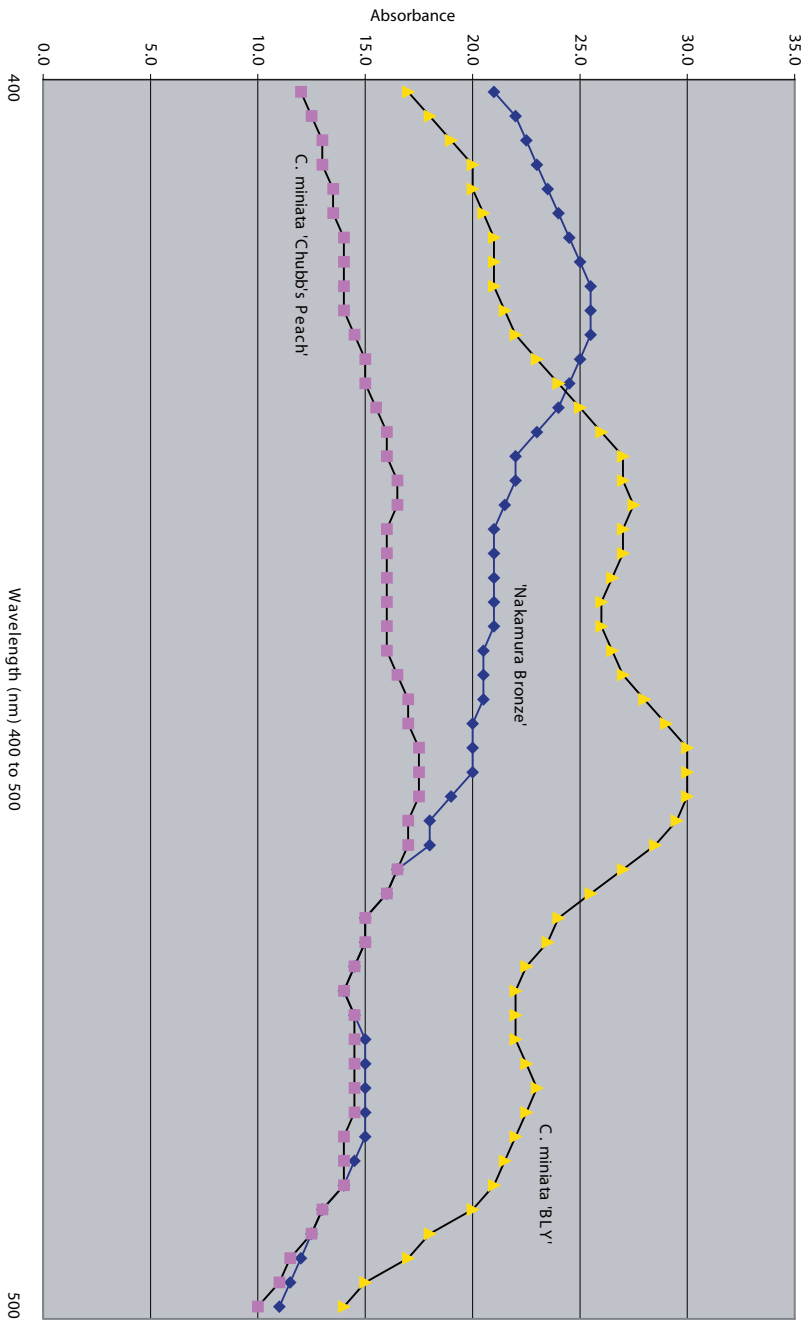


Chart 1



become so low that they can be barely seen on a paper chromatogram. The interaction of this very low-level anthocyanin component with the underlying carotenoid pigment clearly influences our perception of flower colour. ‘Chubb’s Peach’, which has a higher carotenoid reading, appears darker than ‘Alick’s Peach’, while ‘Tony’s Pastel’, which has a very low level of carotenoid pigment, looks cold compared to the peaches.



‘Alick’s Peach’ shown with ‘Chubb Peach’

As already noted, ‘Tony’s Pastel’ has been produced by successively crossing the palest pastels in successive generations with yellows, while the peaches have reportedly arisen by mutation. It would be interesting to see what eventuated if Tony’s Pastel were to be crossed with ‘Bly’ (carotenoid level 9.6) in comparison with crossing it with 8160/04 (carotenoid level 1.4). It would also be interesting to undertake an analysis of the American Peaches that Victor Murillo has produced.

When we look at the three yellow *C. miniata* samples, we can see that the hypothesis of anthocyanin pigment being absent from yellows is confirmed and, not surprisingly, the darkest yellow sample ‘Bly’ has a much higher level of carotenoid pigments than does the palest 8160/04. From the data here, we cannot distinguish between the two putative Type I yellows and the putative Type II yellow ‘Natal Yellow’. As the colour in both types is due to the

absence of anthocyanin pigments, we need to look for analyses that could determine at which point in the biosynthetic chain, which leads to production of the anthocyanins, that the process is interrupted. Without such analyses the nature of differences between Group I and Group II yellows remains speculative.

The two pendulous species analysed, namely *C. nobilis* and *C. caulescens*, show levels of anthocyanins that fall within the range seen in the *C. miniata* samples as do the two inter-specific hybrids.

If we now turn our attention to the absorption spectra for the carotenoids, we see that they cover the range of wavelengths 210 – 500 nm. There are well-defined peaks at 216 nm, 234 nm and 286 nm in the range 210 – 350 nm for all samples. The highest peak is at 234 nm and reaches between 90 and 100 absorption units for all samples. It is in the range of 400 – 500 nm where the results become interesting. Chart 1 gives the spectral trace for *C. miniata* ‘Bly’, the cultivar with the highest carotenoid reading and *C. miniata* ‘Chubb’s Peach’ with about half the level of carotenoid. It can be seen that the profiles are comparable but with that of ‘Chubb’s Peach’ being lower and less pronounced. The same pattern was recorded for all *C. miniata* samples. In Chart 2, the spectral traces for *C. miniata* ‘Bly’ and Nakamura Bronze are repeated and are joined by the trace for *C. nobilis* and ‘Armani’, the putative *C. miniata* x *C. nobilis* hybrid.

Nakamura Bronze had always been assumed to be a *C. miniata* cultivar. It has broadish leaves and has tulip shaped flowers with a green throat. It can be seen to have a carotenoid profile quite distinct from the *C. miniata* profiles and has a peak at 417 nm, which indicates the presence of a different mix of carotenoids in this cultivar.

*C. nobilis* also has a peak at 417nm, as does 'Armani', albeit at a lower amplitude. These data suggest that Nakamura Bronze has a *C. miniata* x *C. nobilis* ancestry. It is tempting to speculate that *C. x cyrnanthiflora* (*C. miniata* x *C. nobilis*) might be an ancestor, while also wondering if the tulip shape of flower found in many Belgian hybrids might be owed to some *C. nobilis* ancestry. It would be interesting to determine the karyotype (chromosome architecture) of Nakamura Bronze and 'Armani'.



The Interspecific 'Armani'

There is some indication that the carotenoid profile of *C. caulescens* is distinguishable from both those of *C. nobilis* and *C. miniata*, but as levels were low in the sample analysed, this needs to be further investigated by more extensive and detailed analyses.

As indicated earlier, this set of analyses is nothing more than a range finder for a desirable longer term, more intensive study. However, it is exciting to find strong evidence to suggest that *C. nobilis* has contributed pigment elements to at least part of the *C. miniata* complex in cultivation today.

## The future

In any future work it will be important that the individual carotenoid pigments in *C. nobilis*, *C. miniata* and *C. caulescens* be identified. It would be good if *C. gardenii*, *C. robusta* and *C. mirabilis* could be included in future studies, especially with so much inter-specific hybridization currently being undertaken.

Equally, determination of chlorophyll levels, cellular pH readings and the determination of pigments from specific regions of tepals are desirable; while histological studies covering a wide range of accessions are needed to verify our current paradigm of pigment location.

It is essential that we gain a good understanding of the mechanisms that lead to flower colour in *Clivia*, before we can consider breeding strategies or start to probe questions of colour inheritance. Even this very small study illustrates the complexity of several interacting systems that lead to colour expression in *Clivia* flowers. If nothing else, it does serve to underline the naiveté of trying to explain *Clivia* flower colour in terms of simplistic genetic models garnered from school textbooks.

Photographs courtesy of Keith Hammett



Four differently pigmented flower heads

# The Photographic



Above: Winner Single Flower  
*Clivia miniata* 'Burned Orange'  
Photographer, Gordon Frazer



Left: Winner Interspecific Section  
'Day Dream'  
Photographer, Helen Marriott  
Breeder: Yoshikasu Nakamura  
Grower: Laurens Rijke

Right: Winner Pendulous Section  
*Clivia gardenii*  
Photographer: Helen Marriott  
Grower: Laurens Rijke, Australia



# Competition Winners



Above: Winner *Clivia miniata* Section  
A bronze *Clivia miniata* with a green throat  
Photographer and Breeder: Harry Erasmus, Australia



Right: Winner Best Photograph (see Frontispiece)  
*Clivia miniata* 'de Villers Peach' variegated x  
Nakamura 'Pinstripe Yellow'  
Photographer and Breeder: Mick Dower, South Africa



# A Practical Approach to Colour Breeding in *Clivia miniata* Sean Chubb, South Africa

I can truly say that I am inspired by the diversity of colour. The perpetuation of uncommon colours has played a huge role in the type of *Clivia* which I have and still produce. I have been fortunate enough to acquire genetic material suitable for breeding that has not only appealed to me but also seems to be regarded as beautiful by many other *Clivia* enthusiasts. This demand from other *Clivia* enthusiasts has motivated me to create the diverse range of *Clivia* supplied by my modest nursery today. Not everybody is a *Clivia* breeder and in the *Clivia* fraternity there are breeders, marketers, show- people, collectors, enthusiastic gardeners, administrators and many others. All come together and form a family, all with a common love of *Clivia*. All contribute to the advancement of the genus *Clivia*.

I have done extensive work on the breeding of *Clivia miniata* colour variations but the approach I have taken could be used on all the pendulous species as well. The breeding of

interspecific hybrids would require a slightly altered approach since the genetic background of individual plants would vary considerably.

*Clivia miniata* are variable in many respects and colour is no exception. The recognition of these variations is vital in the breeding of new varieties. People ask me how I go about creating a new colour. Well, my answer is always that the colour was already created and that all I do is to intensify it and to perpetuate it.

In any breeding programme one needs to be organized and plants need to be grouped into similar plant groups. Remember that the *Clivia* colour we perceive is a combination of many colours and patterns of colours. You may have noticed that plants that we classify as red generally have a very small colour patch in the throat thus giving the impression of the whole being more intense red. Plants classified as pastels usually have a much larger throat colour patch. Thus the distribution of colour in the flower plays a very big role in the general appearance of the flower. Colour and the colour pattern thus should be considered together when grouping plants into breeding groups.

To initiate any breeding programme, a small group of very similar plants should be chosen. Always at the outset of a breeding programme take into consideration that it will take ten years or more to eventually see some fruits



A line bred F3 Peach

of your work. By 'fruits' I mean: to have a breeding group which consistently produces the desirable colour trait for which it was bred. Be sure the 'colour trait' plants you select to work with are desirable and different enough to warrant many years of work to perpetuate their superior characteristics. It would be really fruitless to work on a breeding programme for ten years or longer, only to find that you have not made much progress towards achieving your goal.

The initial breeding group can be as small as one or two plants. The more varied the genetic material is in the initial group the more difficult it will be to reach the goal of perpetuating the desirable colour trait. The general rule is: 'Breed like with like'. In choosing the plants for the breeding programme of 'Breed like with like', all aspects of the flower colour should be taken into consideration. For example, flower colour changes with maturity of the umbel. A perfect example of this is Naude Peach, which opens rich yellow and matures to peach. This colour change on maturing, or 'peaching up', is one trait which I have exploited in the breeding of my pastel blush series. Plants in this series become more pink-peach as they mature.



The contrast between the green throat and the pinky peach blush on the tepals makes an attractive flower

Potential plants in flower should thus always be compared at the same stage of maturity of the umbel. Even go so far as to match together the colour of any existing fruit of the plants before matching them together for flower colour. Since the fruit has been on the plant for almost a year it has had time for any differences in colour to become apparent. Spotting or colour changes very different to flower colour should be noted. Once the plant or plants have been selected they should be selfed and bred together. At this stage properly controlled breeding is vital.

Since there is no such thing as a perfect plant, your selected plant will have deficiencies. One must recognize these and run a breeding programme to try to minimize their impact on your results. The best way to do this is find a plant that is preferably one from a pure breeding line, without recessive colour genes. This plant should have all the qualities lacking in your colour mutation plant. The practice which I use is to find a true-breeding orange plant with desirable traits to complement the weak areas of the selected 'colour trait' plant. Let us say that this orange must have broad leaves, high flower count, good umbel shape, and be very vigorous. Vigour is extremely important, as loss of vigour is one of the biggest problems in line breeding. This select plant will also be pollinated with the desirable colour plant and seedlings split for the colour will be produced. The orange plant would only be used as a *pod bearing plant* as it is my experience that by using it in this way the potential for better offspring is higher than if it is used as a pollen parent. It seems as though the maternal plant contributes more to the phenotypic appearance of the offspring than does the pollen parent.

Record keeping is vital. I keep dual records, that is, on the plant itself in the form of a label or two, and I also document the crosses in my

written records. As *Clivia* are very generous with seed set when crossed one must be careful not to use too many plants in this initial stage as this will lead to huge quantities of plants in future generations. The fewer the plants selected for the initial cross-pollination, the less genetic material present and the quicker the progress. *Clivia* are adapted to out-crossing, so don't expect a high seed set on selfed plants.

Don't expect results in the first generation. Most colour mutations take at least two generations to appear in the offspring, but on the other hand *colour patterns* can be fixed more easily in the first generation in 'Breed like with like' crosses.

Say you started with two original 'colour trait' parents and an orange.

Now, in the next (F<sub>1</sub>) generation, have the following five different groups of seedlings:

- Two groups of selfed seedlings from both 'colour trait' parents,
- One group of 'like with like' seedlings from the crosses between the two 'colour trait' plants (Two groups if you do reciprocal crosses, but this is not essential),
- Two groups of seedlings from the crosses between each of the 'colour trait' parents and the orange plant, using the latter as the mother-plant.

The seedlings from these initial crosses should each be clearly marked, identifying both mother plant and pollen parent. Remember, this marking system will have to last at least 5 years - with no room for errors!

At flowering these first generation seedlings should be very strictly selected, and only the very best from each cross should be retained for breeding the next (F<sub>2</sub>) generation:

- The seedlings from selfed and 'like with like' crossings should be selected mainly for

colour, with less emphasis on other traits.

- The split orange seedlings should be selected for as many traits as possible. Bear in mind that they will eventually – as I show below - help produce your best colour mutation plants. These selected plants should have all the other qualities you have in mind that you would eventually like to be displayed in the colour mutation plants that you are aiming towards.
- These selected split oranges should now be bred with the best seedlings of the 'breed like with like' crosses and should also be crossed with their immediate siblings.
- Both these crosses should produce a percentage of seedlings with the desirable colour mutation in the next generation.
- The best seedlings of 'breed like with like' should also be bred together.

So now, in this the F<sub>2</sub> generation, you can select from the following seedlings:

- Plants from the 'like with like' crosses displaying the desirable colour trait.
- Plants displaying the desirable colour in the crosses involving the orange split line.

All plants not displaying the desirable colour should now be discarded unless a particular plant displays exceptional qualities.

A useful tool I use in my breeding programme is a system of star ratings. Each seedling flowered in the breeding programme is rated. Taking 5\* as the best of the seedlings, try to give the top 5\* rating to one or two seedlings only, and 4\* to a plant good enough to breed from. Plants with lower star ratings should be discarded. Remember that plants improve with successive flowerings and only reach their full potential after four or five flowerings. This said, the best seedling should also prove to be the best mature plant so be careful when star rating your seedlings.

Having thus set aside all plants not true to colour, one can now breed the best of the remaining F<sub>2</sub> colour trait plants together. The next (F<sub>3</sub>) generation will all display the colour trait bred for. Sibling crosses made amongst the 'like to like' line as well as amongst the orange split line should be made, as should crosses between the lines. The greater the selection pressure in this generation the more rapidly your colour trait line will improve. Discard as many plants as possible, retaining only the very best for breeding.

One should try now to produce the perfect plant in the desired colour with as many of the following traits as possible:

- Vigour, (reflected in number of umbels, offsetting ability and rapid growth),
- Balance,
- Umbel shape,
- High flower count,
- Individual flower shape,
- Leaf quality,
- Disease resistance,
- Possibly also leaf variegation.

Having now produced a stable breeding population for a colour trait the evaluation process should not stop. Because of the diverse nature of *Clivia* one will still be able to split this true breeding line even further by selecting for say green throats, multitepals and even variegation. More breeding lines can then be set up in the colour trait population and bred further.

Never lose your initial material from your F<sub>1</sub> and F<sub>2</sub> generations as you may have to breed back to them to fix problems arising from inbreeding, such as loss of vigour or the appearance of other undesirable traits such as albinism.

As I have tried to show here, it is not a quick and easy process and a lot of discipline – including ruthless selection- is necessary to eventually reach one's goals. Once a true breeding line has been accomplished this is only the start of an ongoing selection process. Look at how the Yellows have improved over the last ten years with increased selection pressure. As a breeder I am always on the lookout for new and interesting colour forms in *Clivia*. Even the most insignificant *Clivia* with a colour variation may open doors to new and interesting colours.



Line breeding can produce both highly satisfying and pleasing results such as this pinky peach bloom

Photographs by Sean Chubb



# Ploidy Research in *Clivia* — an Update

Aart van Voorst, Netherlands

## Summary

After treating seeds of *Clivia in vitro* and *in vivo* with colchicine, cytochimerical and tetraploid plants were obtained. Offsets of these plants were tested for ploidy level. Triploid *miniata* hybrids were grown to maturity and flowered. Triploid and a tetraploid interspecific hybrid were bred using embryo culture.

## Material and methods

In two previous articles methods for converting diploid *Clivia* material into tetraploid were described. The first article (CLIVIA 5) showed that it is possible to get tetraploid and cytochimerical plants by *in vitro* treatment of mature embryos of *Clivia miniata* with colchicine. The second article (CLIVIA 6) described a method that made it possible for the amateur breeder to get tetraploid plants without the need of a laboratory.

As previously reported, the first colchicine treatment by me took place in 1995. The resulting polyploid plants were used in different crossings after the first one flowered in 2000. The first crosses were between the polyploid material and orange and yellow diploid *miniata* hybrids. The aim of these crosses was to get triploid material and to examine if normal seed-forming was possible in the case of diploid-tetraploid crosses in *Clivia*.

A real advantage for *Clivia* breeding is to be expected when polyploidy is introduced in interspecific hybrids. Combining the genomes of all the *Clivia* species on a polyploid level could lead to new forms and colors. So, to broaden the tetraploid gene pool crosses were made on a diploid level between several of *C. miniata* yellow hybrids, *C. miniata* as well as

*C. caulescens*, *C. gardenii*, *C. nobilis* and between *C. miniata* and the interspecific crosses *C. x cyrtanthiflora* and a Lötter F2 [(*C. miniata* x *C. gardenii*) x (*C. nobilis* x *C. miniata*)]. Both methods of colchicine application were used on the resulting seeds, and to compare these methods in a number of crosses the two methods were used simultaneously.

In addition, seeds of the species *C. caulescens*, *C. gardenii*, *C. robusta* and *C. robusta* 'Maxima' were used in the project. To investigate what effect polyploidy has on variegation, material from *C. miniata* crosses with a variegated mother was included in the programme. On a limited basis germinated seeds of Chinese origin (LOB, variegated, daruma) were also treated with colchicine. Flow cytometer analyses were conducted on offsets of the tetraploid and chimeric plants from the first colchicine treatment in 1995 to test if these offsets were of the same ploidy level as the original plant.

## Results

### Colchicine treatments

When a colchicine treatment is performed on germinating seeds or embryos, data about the ploidy level can be obtained either by checking the DNA-content, counting the chromosome number, or measuring the stomata or the pollen size (see CLIVIA 5). The last method requires flowering plants, but this can mean waiting for five years or more. Flow cytometry analysis of the DNA content of the cells is the best method to get fast results. The negative aspect of this method is the relative high cost. Counting the chromosome number in root tips needs a plant that has been growing for some time

and has made new roots from that part of the plant that has grown from the colchicine treated meristem. In the Layman's Method the



Fig 1. Germinating seeds treated with colchicine using the Layman's method. Material from different crosses on various coloured clay blocks with the stem meristem covered with colchicine wetted tissue paper and the root not in direct contact with colchicine.

original root is not directly in contact with the colchicine (see Figure 1.) and may grow on as a diploid root even though the stem meristem has converted into a tetraploid state. I have as yet not had much experience with measuring stomata size, and chimerical tissue may cause problems.

A small selection was made of all the colchicine treated material for flow cytometer analysis (Tables 1 and 2). Different crosses of related material showed various responses to the colchicine treatment and there also seem to be differences between species. No polyploid material was found in either the *C. caulescens* material (61 seeds treated) or the *C. robusta* material (22 seeds treated). As shown, *C. robusta* 'Maxima' on the other hand gave two tetraploid plants.

Results from the comparison of the two methods of colchicine application (*in vivo* and *in vitro*) are not yet available, due to the aforementioned high costs of the flow cytometer analysis. An advantage of the *in vitro* method is the higher survival rate of the treated material.

Cross	Mother x Father	Treated Germinated Seeds	Resulting Plants				Total
			Dead	2X	Chimeric	4X	
		Total					
03010	YJK02 x YBW	28	20	8	0	0	8
03012	YJK02 x YPG	39	26	10	3	0	13
Sub-total		67	46	18	3	0	21
% of Treated Seeds			69	27	4	0	
03018	YJK01 x YPG	44	14	23	6	1	30
03019	YJK01 x YBW	43	14	24	3	2	29
Sub-total		87	28	47	9	3	59
% of Treated Seeds			32	55	10	3	
Total		154	74	65	12	3	80
% of Treated Seeds			48	42	8	2	52

Table 1. Results: colchicine treatment using several yellow *C. miniata* crosses. YJK Yellow Jaap Keijzer; YBW Yellow Bing Wiese; YPG Yellow Pat Gore

Type	Treated germinated seeds	Resulting plants			
	Total	2X	Chimeric	4X	Total
<i>C. robusta</i> 'Maxima'	16	12	0	2	14
% of treated seeds		75	0	13	

Table 2. Results: colchicine treatment *C. robusta* 'Maxima'

*In vitro* material has more chance to recuperate after the colchicine treatment, being in perfectly conditioned surroundings with good nutrition, although in the Layman's Method the still-attached seed also gives enough food for the germinating seedling.

#### Offsets from polyploid plants

Most plants from the first colchicine treatment in 1995 have formed one or more offsets. These offsets have been tested for ploidy level. Results show the ploidy level of the mother plants as well as diploid and tetraploid plants (see Table 3.)

#### Seed from diploid x tetraploid crosses

In many plant species, when diploids are crossed with tetraploids, triploid hybrids occur only in very small numbers or not at all. Endosperm failure is the most important reason that seeds don't develop normally and germination does not take place or leads to an early death of the germinating seed. Removing the embryo from the seed under sterile conditions and placing it on an artificial growing medium *in vitro* can save the embryo (Embryo Culture). Especially at the start of my polyploidy research all the material from diploid x tetraploid crosses

Plant number	Type T = Tetraploid C = Chimeric	Offsets		
		Diploid 2X	Chimeric 2X<X<4X	Tetraploid 4X
94007	T			1
94009	C		1	2
94010	C	1	1	
94012	C	1		
94013	C	1	1	1
94015	C		1	
94020	C		1	
94021	C	2		
94022	C			1
94025	C	2	1	
94026	C	1	1	
94035	C		1	
Total		8	8	5

Table 3. Ploidy level of offsets of colchicine treated material (flow cytometer analysis)

was subject to embryo culture. I did not want to risk losing material because of endosperm failure. Between seven and ten months after pollination the berries of such crosses were surface-sterilised, the seeds were removed and, under sterile conditions, were checked for embryos. Many different stages of development were found for the embryos, also depending on the cross. In some crosses many normal embryos were found, in others only a few or none.

Some seeds however did look normal and the question arose whether such seeds would show normal germination *in vivo*. Figure 4 shows the result of a 2X (diploid) x 4X (tetraploid) *C. miniata* cross. The seeds were left for natural

maturation on the plant. Most seeds are not fully developed, but some are indeed looking normal. In Figure 5 some of the normal seeds are shown after chipping and rehydration. Number one has a normal embryo but will not germinate due to its' deteriorated endosperm. The embryo could have been saved by embryo culture. Number two looks normal and will germinate the natural way. Number three shows a very big embryo in a small seed: normal germination is doubted, but not impossible.

### Flowering of triploid plant

The first triploid flowering took place 4 years after pollination. It is a cross between one of the polyploids as a father and a diploid from the same cross. This plant as well as all the

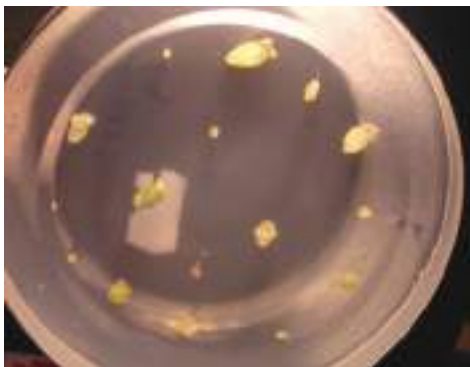


Figure 2. Different sized embryos from a diploid x tetraploid cross

Figure 3. Normally developing embryo from a diploid x tetraploid cross seen through a culture vessel *in vitro*



Figure 4. Seeds from cross 04003: diploid *C. miniata* x tetraploid *C. miniata*

Figure 5. Geminating seeds from cross 04003 *in vivo* after chipping and rehydration



triploids examined till now, proved to be male sterile. Between the tissues of the shriveled anther some good 2n pollen was found, but there was too little to pollinate with, and it was caught between the anther tissue (see Fig 6).



Figure 6. Triploid 00002-01. Flower, anthers and coloured 2n pollen with anther tissue

This plant proved to be limited female fertile. One embryo was saved by means of embryo culture after pollinating this triploid with a yellow Vico Gold cross. The resulting plantlet is growing very slowly and the ploidy level has not yet been determined.



Figure 7. YJK01



Figure 8. 94001-20

In 2001 a cross was made between a Jaap Keijzer Yellow as a mother and 94001-20. Although normal berry development was observed, embryo culture was used after nine and a half months to assure the survival of polyploid embryos. All the plants that reached maturity (18 in total)

proved to be triploid. The triploids came from both groups, normal and abnormal embryos (see table 4). Note that of the 38 normal *seeds*, 14 have proved to have abnormal *embryos*.

The first two plants flowered in 2005, three years after embryo culture. All thirteen plants that have flowered up to now are male sterile. Figure 9 shows different triploids from cross 01011 and figure 10 on the next page shows details of plant 01011-15.

Several crosses were made to get triploid interspecific hybrids. Polyploids were used as father as well as mother. Several triploid interspecifics have been successfully grown from embryos with the aid of embryo culture. There are combinations between *C. miniata* and *C. caulescens*, *C. miniata* and *C. gardenii* and a combination between *C. miniata* and *C. x cyrtanthiflora*. All these have been flow cytometer analysed and have the triploid DNA quantity. The flow cytometer analyses also revealed a pleasant surprise. One of the plants from the *C. caulescens* x tetraploid *C. miniata* cross turned out to be tetraploid. Probably an unreduced gamete of *C. caulescens* fused with a gamete from the tetraploid *C. miniata*. The material of other colchicine treatments as mentioned above in the section headed “Material and methods” is growing in the greenhouse, but results cannot be given yet. In most of the material slow growing plants with thick leaves are present, which is an indication for polyploidy. Colchicine however also can cause mutations, so thick leaves alone are no proof.





Figure 9. Selection of triploids from cross 01011

flowered. The tetraploid and triploid *miniata* hybrids are looking good, but don't stand out yet compared with top quality diploid plants. To get superior polyploid *C. miniata* hybrids the gene pool of polyploid material needs to be widened. Other *Clivia* enthusiasts are using material from different sources to contribute to this goal, but the best way to get more different polyploid material is an increased activity on polyploidisation. At this moment it is good to notice that several people are working in this field and this gives hope for the future.

Cross number	Mother	Father	# Berries	# Seeds	# normal seeds with embryo	# abnormal embryos
01011	YJK01	94001-20	7	48	38	14

Table 4. Results from cross 01011



Figure 10. Plant 01011-15

## Discussion

### Colchicine treatments

Ploidy research in *Clivia* is an exciting hobby, but it takes many years to get results. Ten years after the initial colchicine treatment the first triploid

Most of the seeds that I took with me from South Africa after the *Clivia* Conference in 2002 were small samples of special crosses. I used them in my polyploidisation program, but an individual seed has only a small chance of turning into a polyploid. So only a few plants will be polyploid. Table 1 also shows another aspect that complicates polyploidisation: the two yellow mothers come from the same (genetic) background, but there seem to be differences in reaction between the different crosses. Although a reasonable number of seeds were treated, because of the number of seeds that died after the treatment, not more than an indication can be seen. The treatment of the *C. robusta* 'Maxima' also gives a different result.

What is most important however is that the Layman's Method as described in CLIVIA 6 can produce polyploid material.

### Offsets from polyploid plants

Colchicine treatment can result in partly polyploid plants. If only a part of the plant has a higher ploidy level, it is possible that the plant can fall back to the original chromosome number and turns diploid again. When partly polyploid plants (cytochimeras) are stable in most cases only one layer of the plant tissue has turned tetraploid. As with most flowering plants (angiosperms), a *Clivia* plant is built from three layers that cover each other like a glove. These layers can be genetically different. The outer layer L1 forms the epidermis of the plant and is only one cell layer thick. The L2 is also likely a single cell layer and forms the next layer and nearly all eggs and pollen are formed from it. The L3, the inner layer, is several cell layers thick. So if a plant becomes a cytochimera, with L2 tetraploid, it will breed like a normal tetraploid. If only L1 gets tetraploid it will breed like a normal diploid.

Offsets of cytochimerical plants can have a different ploidy level compared to the mother plant. The result shown in Table 3 is a good example of this phenomenon. For breeding purposes, working with complete tetraploid plants is preferable, as there is always the danger that a cytochimeric plant can revert to a diploid form. On the other hand, cytochimeric plants may grow faster than complete tetraploids and so be available sooner for further breeding.

### Seed from diploid x tetraploid crosses

Although minimal laboratory equipment is required, embryo culture may be too complicated for the amateur breeder to perform. In order to use the potency of polyploidy fully it should be possible to raise triploids from seeds. This has indeed been proven.

**In *Clivia* triploids can be raised from seed.**

### Flowering of triploid plants

Triploids are an exciting breeding possibility, when tetraploid material has been obtained. Tetraploidy can sometimes be too high a level of ploidy because of reduced growing speed or flower count. The flowerings of the crosses for triploids, that I made as soon as the first tetraploids flowered, are eagerly anticipated. The first triploid crosses were between *miniata* material and the results are promising (see Figures 6 - 10). Triploids are by no means always better than diploids. The same rules that apply for diploid crosses are valid for triploid crosses. The chance that all the desired genes come together in one plant is small, so selection in the progeny is also necessary in triploid material.

There are some characteristics that may directly profit by a higher ploidy level. Polyploidy results in thicker leaf and flower tissue, and may cause a more intense flower colour; this can be especially interesting in breeding e.g. yellow or red. Also, characteristics like leaf width and flower size are positively influenced by polyploidy. To get extremely big flowers or very broadleaf material, the best diploid material for these characteristics should have been used in my colchicine treatments. Such material was not available to me, and my interest in breeding polyploids now focuses primarily on polyploid interspecifics. Triploidy in *C. miniata* x *C. caulescens* (mxc), *C. miniata* x *C. gardenii* (mxg) and *C. miniata* x *C. X cyrtanthiflora* (mxcyrt) was identified in the Northern spring of 2006. First flowering is expected in 2007. A pleasant surprise was that one of these supposed triploid plants has since been identified as a tetraploid. This tetraploid is most probably a combination of an unreduced gamete of *C. caulescens* with tetraploid *miniata*. This can speed up polyploid interspecific breeding by a couple of years;

because the material from the colchicine treated interspecific seeds will not flower for about four years. The tetraploid mxc will also probably be more fertile than the colchicine tetraploids.

Triploid plants are in most cases highly sterile because of the uneven number of genomes in the cell. In forming the gametes - which contain one genome in normal diploid plants, big problems may arise in triploid plants. For example, the triploid *Clivia* that have flowered so far have all shown shriveled anthers with no free pollen (see Figures 6, 9 & 10). Figure 6 shows a microscope picture of a few very big pollen grains that were still enclosed in the anther tissue. So these plants cannot be used as pollen parents in breeding. The first triploid that flowered was pollinated with pollen from a diploid *C. miniata*, and one berry developed. The seed did not develop normally and the embryo had to be saved by means of embryo culture. So there is limited fertility on the mother side in triploid *Clivia*. With this

limited fertility it might still be possible to get aneuploid *Clivia* material, i.e., plants with one or more extra chromosomes. This aneuploid material might show special characteristics, if only a limited numbers of genes are present in polyploid number.

### Conclusions

Polyploid breeding in *Clivia* is successful and future developments can contribute to the diversity in *Clivia* hybrids. It is possible for the amateur breeder to get tetraploid material using the Layman's Method and triploid *Clivia* material can be grown from seeds.

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**Photographs in the above article are courtesy of Aart van Voorst**



Photo: Claude Felbert

Ian Brown's Multitepal

# The Visual Allure

Photo: Johan Schoombee



Photo: Claude Felbert



Photo: Z. Kruger



Above: A Charl Malan Interspecific

Above Left: The Horns of a Dilemma!  
Successful first aid from Johan Schoombee

Left: Good enough to eat?

Below: An Interspecific at a post Show  
display in the Cape. Peach with streaks of  
white



Photo: Claude Felbert



# of the Unusual



Photo: Ian Coates

'Hot Lips' a striking picture that can have no other name



Photo: Claude Felbert

A tightly packed *Clivia nobilis* seed-head

Seeds from a multitepal bursting forth and growing from within still green fruit. The exposed seed showing green chlorophyll from the light.



Photo: Chris Du Plessis



# Variation in Clivia

Ben J. M. Zonneveld, Netherlands.

## Introduction

### General

Variagated plants make up a substantial part of the plants in commerce. As foliage plants, they usually arouse more interest than the plain green ones, irrespective of the cause of variegation. A plant is called variegated if it shows different colours in a single leaf. The cause of variegation, however, is important to be able to choose the proper way of propagation. A large body of literature on this subject has arisen (Winkler, 1907; Tilney-Basset, 1963; Steward *et al.*, 1979; Hirose & Yokoi, 1998, 2000; Houtman, 2004). In this introduction, the number of germ layers, chloroplast colour and yellow leaf colour are discussed. After different types of variegation are treated, an explanation of true or chimeral variegation is presented and the term *sport* or *bud variant* is defined. Variegated flowers, irrespective of the cause, are not treated here.

### Some facts about genetics of *Clivia*

Like all organisms, plants are built up from cells. In each cell there is a nucleus. The nucleus contains DNA built from long series of the four bases A (adenine), T (thiamine), C (cytosine), and G (guanine), forming a double helix. These long helices are divided in smaller packets named chromosomes. *Clivia* has  $2n=2x=22$  chromosomes in all species. Despite this, the total amount of nuclear DNA varies from 31.2 picograms in *Clivia mirabilis* to 39.2 pg in *C. miniata* (Zonneveld, 2005). The chromosomes contain the genes, short stretches of on average 1000-2000 bases. There are about 25000 genes, comprising less than 1 % of the total DNA in a *Clivia*. The rest, 99 %, is mainly non-coding DNA. The genes code for all the characteristics that make up a certain plant.

### Apical organization

In the shoot apex there is an apical dome or meristem consisting of three cell layers as elucidated by Satina *et al.* (1940) in *Datura*. These layers, noted as L1, L2, and L3 starting from the outside, cover each other like a glove in the whole plant. The L1, usually a single cell layer, gives rise to the epidermis. A second single cell layer below the epidermis, the L2, gives rise to all egg cells and pollen. The L3 forms the remainder of the plant and is the only layer present in the roots. Therefore a truly variegated plant cannot be grown from root cuttings as these contain only one layer. Another way of looking at this is to consider the L1 + L2 to form the tunica, with a third cell layer forming the corpus. The tunica divides mainly sideways in the apical dome, whereas the corpus cells divide in all directions and form the bulk of the plant. The same meristem organization can be found in the lateral buds. Only when a mutation (a change in the genetic material) takes place in the meristem can a variegated plant arise. Moreover, only when the mutation affects *all* cells of one of the layers in the meristem, will a stable periclinal chimera result.

### The relationship between nuclear and chloroplast mutations.

The green colour in plants is determined by the colour of the chloroplasts, small particles responsible for converting carbon dioxide to sugars. This green colour can vary with the species, growth circumstances, and the specific combination of chloroplasts with the nuclear genes. Chloroplasts and mitochondria contain their own circular pieces of DNA, a remnant of the time they were free living organisms. During evolution most of the genes of the chloroplasts migrated to the nucleus. From the

1000 or so genes involved with functioning of the chloroplasts, around 900 are now coded for by nuclear genes, and only about 100 by genes still on the chloroplast DNA itself. In a diploid plant, during formation of egg cells and pollen the amount of nuclear DNA is halved, with each pollen or egg containing a single chromosome set (haploid). After the fusion of pollen and egg cells during fertilization the original chromosome number is restored resulting in a diploid organism with two chromosome sets. Therefore, in a diploid organism, each nuclear gene is present twice, one from the seed parent and one from the pollen parent.

This is not true for cytoplasmic inheritance as exemplified by chloroplasts. Firstly, there can be a large number of chloroplasts in a cell, from a few to a few thousand. In an average *Hosta* cell I observed about 10-30 chloroplasts. A fraction of these is found back in the egg cell, but not in the pollen. In most plants chloroplasts can only be inherited from the seed-bearing plant, but in about 10 % of the species the pollen parent also contributes chloroplasts (Corriveau & Coleman,

1988). The products of the chloroplast genes are mainly involved in their own protein synthesis and photosynthesis. Moreover, each chloroplast contains 100-200 copies of its genome with each a size of about 150 kb (1 kilobase = 1000 bases, A, T, G or C). Compare this with the average nuclear genome size (2C) of *Clivia miniata* of 38 million kb (Zonneveld, 2005). By the way, this is about 6-7 times more DNA than is found in a human nucleus!

## TYPES OF VARIEGATION

### 1. Natural variegation

Some plants show natural leaf variegation. In these cases (nearly) all plants of a certain species show it. They can be grown 100 % true to type from seed. They are not considered as truly variegated. Examples are the yellow spots in *Dracaena surculosa*, the whitish spots on *Pulmonaria* or the dark leaf rings in *Pelargonium*. In natural variegation all cells of the plant have the same genotype. That is why they can be grown as such from seed. The different colours on a leaf seen in natural variegation are the result of differential gene expression. Differential gene

expression means that a gene is only active in certain tissues or leaf parts. For example, flower pigments are only found in the flower and not in the leaves; a wax layer is found on the leaf but not on the roots etc.

### 2. Environmental variegation

Several environmental factors may result in more or less variegated plants. Shortage of some (trace) elements may result in a yellow margin in *Buxus*. Some plants show different



Photo: Hein Grebe

Longitudinal variegated plants stand out amongst 'Light of Buddha' plants

leaf colours due to spraying or due to a toxic compound in the soil or induced by insect damage. This is of course not true variegation but depends on the environmental condition. Transplanting or removing the culprit otherwise may solve the “problem”. Another type of variegation, often a streaked or spotted pattern, can be due to a virus. Often plants with virus are stunted, but sometimes the effect is pleasing as in *Aucuba japonica*. All these are, in the biological sense, external influences and don't result in a truly variegated plant.

### 3. Temperature or light dependent variegation

A special case of environmental variegation is found in plants that only show deviant leaf colours during part of the season, or depending on light conditions. This is often shown in new growth. Roger Dixon mentions five types (in this yearbook):

1. Light of Buddha starts yellow in spring and can green up later but will stay yellow with the proper light conditions.
2. Moonlight type starts green and becomes irreversible whitish green.
3. Akebono starts green and develops whitish bands, and
4. Longitudinal
5. Negishi starts as whitish seedlings but leaf colour later develops into yellowish green. It also is striped, as it was developed from longitudinally variegated plants..

It can be speculated that all these cases are determined by temperature and/or light sensitive genes. They have in common that the edges between the colours are not distinct but gradually merge into each other. According to Comstock (Koopowitz, 2002), Akebono is inherited as a cytoplasmic character and this might be true for the other types mentioned here too.

Occasionally, in crosses between species, unstable situations arise when the part of the nuclear DNA, derived from the pollen parent, must cooperate with the maternal chloroplast genes of the other species. This hybrid situation could also be more sensitive to environmental stresses like heat and light. This might give rise to permanent unstable situations, resulting in yellow coloured patches, or whole yellow leaves. If the seedlings are not discarded at the start or die anyway, reshuffling of the DNA might lead to a more green and vital plant. The possible wandering around of some *C. nobilis* genes in the Belgian *Clivia* might be responsible for the occasionally variegated plants arising from green parents.

### 4. Yellow colour in leaves

Yellow leaves are not really variegated, having a uniform colour, but yellow is mostly present in all true variegated or chimeral plants. Wholly yellow, properly growing plants are often encountered in conifers, and also in trees like *Ulmus* or *Sambucus* or perennials like *Hosta*, *Sedum* and *Aubrieta*. A mutation producing a yellow plant has usually a nuclear encoded, heterozygous mutation that is dominant for the yellow colour, but recessive for its lethal character. ‘Dominant yellow’ means that if one



Akebono variegation

Photo: Helen Marriot

of the two homologous genes is mutated to yellow the leaf will be yellow. 'Recessive lethal' means that, if only one of a gene pair is mutated, the lethality of the mutation is not expressed and it is perfectly viable. However if both genes are mutated to yellow, this is lethal for a plant, unless it is present in a chimera. In these heterozygous yellow plants, all cells have the same genetic constitution and will give rise to 50-60% yellow seedlings. I am a bit surprised that so far no well-growing pure yellow-leaved *Clivia* seems to have been found among the many *Clivia* grown each year from seed. Or were they tossed away as not likely to survive anyway? On 22<sup>nd</sup> January 2006 Ian Coates of England showed on the internet a picture of a surviving "albino" that seems to have yellow leaves and grows well. Is this the long-awaited yellow leaved *Clivia*? According to the investigations of Vaughn *et al.* (1978) yellow *Hostas* have a defect in the p700 protein complex. The p700 mutation results in a different structure for the chloroplast i.e. a lowered granula stacking and dilated thylakoid membranes. These chloroplasts are still functional and result in a yellow-leaved, properly growing plant.

The yellow leaf colour can also be due to a mutation in chloroplast DNA (cytoplasmic or maternally inherited yellow). It seems only to be found in a chimeral situation. Streaked *Clivia*, as many streaked species, don't give good growing yellow seedlings or sports. In these cases, yellow shoots are the final stage of plants that started as streaked and do not have a nuclear but a cytoplasmic origin. They have in *Hosta*, and likely in *Clivia*, a different type of mutated chloroplast with magnograna that make the chloroplast non-functional (Vaughn *et al.*, 1978)

### 5. True or chimeral variegation.

All truly variegated plants are chimeras i.e. they contain genetically different cell layers. Chimeras or genetic mosaics can arise when a cell in the apical meristem undergoes a mutation. In the next step, this mutated cell divides and then results in the end in a partly or wholly genetically different cell layer. Genetic mosaics are only visible if the mutation affects the leaf colour or any other visible trait. The first result is often a so-called streaked plant as found in *Clivia*. Such a streaked plant can be very stable as such, despite variation, as seen in *Clivia*. Plants that have barely visible stripes are probably mericlinal chimeras where only part of a single layer is affected. Plants with clearly visible stripes are likely sectorial chimeras where parts of all three layers are affected. These part chimeras in turn can lead to the much more stable periclinal chimeras, where all cells of a single layer are genetically different from the rest of the plant. We have then a green plant with a yellowish edge.



Photo: Helen Marriott

Interspecifics can also show variegation

The reversed type has a yellowish green centre, since the yellow L<sub>3</sub> is here covered by a green L<sub>1</sub> (and L<sub>2</sub>). These streaked plants are nearly always due to a cytoplasmic or maternally inherited mutation, that is to say, a mutation in the DNA of the chloroplast. *Clivia* grower Jaap Keizer from Ter Aar, in the Netherlands, told me that despite selection for plain green for years, a few seedlings from every 1000 seeds are streaked. I can think of several ways in which these streaked plants can arise from green parents.

1. The gene responsible for defective chloroplasts mutates easily or is unstable.
2. The gene has a variable penetrance that is to say it does not always show itself. In this case the plant may seem plain green but the variegation may reappear later.
3. There may be an imbalance between some still lingering *C. nobilis* (nuclear) genes and *C. miniata* (cytoplasmic) genes in the Belgian *Clivia*, resulting in the occasionally variegated plants arising from green parents.
4. Cases have been described in *Zea mays* and *Oenothera* where a nuclear gene causes mutations in the chloroplast DNA. These then in turn can be transmitted maternally, independent of the nuclear mutation. These are called plastome mutator genes and it can't be excluded that they are present in *Clivia*.

Chimeras, even periclinal chimeras, are nearly always unstable to a certain extent and often show green or yellow shoots, as often seen in streaked *Clivia*. The resulting deviating shoots are called sports or bud variants and are rarely mutations (see below). Seeds from streaked *Clivia* give mainly green but also streaked or yellow/white seedlings, depending on the genotype of the L<sub>2</sub>. The fact that all three types can be found shows that the L<sub>2</sub> is not uniform and that chance dictates whether the cell forming an egg has green, yellow / white or both types of chloroplasts.



Photo: Hein Grebe

Striking pale and dark green with yellow variegation

## EXPLANATION OF TRUE VARIEGATION

### 1. Leaf colour in monocotyls

Variegation is very common in cultured monocotyledons like *Hosta*, *Agave*, *Sanseveria* and *Clivia*, especially so as they are selected for that character! Monocotyledons are plants that germinate from seed with a single seed lobe or cotyledon that serves to extract its food from the endosperm. They differ further from dicotyledons due to the fact that the L<sub>1</sub> forms not only the epidermis but also a significant part of the margin of the leaf. Moreover, the L<sub>1</sub> or epidermis has chloroplasts in all cells. The result is that in plants like *Sanseveria trifasciata* 'Laurentii' or *Clivia* the yellow margin of the leaf is formed by the L<sub>1</sub>. The L<sub>2</sub> from which the gametes arise, forms only a single layer in the leaf and is rarely visible as such.

### 2. The relationship between the terms 'sport' and 'mutation'

The terms 'sport' and 'mutation' are often used as if they interchangeable. The advantage of using the term 'sport' is that no underlying cause for the observed variegation is suggested. This is contrary to the term 'mutation', which should be confined to changes in DNA.

- A mutation is a heritable change in the DNA of an organism.
- A sport is a shoot deviating from the mother plant, irrespective of the cause.



**A sport can be due to several different causes:**

- Chimeral rearrangements or displacement, i.e. displacement of cells from one to another layer. This will result for example in a whole yellow plant from a yellow edged plant. A chimeral rearrangement can only take place when the plant is already a chimera and a plant can only be a chimera if an earlier mutation has taken place!
- Mitotic, or somatic recombination, i.e. an exchange of parts of chromosomes (Marcotrigiano,1997). Genes that are present only once, like the gene for yellow leaves in *Hosta* (heterozygous) can become homozygous or present twice in one of the layers or, alternatively, can be lost. A green margin will then appear in an originally heterozygous yellow plant.
- A mutation, i.e. a change in the DNA. It is a rare process, taking place with a frequency for a single gene of about 1 in 100,000. Mutations can also be divided into nuclear mutations that inherit via both parents, and cytoplasmic mutations in the DNA of chloroplast or mitochondria that can, with few exceptions, only be transmitted via the mother (seed parent). If a leaf changes from green to yellow, it can be caused indirectly by a nuclear mutation or directly by a mutation in the chloroplast DNA. So the fact that the chloroplast is in the cytoplasm does not mean that a change in its colour always means a cytoplasmic inheritance. Such a mutation can arise 'spontaneously'; which actually means that the cause is unknown, or induced, say by the use of mutagenic chemicals or radiation. Contrary to what is thought, mutations reverting to the original form are nearly as rare as the frequency of the original or forward mutations. A wholly green branch from a plant with a yellow edge is usually not due

to a back mutation but due to a chimeral rearrangement. A wholly green branch from a yellow plant is not back mutated either (or rarely so) but is the result of the much more frequent somatic crossing-over or somatic recombination.

- Loss or gain of whole chromosomes or sets of chromosomes. It occasionally happens that something goes wrong with partition of the chromosomes to the daughter cells. A single chromosome might end up in the wrong cell, leading to aneuploidy and often low fertility. Occasionally all chromosomes go to a single cell. This leads to a doubling of the chromosomes in a single cell. If this cell gives rise to a whole layer with a double number of chromosomes, one gets a so-called ploidy chimera. Several of these have been found in *Hosta* (Zonneveld & van Iren, 2000) and *Sanseveria*. Aart van Voorst, of Hillegom in the Netherlands, has induced several tetraploids in *Clivia* with colchicine.



Photo: Hein Grebe

Fruit colouration sometimes follows leaf variegation

### 3. How to discriminate between different types of variegation

Leaves can have different patterns of variegation. If we confine ourselves to yellow mutations we can find the yellow colour as yellow margin, yellow centre, yellow spots, yellow streaks, yellow veins, yellow leaf tips, yellow leaf bases or wholly yellow leaves. If we take yellow spots as an example, these can be due to a virus as in *Aucuba*, due to a mutation as in *Aspidistra* or be a natural variegation as in *Dracaena surculosa*. Only experiments, especially crossings, can make out what we have.

Environmentally induced variegation can usually be traced by transplanting a green and the 'variegated' plant to identical circumstances, in which case the variegation will disappear. Of course one has first to exclude the possibility that the variegation might be due to a virus. This is most easily done by grafting a green scion onto a variegated stock. If the stock has virus, it will be transmitted to the green scion. Natural and true/chimeral variegation can be differentiated since the latter often gives rise to yellow or green branches. To differentiate between natural and periclinal variegation seedlings can be raised. Natural variegation usually inherits 100 % true and is found as such in all wild members of the species in question. Plants with a periclinal variegation on the other hand cannot be grown from seed but must be vegetatively propagated. If seeds are sown one usually gets only green or only yellow/white offspring. The exception is the plants with irregular yellow or white streaks as in *Clivia*. These can give a fair number of streaked offspring that in time can result in stable periclinal chimeras.

To find out whether streaked variegation (or wholly yellow leaves for that matter) is only inherited via the seed parent or can also come from the pollen parent one has to do reciprocal

crosses. If it is cytoplasmically inherited, only a streaked mother will give streaked offspring and the pollen parent is irrelevant. However if the variegation is nuclear inherited, it is irrelevant whether the seed or pollen parent is the streaked plant. It cannot be excluded that plain green plants from streaked parents are more inclined to give variegated seedlings, than plain green plants without streaked parents in their pedigree.

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# Types of Variegation in Clivia

## Roger Dixon, South Africa

The aim of this article is to briefly give an overview of the types of variegation which have been observed in *Clivia*. There are many variations in patterns of specific variegation types, with many names attached. An example of this is the longitudinal type of variegation which, being the most common, has also the largest number of names, which includes 'striata', 'fukurin' and many others. This article does not try to address these variations, but rather to highlight the origins and mechanisms of variegation, where known. For more information on the types of variegation and the terms used, there are a number of articles in various publications of the Clivia Society which can be consulted.



Photo: Helen Marriott

An attractive yellow bloom has another dimension added with the longitudinal leaf variegation

### 1. Light of Buddha

#### Characteristics:

The first three or so leaves from seedling may be normally pigmented, and then the next new leaves come out a clear yellow. As these leaves age, and depending on how much light they get, the yellow leaf becomes normally pigmented. Experiments have shown that direct sunlight, with its higher UV content, stimulates the chlorophyll activation.



Photo: Helen Marriott

'Light of Buddha' with Berries

#### Variegation mechanism:

Unknown, but appears to be a weak gene that is light activated.

'Light of Buddha' - note the distinctive yellow of the new leaves, which go green with age



Photo: Helen Marriott

### History:

Light of Buddha (LOB) was developed by Mr. Wu Bo, in China, who chanced upon the colour mutation a number of years ago. The leaves of original LOB plant were long and narrow, and he started a breeding program crossing LOB with Japanese Daruma with short and broad leaves as pollen parent.

### Cultivation:

LOB needs bright but not direct sunlight. If there is too little light, however, the leaf colour will not be as bright and dramatic.



Photo: Hein Grebe

'Light of Buddha' with distinctly Yellow patches between green areas on the leaves

## 2. Moonlight:

### Characteristics:

At first the leaves are normally pigmented, and as they age they bleach, starting at the leaf tip. A full grown plant has a pale whitish or ghostly appearance. Experiments have shown that direct sunlight, with its higher UV content, stimulates what appears to be chlorophyll inactivation.



Photo: Roger Dixon

Leaf tip of 'Moonlight', showing greener veins and a pale, bleached appearance

### Variation mechanism:

Most probably the same or similar phenotype as the *immutans* (*im*) mutant from *Arabidopsis*. Light affects the phenotype of the *im* mutant by increasing the amount of albino tissue. This phenotype is cell autonomous as the change is irreversible.

### History:

A single plant which was raised from seed by Pat Gore (origin indeterminate). This was acquired by Fred van Niekerk who has had the plant for many years. It has never flowered, and I think that this is because the plant does not produce sufficient energy to stimulate budding. No similar plants are known.



Photo: Roger Dixon

'Moonlight', showing the bleached effect that begins at the leaf tip and works towards the stem

### Cultivation:

Normal cultivation as for *C. miniata* but do not expose to full direct sun as the leaves will



get sunburnt. Needs slightly more nutrition - fertigation is recommended.

### 3. Akebono

#### Characteristics:

At first the leaves are normally pigmented, and as they grow they may develop white horizontal bands. These bands do not revert to green as the plant ages but are stable. Seedlings whose first leaf emerges yellow will not die but will produce green after a few weeks.

#### Variation mechanism:

This type of variegation seems to be triggered by seasonal factors, either light or temperature or both. The white horizontal bands are formed in mid-winter, appearing in spring. If grown from seed, this should be kept until winter is over before sowing, to ensure good initial growth of the seedlings by ensuring that the first leaves are green.

#### History:

Identified and bred in Japan, initially the variegation pattern was not stable and often disappeared, but the pattern is now stable.

#### Cultivation:

Normal cultivation as for *C. miniata* but do not expose to full direct sun as the white portions of the leaves will get sunburnt.

### 4. Longitudinal

#### Characteristics:

This is longitudinal variegation in which the different coloured stripes are stable in the length of the leaf, but highly variable between leaves on the same plant. In addition to normal green, light green, yellow, white and grey colours are also known. These colours can occur in combination, and multicoloured variegation is known. Four and five-colour variegation is known but is very rare. The most



Photo: Helen Marriott

A typical 'Akebono' showing white banding at all positions on the leaves



Photo: Helen Marriott

Peduncle with berries which developed during a period in which the chloroplast development was inactive



Photo: Helen Marriott

This plant shows the extreme case of longitudinal variegation with just two stripes



common is green + white or green + yellow, and less commonly three-colour. In *C. gardenii* the leaf variegation is carried through to the green outer tips of the flower tepals.

**Variation mechanism:**

This is chimaeric mericlinal (or possibly sectorial) variegation. The colour variation of the different phenotypes is not understood.

**History:**

The best known variegation which was developed by the Japanese who have defined a wide range of categories.

**Cultivation:**

Normal cultivation as for *miniata* but do not expose to full direct sun as the white portions of the leaves will get sunburnt.

**5. Negishi**

**Characteristics:**

This is longitudinal variegation with very narrow (sometimes broken) green stripes on a yellow-green or lime-green ground. Seedlings begin as albinos but become yellowish-green.

**Variation mechanism:**

The yellow-green ground varies from very yellow to darker green and appears to be a function of the number of functional chloroplasts.

**History:**

Developed by the Japanese, it was originally bred from Shima-fu (longitudinal or striata variegation).

**Cultivation:**

Normal cultivation as for *C. miniata* but do not expose to full direct sun as the leaves will get greener as more chloroplasts begin functioning. These plants are stronger growers than other variegated types.



Photo: Helen Marriott

A 'Fukarin' style longitudinal variegation.  
Grower: Yoshikazu Nakamura



Photo: Helen Marriott

Longitudinal variegation is carried through to all parts of the plant



Photo: Helen Marriott

Negishi variegation showing very fine green lines on a yellow ground



Photo: Helen Marriott

Negishi variegated plant is quite different from a typical longitudinal variegated plant

# Clivia in New Zealand

## Tony Barnes, New Zealand

### Introduction

New Zealand has been called “A Nation of Gardeners”, for several obvious reasons.

The majority of the early settlers came from the British Isles during the late 1800s, and to remind themselves of home they imported the plants they were used to. So the British love of plants, and the idea that gardening was an art form and part of their culture, was brought to NZ. Those with access to the wealth of new plants being discovered and introduced to the West at this time, continued to seek these, and bring them into their new country.

Stretching between 35° and 46° latitude, NZ generally enjoys a temperate maritime climate, with most of the country seldom experiencing summer daytime temperatures higher than 26°C or below 10°C in winter. Corresponding nighttime temperatures are 15°C and 0°C. Rainfall is regular and year-round, with the wetter west coast of both islands receiving between 2500 mm and 1500 mm annually, while the drier east coasts receive about 750 mm. We have a very high uv light intensity, lots of sunshine year round, and fairly good soils, tending slightly to the acidic in most places.

So for coastal parts of the South Island, and much of the North Island except the mountainous central area, summers are moist but not too wet and humid, and winters are mild and often frost-free. Even within cooler parts of the country, most gardens have a sheltered, warm north-facing spot with a microclimate that enables relatively tender plants to be grown.

In short, it is easy to garden in NZ, with a very benign climate, few extremes of temperature or rainfall, reasonably good soil, and a history and love of gardening in our ancestry, along with the urge to be adventurous and try something new.

### History of *Clivia* in NZ

The earliest record I have been able to locate of *Clivia* being offered for sale in NZ is in an 1892 nursery catalogue of David Hay, whose Montpelier Nursery in Remuera was Auckland’s leading nursery for many years. Hay was an excellent plantsman, and also frequently corresponded with the great American plant hybridiser Luther Burbank, of Santa Rosa, California, from whom he may well have sourced plants.

“*Clivea nobilis*. A splendid bulb for pot culture. Produces a profusion of large crimson flowers. Highly recommended. 2/-”

My guess is that it was actually the *C. miniata* x *C. nobilis* hybrid *C. x Cyrtanthiflora*, which has been sold in NZ for decades as *C. nobilis*, the misidentification only being recognised and rectified in the last twenty or so years.



‘Jude’ an Interspecific

The most widespread clone of *C. miniata*, both here and in Australia, is a narrow leafed, fairly rapidly clumping form, with soft apricot-orange flowers that have rather narrow, gappy petals. This form, along with *Cyrtanthiflora* and possibly *C. gardenii*, probably reached our shores via Australia over 100 years ago.

After searching over 100 individual catalogues, of 23 major NZ nurseries, dated between 1885 and 1960 *Clivia* were listed for sale in only 7 of them, and not once between 1912 and 1951. This suggests that they were not readily available, or greatly esteemed, and for most of the 20th century *Clivia* lurked in dark corners of old gardens, forgotten and neglected. A few passionate plantspeople scattered around the country, such as Dr Ray Freeman, Max Goodie, Jean Aldred of Auckland and Felix Jury and Jim Schumacher from Taranaki, imported seed from specialist nurseries in Europe and South Africa, but *Clivia* were seldom offered for sale. They tended to be swapped and exchanged among keen gardeners more as a curiosity than a plant of any value or real use.

However, as society changes, so do peoples' tastes in plants: during the 1960's, '70's and '80's Dow Seeds of Gisborne were importing seed from European growers, from Antonia Nurseries in California, and from various sources in South Africa. Ken White, then owner of Parva Plants, was obtaining Californian seed for his mail-order plant business. In the mid to late 1980's Topline Nurseries was for a short time importing up to 50,000 seeds a year from Miyaki in Japan, to be shared with other nurseries. These were broad-leafed, deep

orange/red, and were sold around NZ as *Clivia* "Grandiflora" when 2 years old. They were retailing at between \$15 and \$20, which most gardeners considered expensive at the time for a smallish plant. A major nursery still imports seed from Miyaki, to provide plants for a chain of garden centres.

New Zealand experienced a gardening boom – almost a frenzy - from the mid 1980's to the late 1990's, with three weekly gardening programmes on television, several magazines, and a myriad of new nurseries opening to supply the seemingly insatiable demand for plants. Many plants that had been traditionally difficult to propagate and hard to obtain were tissue- cultured, and suddenly became available in large quantities. Everyone *had* to have a garden, even those who till now had not been remotely interested in knowing the difference between a protea and a pansy!

It was about now that nurserymen and plants people began to take a real interest in *Clivia*, especially the hybrid forms offered by overseas nurseries. However, *Clivia* only really came to be appreciated about a decade later,



A Tony Barnes Pastel

after the bubble of gardening enthusiasm burst. The new enthusiasts realised that gardens DID entail some work after all, and that *Clivia* were plants that could look after themselves.

It was at this time, too, that the clone named 'Redgrove' appeared on the NZ market, one of the few named varieties to be marketed in NZ and also the first to be tissue-cultured. This was not a particularly noteworthy variety, merely one of the best available at a time when there wasn't much around.

### Modern times

At this stage of the story integrating the strands becomes tricky. I will therefore outline the broad picture, and then tell you in greater detail about some of the individual *Clivia* personalities involved and where their stock came from.

Yellow *Clivia* were first offered commercially in quantity by Bruntwood Nurseries, with plants from Ian Duncalf of Parva Plants. These were basically Solomon yellows and hit the market in 2001.

Around the same time Keith Hammett began marketing his 'Moonglow', 'Fireglow' and 'Sunset Glow' strains, launching an ambitious growing and marketing strategy partnership to ensure a plentiful supply to meet the rising demand. Terry Hatch of Joy Plants had *Clivia* available, and Tony Barnes was selling a few hundred reds and Australian yellows annually from his Taranaki garden, Ngamamaku. Suddenly *Clivia* were the "in" plant, gaining good media exposure, and the gardening public was scrambling to obtain them.

When the NZ *Clivia* Club was formed, many other addicts who had been playing with their *Clivia* in isolation emerged. There

was a focal point now, and these scattered individuals linked up and pooled knowledge and enthusiasm. Since the Club's inception, and with help from the *Clivia* Society, our knowledge about the plant has expanded. The club has been very active, bringing overseas speakers out to NZ, holding non-competitive shows in different parts of the country, initiating and funding research into flower pigments, doing displays at various horticultural shows, organising social events and generally promoting and building up public awareness of *Clivia*. The NZCC at present has almost 200 members. I don't foresee this increasing dramatically in the near future; our population is small, and to the uninitiated *Clivia* offer limited variation. However this may change as interspecific hybrids become available, spreading the flowering season, ranges of flower shape and of colour.

I estimate that currently about 60,000 *Clivia* are sold annually in NZ, grown from imported seed and NZ sourced material. Seed is generally sown in June, and seedlings are sold by liner nurseries in 5cm pots at ten months old, for \$1.20 (6 Rand). At retail level, a 2 year old plant in a 1 litre pot sells for about \$8.00 (35 Rand). Some plants are grown to flowering size, retailing to the public at \$25 (110 Rand). Premium priced products are not in high demand.

There is currently a glut of *Clivia* available, brought about by overly optimistic estimates of the size of the market. Commercial nurseries work on space rental economics, and currently it is simply not profitable to grow *Clivia* to flowering size when the public are not prepared to pay a realistic price. Perhaps when the 2 year flowering strain from Belgium is introduced this may change.

The general public merely wants a plant that looks pretty, or one that will do a job. They are not interested in breeding or background, and don't seem to like orange, preferring red. There is general interest in pastels, peaches, green throats and variegates, but these are not yet available in retail outlets, and the few offered by specialist growers and breeders are quickly snapped up by collectors. Rare and novel plants are in demand, but the connoisseur market is extremely small, and not lucrative.



A red hybrid

There is little enthusiasm among *Clivia* breeders and growers here to formally name plants. Because demand is not great, and clonal division would be so slow, it is not considered worth doing. General consensus is that unless a plant or flower is different enough to be noticed from the back of a galloping horse, it does not warrant a name.

Things may change radically within the next five years due to the huge increase of diversity in the gene pool. Seeds have been sourced by enthusiasts from all around the world, and amateur hybridists are frantically cross-pollinating here just as they are in Australia, Japan, USA, South Africa and UK. Undoubtedly some wonderful material

will emerge from all these places, and yet the large-scale popularity and commercial success of these glorious plants still depends upon the whims of the public at large.

Increasingly, folk have less time to garden, and many now don't have space either. This is very sad for society, but in a way very good for the long neglected *Clivia* - a plant that is non-demanding, looks tidy and attractive all year, doesn't quickly outgrow its allotted space, has beautiful flowers, and is a survivor. It is a perfect plant for the low maintenance garden of the future.

#### ERMA enters the scene

Until fairly recently it was relatively easy to import plant material into NZ, despite a strict quarantine requirement. This enabled a steady flow of new material to enter the country, and NZ plant breeders have a history of developing new plant varieties, many of which have generated great income for the country's economy, e.g, Kiwifruit and *Zantedeschia* (Calla) lily tubers and flowers.

All that changed in 1998. The Environmental Risk Management Authority (ERMA), a newly-created government body whose job is to manage and assess the risks that all introduced organisms may potentially have on the NZ environment, created a plant register which they thought contained all plants known to have been introduced into NZ. If a plant was on their list it could be imported into NZ. If it wasn't, then tough luck, unless you were prepared to front up with around \$50,000 to pay for the assessment while the plant was still confined in quarantine. This has virtually stopped the importation of anything new into the country, and has had serious ongoing effects for the horticultural trade.



While done with the best of intentions, such was the concern that even *Clivia* themselves were for a brief time considered to have noxious plant potential, and almost put on the banned plant list. Only prompt representations by Keith Hammett to the head of ERMA avoided this happening. *C. nobilis*, *C. miniata* and *C. gardenii* appear on the list, but not *C. caulescens* (which has been in NZ for about 40 years!), or, of course, *C. robusta* and *C. mirabilis*. Keith proved that *C. caulescens* and *C. robusta* were in the country prior to 1998, so they were added to the list. The NZCC is currently making representations to have *C. mirabilis* added to the list so that seeds and/or plants of these species can be legally imported.

### Some breeders and growers

Dr Keith Hammett, plant breeder of Auckland, has probably done more than anyone else to promote *Clivia* in NZ. In 1973, the year Keith moved to his present property, his appetite was whetted by an article about *Clivia* written by Kevin Walters, and two years later Keith obtained two seeds and an offset of yellows from Kevin. These took five years to flower. These were selfed, crossed with Belgian reds and oranges, then backcrossed to recover the yellows.



Keith Hammett at work with his *Clivia*

A foundation member of the old Clivia Club (now the Clivia Society), he traveled to South Africa in 1994, taking with him photos of Solomone yellows, which created great interest. Keith had met Joe Solomone in NZ the same year, and then visited him on the way to the Clivia Conference in Pretoria. Keith has acquired seed from habitat populations, and from many other collectors and breeders, including Yoshikazu Nakamura. He has been involved with a chromosome study of *Clivia* species, and with the naming of *Clivia robusta*.

With Alick McLeman, Terry Hatch, Lisa Mannion and Cindy Barnes, Keith organised a *Clivia* display at the Auckland Botanic Gardens, and from there the New Zealand Clivia Club was formed, with Keith as Chairman. He has initiated and helped Club-funded research into flower pigments. His property in Auckland grows many thousand *Clivia*, both wild accessions and hybrids, and has been used on several occasions for Club events. Keith has always freely given of his experience and knowledge of *Clivia*, and is at present Club Patron and Technical Advisor.

Terry and Lindsay Hatch, of Joy Plants in Pukekohe, are two of our country's most respected plantsmen, and as plant collectors have been selling *Clivia* for many years.



A rich salmon colour *C. miniata*

Terry's original plants were from nurseries growing seeds sourced from Dows (originally Belgian and Californian) and Topline (Japanese). Their garden is built around a remnant of native rimu, kahikatea and totara forest, and underplanted with great sweeps of established *Clivia*, which thrive in perfect conditions. Terry is convinced that these native trees, related to South African trees, produce a soil mycorrhiza that is symbiotic and beneficial to *Clivia*.

In 1984 Terry swapped a bulb of the very rare blue *Worsleya* (value approx 150 pounds) for an offset of a yellow *Clivia* belonging to Lord Aberconway. This wide-leafed plant took three years to flower, and when it did it was crossed with pollen obtained from Jim Holmes and also with one of Keith Hammett's early yellows. The progeny had flowers with notched petals, and a plant of the next generation has flowered with keeled petals. Terry has been selling mostly red and yellow flowered plants, and more recently a pastel range, the result of red/yellow crosses.

Ian Duncalf owns Parva Plants, one of NZ's oldest and most respected plant mail order businesses. Ian, a consummate plantsman, met Joe Solomone at an International Plant Propagators conference in NZ in 1994. Joe was promoting his yellow *Clivia*, and Ian, always on the lookout for something rare or new, imported 100 flowering sized plants (US \$35 each) and 100 offsets (US \$6.50 each). They left USA on 7th Nov 1995 and were released from NZ quarantine in May 1996, having flowered and been pollinated while in quarantine. The resulting seed was grown on to flowering size to confirm that the progeny would be true yellow. They all were. The original plan was to produce plants for sale clonally, by offset, but as there

was considerable variation, it was decided this was not feasible. Ian gave some of the big ones to Keith Hammett, Peter Goodwin, and Eddie Walsh of Massey University. The rest were kept as stock plants for a further few years, and then sold, only 15 of the best being kept.

One of these was a relatively compact, broad leafed plant that consistently produced striped seed berries. Seed of this was kept separate, but offspring did not have the stripe. However, the most compact, broadest leafed of these seedlings were kept and intercrossed, and this was the nucleus of Ian's 'Yellow Tiger' strain.



'Yellow Tiger', Breeder Ian Duncalf

Ian's overall plan was to develop seed strains, going with the obvious differences in plants he had, and developing these. This he has done, now selling 'Solomone Yellows', 'Yellow Tiger' strain, and 'Yellow Spider' strain. These names are not registered, and basically are for his own reference. He still has hopes for a good red strain, and a true breeding wide-petalled peach.

Tony Barnes planted his first *Clivia* at Ngamamaku in 1986. They were plants sold by Topline and North Shore Nurseries, ex Japanese seed. He obtained an Australian yellow via Bill Dyk in 1995, and imported seed of cream and cream crossed with orange from Lois Hurley



An Australian / Japanese cross

in Australia, plus some seed from Bill Morris via Peter Goodwin. He was also fortunate to be encouraged and given plants of orange/red by Alan Gray, an orchid breeder who had made some crosses and selections from plants bought at local Taranaki garden centres.

Tony has been crossing his darkest-coloured plants to obtain a deep red, and in the opposite direction the softest pastels, which are crossed again with yellow to lighten them still further. Of course a large portion of seedlings are non pigmented yellows, which are sold, and only the pigmented seedlings kept and flowered. Stem pigment on the reds is quite a deep purple, while now into the third generation the pastels are generally showing only light pigmentation.



Some of Tony Barnes plants

Lisa Mannion's affair with *Clivia* began in 1985, when she was given seed by John Lesnie, who grew Belgian seeds imported from Germany by Dow Seeds. In 1995 Lisa met Keith Hammett, and did pollinating for him, in return being generously given 25% of the yellow/orange split seed. She also imported Walters' Yellow and Twins strain seed from Ken Smith, as well as other material from South Africa and Japan. But it was the wide-leaved plants of the Belgium Hybrids that really caught her eye, and she has transferred this wide-leaved characteristic over to her yellows, and continues to breed for that. Her 'Great Wide Yellow' strain was very imaginatively promoted at the Ellerslie Flower Show, and these now consistently come true with leaves 100 - 120mm wide. She sells her wide leafed reds and yellows mostly to Auckland landscapers.

Alick McLeman joined the Clivia Club in South Africa in 1992, and met Keith Hammett at the Pretoria conference in 1994. Alick had already established a large collection when he and his wife Frances decided to emigrate to NZ, so when the move was made in 2000, they carried a large number of plants with them. Frances' personal luggage had to follow in the shipping container!

These plants, surviving 5 months of MAF's totally indifferent care in quarantine, formed the basis of Alick's breeding and sales stock, and have certainly boosted the range of *Clivia* plants available to enthusiasts here. Some of us have been able to purchase offsets and even flowering size peach plants, rather than growing them from seed. Alick describes himself as "basically a hobbyist, playing with peaches, 'Wittig's Pink', and green throats."

David Brundell is a plant nutrition scientist who has worked for many years in food and crop research, mostly with cut flowers. He has gathered a wonderful collection of rare and exotic bulbs and plants, and was fortunate to meet Sir Peter Smithers in 1986, and be given a piece of the original 'Vico Yellow' plant (see CLIVIA 7 page 80). This has formed the basis of his breeding program, which aims to produce commercially viable strains in orange and yellow shades that are the best in the marketplace, with blooms that are bigger, bolder, brighter and better in all ways.

David grows all his plants under cover on a fertigation system, and believe me, they *are* bigger and better! He believes that NZ's climate hovers around the range that induces flowering in *Clivia*, and that by removing the extremes of hot and cold, wet and dry, and providing ample nutrients, he has found that many of his plants will produce a flower every five or six months. He has not formally registered any varieties, but has named 5 selections 'Heaven Scent', 'Honey Moon', 'Happy Sun', 'Apricot Sun' and 'Mighty Sun'.



David Brundell's 'Heaven's Scent'

Peter Goodwin, of Waikanae, assures us that *Clivia* are the most therapeutic plant he knows, and that many young students were saved from

his wrath during the 18 years he was a secondary school headmaster because he de-stressed while tending his *Clivia*! Obtaining plants from Topline in the early 1980s, Peter also imported 3000 seeds from Miyaki in Japan, and being a compulsive pollinator, crossed them onto the common apricot form to increase vigour and deepen flower colour. This was a rather hit and miss affair, as there was no literature available at the time. However, he joined the South African based *Clivia* Society, to whom he feels eternally in debt as the early bulletins were a huge help. He would love to meet Nick Primich.

He obtained seed of yellows and variegated daruma from Nakamura in the early 1990s. Ken Smith and Bill Morris in Australia were very helpful, and also Lois Hurley in Australia in 1997 provided plants which flowered pale yellow or cream.

Di Smith, Secretary of the NZ *Clivia* Club since its inception, has worked tirelessly to spread knowledge, increase membership, raise funds, make overseas contacts to import seed, organize club events and activities and generally encourage members to grow, cross and show.

Rex Williams, originally an orchid and palm man, obtained his first *Clivia* about 15 years ago at an orchid show, and was seriously smitten with 'cliviatis' six years ago. He is currently still gathering a large diverse range of plants from China, South Africa and U.S to assess for future breeding. While loving everything, he is particularly interested in variegates and dwarf forms, and wants to breed good quality pinks and interspecifics. He is very organised and methodical, and along with his wife Dee is creating a wonderful large bush garden in the Waikato foothills. Watch this man; he will become one of the leading *Clivia* breeders of NZ in the future.



Craig Benson swapped *Sandersonia* tubers for seed of early crosses done by Jim Holmes, the resulting flowering size plants being sold around Auckland and Waikato, as were plants of Holmes and other yellow seed grown by Peggy Pike who came from South Africa to live in Cambridge in 1999. Murray Gow was given seed of Sir John Thuron's yellow plant by a friend of Sir John's Head Gardener in 1991 and 1992; and Keith Boyer of Auckland was given seed and an offset of Giddy's Yellow when Cynthia Giddy visited NZ in 1985.

Bill Dyke, a specialist bulb grower in Tauranga, acquired several yellow plants via Gordon Julian in 1992. These were originally from Kevin Walters in Toowoomba, Australia. Bill sold a small number of plants via his mail order business, and it was one of these that Tony Barnes obtained in 1995. These plants were the 'Flowerdale' strain named 'Aurea' in Australia, and generally thought to have been brought from England to Rippon Lea, the garden of Sir Benjamin Nathan in Victoria, in the early 1920s. (See CLIVIA 2 page 50).

Eric Walton, an avid plant collector, imported yellow seed between 1984 and 1990 from Les Hannibal, an Amaryllid collector in California, and Gordon Julian of Toowoomba, Australia.

### Conclusion

I would like to thank the Clivia Society for inviting me to share this story; and all the living people mentioned in this article, and others I have spoken to while gathering data, for their help and willingness to pass on to me, and hence you, the readers, their knowledge, enthusiasm, and love of *Clivia*. In particular I thank Keith Hammett, Ian Duncalf and Terry Hatch, and also Ross Fergusson of HortResearch Library Auckland, Sue Daveson of Auckland Botanic Garden Library and Barbara Brownlie of the Alexander Turnbull Archives Library, Wellington.

For space reasons we have had to abridge this article from a thoroughly researched major paper which we would have liked to have published in full. It was extremely difficult to decide what –and whom - to omit. The responsibility for the cuts is entirely ours.

Eds.



Keith Hammett's garden



Ian Duncalf

Photographs by Tony Barnes



# Collecting, Growing and Breeding *Clivia* In a Challenging Nursery Environment

## John Craigie, Australia

Pine Mountain Nursery is located on the middle reaches of the Brisbane River at Pine Mountain, Queensland, Australia. It is approximately one hour's drive inland from the city of Brisbane (off the Warrego Highway) and about one hour's drive further west to Toowoomba.

The nursery is a small family owned business operated by my wife Gail and me. Gail operates and manages the nursery. A range of warm climate bulbs, annuals and general landscaping plants are grown for the wholesale and mail order markets. Plant breeding has become a passion with me, particularly with *Agapanthus* and *Clivia*. Breeding new flower colours in *Agapanthus* is advancing along a similar path to *Clivia* and several new *Agapanthus* flower colours and types will be internationally released through Pine Mountain's marketer, Ozbreed Pty Ltd, within the next few years.

It is somewhat unusual for plant breeding to be undertaken in a small wholesale nursery

environment that produces a range of general landscape plants. This is particularly so given the investment needed in infrastructure, breeding stock and carrying the bulk of ones breeding efforts through to flowering. In the absence of winning the lottery or being in the financial position to enjoy early retirement, one needs at the very least to keep your day job. Other vital ingredients include motivation, a lot of patience and passion.

The motivation came during a time when I participated in a Leadership Programme that ran over two years. One of the programme benefits was exposure to many "earthy" but truly remarkable people. I recall meeting a man who had spent over half his working life as a boner in a meat works. One day this gentleman decided that if he continued to work as a boner then that is all he would ever be, so he resigned. The manager of the meat works could not believe that his best boner wanted to leave and more particularly, that he had no idea about what he wanted to do, possessed little money and only owned an old



Flowering time inside a shadehouse at Pine Mountain Nursery

light truck. The manager gave his departing employee good counsel, including what was described as ten common sense laws. At the time I met him this gentleman was already the largest wool producer in Australia, owned a network of abattoirs and exported over half a billion dollars worth of meat goods annually.

Three of these laws had lasting significance:

- use what you're got
- don't do the easy stuff, because everyone else does that
- if you always use the same ingredients you will always make the same cake.

Plant breeding fitted in well with these three common sense "laws".

### **Clivia Growing**

In 1998 the first commercial purchase of 2,000 orange *C. miniata* seeds was made. Unfortunately the success with raising this seed (strike rate above 90%) was not reflected in the subsequent purchase of 500 cream *C. miniata* seed (strike rate about 20%). With confidence in striking seed restored from a subsequent purchase of seed imported from Japan, seed was actively acquired from respected breeders around the world, either directly or indirectly through agents.

At about the same time, a range of *Clivia* plant types was sourced from breeders and growers within Australia. The greatest boost came with the acquisition of a large part of a collection owned by Gordon Julian. Gordon previously lived in Toowoomba and continued his *Clivia* breeding passion from Tasmania. Whilst a large genetic pool of *Clivia* sourced from Australia, Belgium, China, Japan, South Africa and the United States is grown, advancing the generational breeding efforts of Gordon Julian remains a priority area, particularly the pastels.

### **Challenging Climatic Conditions**

At the time of purchase of the property in 1993 we had no idea that the location was subject to extreme temperatures. The property was purchased because its frontage onto the middle reaches of the Brisbane River provided a ready source of clean running water and also because of the scenic amenity of the area with over 600 acres of hilly protected nature reserve within 500 metres of the property, against a backdrop of mountains. Living near a reserve can be magical, with early morning sights of kangaroos, wallabies, echidnas, koalas, goannas, but also some less welcome visitors in the form of dingoes (wild dogs), lots of snakes and the occasional wild pig! Another factor was that we wanted our children to grow up in a rural environment.

The isolation comes at a cost. It takes 40 minutes in travel time for a round trip to the post office to dispatch mail order plants. We have to make arrangements with a local nursery (15 minutes away) to dispatch or collect plants from transport companies and there's a three hour round trip to deliver plants to the wholesale plant markets in Brisbane. Each day I travel about two and a half to three hours to and from work.

In terms of a plant hardiness zone category, the somewhat arbitrary zoning means very little because of extreme temperature variations. Although the property is perched about 40 metres above the river it is in the shadow of the hilly and mountainous backdrop. Very low humidity allows night time temperatures to drop well below normal, particularly in winter when overnight temperatures can be low, down to - 5° to - 7° Celsius for about seven days a year. Summer daily temperatures typically get to 33° C and climb above 40° C for at least seven days. The daytime humidity is typically relatively low, ranging from the low thirties to forties.

Whilst the cold can be managed, mastering extremes in summer weather patterns remains challenging. Sadly, with the extreme heat there are *Clivia* fatalities and great efforts went into trying to solve that problem, from reformulating and testing various potting media, controlling water quality, proactively managing pests and diseases, to even designing new shade structures. In hindsight it may have been more effective to just move to a nice cool place like Toowoomba!

Over the 2005/2006 summer, temperatures at Pine Mountain exceeded 40° C for a week in December and two other periods in late January and February. On one day in December the ambient air temperature in the large *Clivia* shed (40 metres by 18 metres) reached 45° C at about one metre above ground level. Now some books will rightly point out that at prolonged high temperatures plants should not survive. About 100 *Clivia* “fell over” through this period and about two-thirds of these are regenerating. In percentage terms, the loss, whilst insignificant at under a small fraction of one percent of the *Clivia* population, is nevertheless disappointing.

### Managing High Temperatures

In order to manage extreme temperatures some basic understanding of the impact of high temperatures on plant behaviour was essential. With apologies to scientific and learned horticultural professionals, here is a simple guide to what happens in a heat event.

Photosynthesis is a synthesizing reaction in which carbon dioxide and water are converted into carbohydrates, with oxygen and water as the byproducts. Respiration is a degrading reaction in which carbohydrates are ultimately broken down to carbon dioxide and water with the release of stored energy for cellular metabolism and functioning. The rate of photosynthesis in a plant rises as temperature increases. For *Clivia*,



Comparing the colours

the optimum level of photosynthesis may be up to 28° C. Up to this point the respiration rate (its rate of use of food reserves to keep it going) also slowly increases. As temperature rises above the optimum, the photosynthetic rate declines and the respiration rate increases dramatically. The plant starts to use its food reserves faster than it can produce them, and slowly starves.

Water is an essential part of photosynthesis. Water is lost through the leaves through transpiration. Transpiration is a passive process. When the sun rises, plants simply open their pores (stomata) and permit the evaporation of water from the leaves. As water is lost from the leaves a state of tension, or negative pressure, is formed in the transpiration stream (the xylem) that extends down the plant from the leaves to the roots. Through this negative pressure, water is drawn from the root zone, into the roots and through the vessels into the leaves. The rate of loss of water vapor by the plant is a function of the atmospheric demand for moisture. At high temperatures the air is capable of holding more moisture than cooler air, and the atmospheric demand for moisture accelerates the transpiration process.

At high temperatures the root zone of *Clivia* can be damaged. Kevin Handreck and Neil Black in "Growing Medium for Ornamental Plants", University of New South Wales Press Ltd (2002) make some very sobering comments:

- *four hour bursts at 40-45° C will kill root tips of many plants but they may regenerate ...longer periods above 40° C will be more likely to cause permanent die-back*
- *roots killed or damaged by high temperatures are easily invaded by pathogens.*

Root death and damage affects the plant's ability to draw water from the root zone and therefore impedes the efficiency of the xylem process. Damaged roots combined with high atmospheric demands for moisture, may create a situation where the xylem cannot supply sufficient water into the foliage for transpiration. The plant will exercise a variety of mechanisms to cope. These mechanisms may include, for example:

- slightly closing its stomata in an attempt to slow down its transpiration rate
- discarding older leaves (lower leaves yellow, wither and die) reduces the leaf area available for transpiration.

Ultimately the plant may close its stomata to retain moisture and prevent additional water loss. When the stomata are closed, no carbon dioxide is absorbed. This in turn impedes the growth of the plant by stopping photosynthesis and the plant starves and ultimately "stews" and may die. Without intending to be too controversial a further survival mechanism *Clivia* may have available is to discard all foliage, leaving the plant base and roots intact so that later regeneration can occur. At very

high temperatures a parent plant may "fall over" leaving the offsets unaffected. An obvious sign is bacterial infection, but this is seen as a secondary effect of damage caused by a starvation event. Leaf cell walls subject to a starvation event / water stress become damaged and vulnerable to bacterial infection.

What is the fate of the basal part of a plant that has fallen over? *Clivia*, planted in gardens, that have fallen over after a severe heat event regenerate with no bacterial treatment or external assistance. With *Clivia* in pots regeneration can occur provided the bacterial infection can be eliminated and this usually involves cleaning up the basal area, but not always. Simply pulling off or cutting off a damaged plant top may be all that is needed, if done before the bacterial invasion gets into full swing.

### Managing High Temperature Events

During extreme temperature events light watering is undertaken daily at the earliest possible time. As temperatures rise ambient air temperatures and humidity inside and outside of shade houses may be monitored at regular intervals. Potting mix temperatures, medium moisture levels and air flows within the structures may also be checked.

As temperatures rise, relative humidity



Good colour and large tepals make an attractive flower

may fall and atmospheric demand for moisture increases. This vapour pressure deficit in the ambient air is the driving force for transpiration. Strategies to help lower temperatures/manage humidity may include:

- flooding the floor with water
- using fogging systems but ensuring foliage is kept dry
- using fans and evaporative coolers
- controlling air flows through the shade house via roof vents, side and end vents
- using external shade screens and internal ceiling curtains
- preventing or minimising overnight dew

Strategies to protect the plants may include:

- good hygiene practices
- using preventative chemical applications for fungal and bacterial protection
- ensuring plant nutrient balances remain in check
- applying chemical polymers to leaves to reduce the rate of transpiration
- using light coloured pots for heat reflection
- using unglazed terracotta pots (mini evaporative coolers!)
- clumping pots together to help maintain



Note the size of the flower compared to the leaves

ambient humidity around the pots but not so much as to impede good air flows

- removing plants off benches and placing them on the floor
- modifying the potting medium to assist in root protection

### Optimum Growing Medium

*Clivia* in their natural habitat may be seen as semi-epiphytic plants, living above the ground with their roots in leaf litter, on top of rocks, cliffs, or seen as epiphytes on trees. Ample oxygen around the root zone is vital to the plant's overall health.

Like many neophyte *Clivia* enthusiasts, the pursuit of the optimum growing medium became an all-consuming pastime with various ingredients and blends constantly put to the test. Ingredients tested included commercial potting mixes, composted pine bark, crushed rock, fresh manure (sadly no elephant dung was available!), orchid mixes, peat mixes, perlite, river gravels, sand, etc. Some ingredients were readily discarded (horse manure, peats and soils) and others were found to be not sufficiently robust (orchid blends, whilst initially performing well had a finite usefulness – the bark chips break down, clog drainage outlets and can cause waterlogging). Combining various particle size ingredients causes compaction and also waterlogging.

So, is there a perfect, “one standard fits all” potting medium? We are yet to find one. It depends upon many factors and what works for us may not work in other areas. Some circumstances that need to be considered may include:

- Plant maturity
- Container size, air fill porosity and irrigation frequency
- Climate



The basic elements of a good medium remain important – it must be relatively robust (won't rapidly break down), have good air porosity/drainage, good available water holding capacity and good cation exchange capacity (fertilizer drawn down is minimised).

The medium used for striking seed is a sterile crushed rock based material placed in trays of 99 cells. One seed is put into each cell and the trays are then placed on heating mats. A minimum temperature of 24° C is maintained. The medium in the trays is kept moist.

Struck seedlings are potted into 75mm tubes when the main root is at least 3cm in length. The medium used is a slightly modified standard bark based potting mix. The mix is modified to slightly lower air porosity and drainage capability. Seedlings are potted up into 175mm pots when about 12 months old and the potting medium is again altered, this time to raise air fill porosity.

Plants selected for breeding are potted up into 250mm pots at about two years of age. Higher air fill porosity is needed in mixes in larger pots. An added requirement is to provide some increased protection to the plant and root zone from heat transmission. Two mixes

are used – one for the root zone with higher air porosity and insulating characteristics, and one for the basal zone with lower air porosity characteristics for moisture maintenance around the base. With higher air porosity, the medium will contain reduced levels of available water and more frequent irrigation occurs during hot weather, but not so much as to contribute to water logging.

### Repotting and Potting Up

Repotting and potting up are activities that are now undertaken all year round. Once, these activities were never undertaken in the summer months. The key to potting up was found to be water or more precisely the lack of it. Water is not applied to *Clivia* that have been newly potted for at least three days and then only small quantities of water are introduced over the next week or so. Watering plants after potting up in hot conditions can be fatal particularly when roots have been damaged and have not had time to seal in order to keep out pathogens.

### Watering

We have disconnected the sprinklers and hand water all our *Clivia*. Whilst rainwater is preferred, from time to time river water must be used. All water used on *Clivia* is chlorinated and the pH is adjusted back. Watering is a



Pine Mountain Nursery with some Craigie grown flowers computer posed into the foreground

function of understanding your environment, your potting medium characteristics and knowing your *Clivia* types.

### **Clivia Breeding**

A quick scan around the nursery reveals masses of colour coded pots of *Clivia* collections, with a growing emphasis on broadleaf types, including different flower colour types and multitepals. Also broad and narrow variegated types from Belgium, China, Japan and South Africa can be seen. As a relatively young collection, each flowering season brings a heightened sense of anticipation as the breeding efforts of fellow *Clivia* enthusiasts and our own efforts reveal themselves for the first time.

Each year the flower show gets bigger and better than ever before and there is a great sense of exhilaration standing in a large shed around lots of flowering *Clivia*. If there is one disappointment at this time it is that the public are not allowed to visit the nursery. Occasionally the odd flower type turns up and a decision is made whether or not to destroy the plant.

For many years the collection of yellows and split for yellow (Orange x Yellow) x Yellow obtained from Gordon Julian have been the centre of breeding efforts. With increasing quantities of plants grown from imported seed now coming into flower, the genetic diversity of the collection continues to grow. Each year there may be a number of breeding themes, depending upon pollen stocks taken in the previous year and current flower availability. Apart from *C. miniata*, other species of *Clivia* grown are *C. caulescens*, *C. gardenii*, *C. nobilis* and a range of interspecific crosses.

The broadleaf splits for yellow crosses provide an opportunity to breed broader leaf

types. To date we have found it challenging to achieve broadleaf yellow and pastel flowering types, but progress is being made. Crossing the broadest-leaf pastels in 2004 resulted in about 50% of the seedlings being unpigmented. About 33% of these unpigmented seedlings are developing broad leaves. This may be a more efficient way to develop broadleaf yellows than crossing broadleaf split for yellows back over yellows.

A major focus has been on breeding strong green-centre *C. miniata* types with an ambition of producing some stable green flowering types. A couple of *Clivia* in the nursery have a history of flowering green. Green flowers are very slow to open, produce little pollen and stay open for many months, to the point that the flowers become quite ugly. With a change to hydroponic fertilizers in 2005 to boost growth and flowering, the green flowers reverted back to normal flowering green-centre oranges.

Whilst the focus on green-centres and developing greens continues, in the last couple of years emphasis is also being placed on interspecific crosses, peach and pastel pink colours. For example, Pine Mountain currently has over 1,000 peach types at various stages of maturity, up to 250 mm pots. Whilst most of these peach crosses have unpigmented bases, a couple of hundred are pigmented, including many acquired from international breeders. Again, most of the breeding efforts in these areas will be retained through to flowering. In the next couple of years the focus will turn also to reds, multitepals and variegates, as increased numbers of these plants come into flower for the first time.

Strong green-centre orange Belgium and Sahin Twin types hold a special fascination and we have been accumulating the seedlings

from these types.

Using the split for yellow types, a number of different colour green-centre types have been produced, including bronze green-centres with extensions of the green, to “vein like” markings up the tepals. Also other splits can have some quite vivid orange red colours.

Straight pastel colours have also been a focus in the last couple of years. Some near transparent tepal types and pink pastel types showed up in the 2005 flowering season. Further development on the flower colours is required. The straight pastels with well-developed tepals remain hard to beat.

Over the last few years a *Clivia* called ‘Orange Yellow’ has been crossed over creams, pastels and peaches. It has strong yellow veins running up the tepals. If this plant is allowed to flower in a very bright area, the tepal colour on emerging flowers is

dominantly yellow with orange outer areas. Every seedling that has been produced from this plant has been pigmented. Again, the seedlings are being accumulated and most will be retained until flowering. The offsets from this plant all have pigmented bases.

During peak flowering periods, there is very little time available outside of *Clivia* selection and breeding. Most of the *Clivia* are grown in 175 mm pots and plants judged to be suitable for breeding are potted up into 250 mm pots, photographed and coded. The genetic background of the plant, if known, is also recorded. Decisions are then taken about pollen collection, storage and cross pollination. Flowering *Clivia* not kept for breeding are sold out to wholesale markets for landscape and nursery trade. Plants kept for breeding in prior years are re-assessed and some may also be sold out to the trade, while those judged inferior and are simply destroyed.



‘Orange Yellow’ with its interesting patterned tepal

The selection process is somewhat flawed as *Clivia* flowers improve as plants mature, but space remains an important consideration. Limitations on space have meant a move away from the production of typical orange flowering *C. miniata* and only four stock plants remain. Nevertheless, growing our special crosses through to flowering provides a lot of satisfaction besides gaining a greater understanding of the potential of breeding programmes.

Photographs by John Craigie

# Ultra Violet Photography of *Clivia*

## Ian Coates, United Kingdom

Many insects have strong vision in the ultra violet portion of the spectrum and plants can take advantage of this by making attractive markings to lure their pollinators. As a photographer of long standing, I was delighted to be asked to prepare an image for last year's article by John Manning to show the UV patterns in *Clivia*. I had no idea what to expect and, since my photographic experiences were in portraiture, this was bound to be a challenge. My progress is given below because I hope this will give others an understanding and encourage them to photograph the UV patterns of their *Clivia* in variety so that a greater understanding is obtained.

but, sadly, their digital chip was too good at showing just the humanly visible part of the spectrum. This meant I had to revert to film and I selected the convenience of a 35mm camera. Here again, steps have been taken by the manufacturers to eliminate UV transmission with special glasses and multiple coatings in the lens. Special lenses are available



The camera with filter, lens, extension tubes and body.

### The Challenge

Unfortunately, because the human eye is not sensitive to UV light, manufacturers of photographic materials and equipment have been trying to eliminate for over 150 years the very things I wanted to see, and have been largely successful. They want to reproduce what is seen by the human eye, not that of a pollinating insect.

### The Camera

I first had to choose a camera and my natural choice was digital. Images are free and instant, but I had to check if the camera chip had adequate sensitivity in the UV part of the spectrum. I approached the major manufacturers, without success, except for Fuji who first wanted to know if I was sufficiently 'high profile' to be told such information! Luckily, it appeared that I had

to overcome this - but not at my budget. I therefore initially tried an uncoated enlarging lens taped to the camera, with success, but later found that the old camera lens was also satisfactory. I additionally bought some extension tubes to allow close focussing. The complete outfit cost £40. I also had to buy a special filter, for a similar amount, to allow the passage of ultraviolet light only, and to exclude the visible spectrum. The filter you require is **not** what is described as a UV and often fitted to the front of lenses where its function is mainly as a protection against dust and scratches. This looks clear and excludes UV, whereas you require one that looks opaque black and allows the passage of UV, whilst excluding visible light. These filters are not generally available, but I was able to order one manufactured by B&W, reference 403.

This allows light with wavelengths between 320 and 385 nanometers to pass through. (The wavelength of the human visible spectrum starts at about 400nm.) The only other necessary equipment was an ultraviolet light source. There is none better than the sun - the same as the pollinators use. Use shaded sun or the contrast will be much too high for the film. Sadly for this purpose, modern flashguns are low in UV emission and so are not suitable.



The picture clearly shows the flower reflects UV light whilst the pollen absorbs it, and appears dark.

### The Film

The same problem existed with film as with camera. Manufacturers try to match the sensitivity of the human eye so I contacted them and each referred me to their website. Again, the relevant information is not there. Fuji were the exception and sent me a complimentary pack of colour films to test. Sadly, their film was much too good at matching our visible spectrum and thus excluded UV. Such criteria are not so important in monochrome, so I tried their Neopan 400 black and white film with success. I also had success with Ilford HP5 and other monochromatic films. I processed the films myself and was surprised at how difficult it now is to buy black/white processing chemicals in the UK.

### The Photography

With all my equipment and material selected after a lot of trial and error, I could at last start some serious photography. This brought a couple of final challenges. Firstly, exposure. Obviously, the film was not originally tested for sensitivity through a UV filter and there are many new



The normal and UV images show how the colour marking on the tepal is invisible to the pollinator. It is only the pollen which stands out in stark contrast to the rest of the bloom, and some can be seen on the lower tepal of the lower tepal.

variables. If you are trying this, I suggest you meter the exposure and then multiply it by approximately 25 when adding the UV filter. To allow for your particular variables try making several exposures between ten and one hundred times the indicated amount. In bright shade this could be of the order of 5 seconds at f11! This exposure will need to be increased further if extension tubes are being used, and a tripod and cable release or similar will be essential, due to the long exposure. Secondly, precise focus is



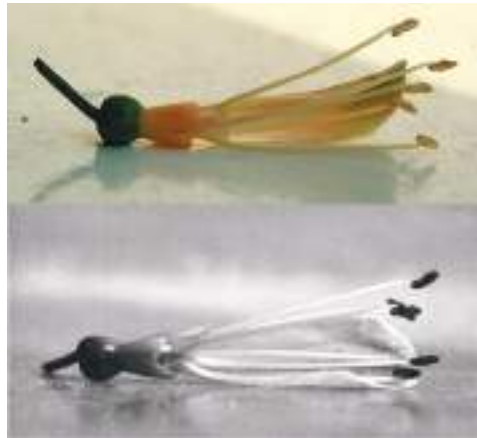
difficult. You cannot focus with the filter fitted, as it is much too dark. It is therefore necessary to focus through the clear lens and then put the filter in place. Unfortunately, because UV has a different wavelength to visible light, it will focus on a different plane inside the camera. To allow for this you will need to increase the distance between the camera and plant a little. However, this is not considerable and, at all but the closest distances, it can be compensated for by stopping down the lens to around f11.



Showing the difference between ripe and unripe anthers

### The Results

Throughout the photography it is apparent that ripe pollen does not reflect UV light, whereas all other parts of a *Clivia* flower do. This is true of all species and varieties which I have so far been able to test, even though they rely on a wide range of different pollinators and flower in different seasons. Maybe the plant does not want pollinators until its own receptors are ready, although stray insects will always be around. If already receptive, the protusion of the stigma through a barely opened *C. gardenii* flower could be to seek early cross pollination. If the anther is not receptive at this stage, the extension could be intended to keep it clear of its own pollen and thus avoid self pollination. I hope UV photography will help clarify this and other points. My research continues!



Section through a *C. nobilis* showing similar markings to *C. miniata*.



A pendulous hybrid showing the same effect.



The stigma having received pollen.



This array of English early spring flowers shows a variety of effects. From the left, the Daffodil absorbs UV but has reflective stripes radiating along its petals from the centre. The Primrose absorbs UV and the darker centre is no longer discernable. The Daisy has partial absorption throughout, except for a small area at the base of each petal. The violet Vinca, as would be expected, reflects UV and the Celandine reflects along the majority of the petal but absorbs near its centre.

### Comments by John Manning

Ian Coates has achieved excellent results in visualizing the UV patterns of some flowers. From the perspective of cliviaphiles it is only unfortunate that our favorite flowers do not dazzle with UV patterns. Of course UV light constitutes just a portion of the spectrum that is visible to insects, in like manner that red light is just a portion of the wavelengths that are visible to us. Just as the visibility of red light to us is modified by the presence of other wavelengths, such as green or blue, so we might expect the appearance of UV markings to the insect to be modified by other wavelengths, or colours, of light reflected from the flower. Thus we should be aware that the UV images reproduced here are not the whole story by far. The lack of UV reflectance in the daffodil, for example, is obviously more than compensated for by the bright yellow colour.

I would like to comment also on Ian's speculations about *Clivia* pollen. Experiments with houseflies have demonstrated that they are attracted by UV reflectance (rather than absorption) and it is likely, therefore, that other insects will react similarly. Since pollen in *Clivia* is not the attractant to the pollinator, and indeed its loss is catastrophic as far as the plant is concerned, it makes perfect sense that the pollen is strongly UV-absorbing, and hence probably invisible to the insect. The transfer of pollen to stigma in *Clivia*, as in most plants, is a passive byproduct of a visit to the flower by the pollinating insect, and there is thus no reason to expect either pollen or stigmas to be UV reflecting.

Photographs by Ian Coates.

# Accent on



Photo: Courtesy Gem Wildflower



Photo: Helen marriott



Photo: Gordon Frazer



Photo: Courtesy Johan Schoombee



Photo: Gordon Frazer



Photo: Mick Dower

# Single Flowers

Photo: Courtesy Joburg Clivia Club



Photo: Gordon Frazer



Photo: Claude Felbert



Photo: Helen Marriott



Photo: Courtesy Gem Wildflower



Photo: Courtesy Gem Wildflower





# The Seeing Hand — *Clivia* Depicted

## Roger C. Fisher, South Africa

The *Clivia* is one of those charismatic plants that have insinuated their way into human culture through their aesthetic allure. Our aesthetic sensibilities are - as is all our nature - a particular cultural refinement of a once survival strategy. We, as a species, are blessed with stereoscopic and polychromatic vision. In other words, we can not only make out three dimensional objects, but we can see them in colour. The survival value of these visual mechanisms was to find and distinguish edible plant material from the inedible, recognise friend from foe, and spot and kill our next meal at a distance.

We see not once, but many times. We in fact have many ways of seeing, on which I shall not elaborate here. It is our brain that elides all these differing visual stimuli into one image. And then this is all done in a memory bank. A new object is seen with difficulty for what it is. Our ways of depicting what we see rely on only a small and limited number of our ways of seeing. For instance, there are no lines at the edges of objects in nature. What we use in perception is the edge of critical difference to distinguish an object or 'figure' from its context or 'ground'. Stereometry is captured graphically through either the continuity or the interruption of line. We perceive an interrupted line as being placed behind a continuous line, that is where two parts of an object are both 'figure', the nearer can be represented in continuous line and understood as closer. The line drawing seems to be of the earliest of humankind's artistic endeavours, and it is still the most useful and powerful of scientific devices enabling us to communicate the most complex of ideas in abbreviated fashion,

from ideograms to layout and assembly drawings for spacecraft and microchips. To see and understand these depictions requires however an understanding of the conventions, and particularly those of depicting, of the cultures that produce them. Depicting is a cultural construct.

### Drawings of plants

Drawing is one of the earliest mediums for recording and in particular the capturing of plants for the record. Hence, when explorers discovered strange plants in strange places, these would be recorded in their natural form by means of line drawings to communicate their discoveries to peer and patron back home. This record was an alternative to the dried or living collected specimen. This practice originated in the apothecaries yard, but soon became standard practice for the botanical world, and hence the norm in what is now termed botanical art. What were deemed mere illustrators are now ranked as botanical artists. They too have their own artistic licence.

When the illustration was presented for reproduction, a further licence entered into the line of communication, namely that of the illustrator and the medium of illustration - woodblock print demanded a far greater reduction of line and coarsening of detail than the needle-point engraving. We can, by way of example, look at Backhouse's illustration of Eastern Cape flora, which I believe, contains an example of *Clivia nobilis* - although in his text he merely refers to seeing 'amaryllis' - a drawing done *plein aire* as a pencil sketch and later given over to his cousin, the engraver for illustration in his published travels.





Backhouse trees and plants

His is an attempt to locate the plant in its ecology. This was not going to be done again for the *Clivia* until the drawings of Auriol Batten. She presents a scene of *Clivia nobilis* portrayed in its natural context. We recall her dramatic portrayal of *Clivia mirabilis* as its introduction to the botanical world. (See CLIVIA 4 cover).

We do have some splendid earlier examples in oil by that intrepid traveller and botanical artist, Marianne North, who travelled Natal and visited her friend Katherine Saunders of *C. miniata* var. *flava* fame. In Natal she depicted the *Clivia* species there, namely *Clivia gardenii* and *Clivia miniata*. It is



Marianne North paintings, the first depicts a *Clivia miniata* while the second shows a *Clivia gardenii* amongst other plants



debatable whether these are true habitat depictions or flights of fancy as regards the companion plants and insects.

Another licence we discover in the illustration of plants, and here by way of example, that of the *Clivia*, is artistic licence in the service of science. The *Clivia* is a large plant, yet many of its organs, as with all plants, are microscopic. That licence serves to frame more than the eye can encompass, to reveal more than the eye can see, or to freeze in one time frame more than can be seen in a moment, in other words aspects of the plants lifecycle. We, as a rule, take this all for granted, but as I have noted earlier, for these depictions to be intelligible we need to understand the conventions. Hence we find in the *Clivia* depicted, pieces contorted into unnatural form, bits missing, or disproportionately large,



*Clivia miniata* depicted in a pencil drawing

disembodied – or should I say disemplanting – fragments in dissected form, or various phases of a lifecycle of the plant in order that the viewer be given access to a world far larger in time and space than the paper on which it is portrayed. The record may be complete but it requires the mind of the beholder to reassemble them in the imagination in order that the whole be comprehended. The line and the microscope by means of the seeing hand were united so that which the eye at the lens beheld could be revealed for all to see - this before the advent of photography, although often the line drawing is more accessible to the viewer than the photograph.

#### Colour

Another of the important ways we see is by colour. For *Clivia* enthusiasts one might say the most important of the ways we see – but then I must quickly qualify that I have met magenta-green colour blind *Clivia* enthusiasts. Also, the largest body of enthusiasts are those of the far east – China, Japan and Korea – and for them the flower is of lesser allure than the plant itself. Our sense of the colour of flowers, and in this instance those of the *Clivia*, is different to that of the insect and bird pollinators. Ours is all too human and not lepidopteran or avian. Yet that is their allure. Colour, and in particular its diversity and variability, appeals to our aesthetic nature.

But how to record colour? One of the species – that of the greatest aesthetic appeal – has a colour in its name - '*miniata*' from *minium*, Latin for 'red lead' an oxide of the metal used as medium for the rendering of red in paintings, although now recognised as poisonous. Colour, before photography, was recorded by way of colouring. The original was painted, the printed plates then rendered according to the original for reproduction and dissemination.

The botanical journals of the 19<sup>th</sup> century had set the course. The botanical artist would prepare the master, and sometimes but not always, and in fact seldom – the engravings of the plates. The monochrome serigraphs would be coloured, either by the artist themselves, or assistants in the employ of the publisher. This would not necessarily be done simultaneously, but over time as orders for the publication was received, and often at a distance from the original depiction and in time. We discover then a distinct variability in the presentation of colours. The medium of water-colouring proved itself as greatly suited to the purpose. Colour could be laid down in bold blocks, yet nuances of shade and the translucency of the play of light were readily depicted.

It was decided early in the twentieth century to publish for South African flora the equivalent of Curtis's Botanical Magazine, known in *Clivia* circles for its depiction of Hooker's *Imantophyllum aitonii*, now relegated into synonymy with *Clivia nobilis*. A process similar to Curtis's earlier publications was to be followed, with the botanical artist preparing a coloured rendition, but because of the distance and logistics involved the process became far more Byzantine. John Rourke has told in detail the story of the publication 'Flowering Plants of South Africa', in his essay 'Beauty in truth' (pp. 60-63) as contribution to 'Botanical art in South Africa - peeling back the petals'. In this he quotes Reeves, sponsor and benefactor of Curtis's Botanical Magazine as reporting that Mr Fitch, longstanding artist and contributor to the series "who has lithographed plates for so many years and was also doing yours ... has drawn his last plate", this because of failing health. And so Rourke says "in these early volumes of the Flowering Plants, the creative input of the lithographers and colourists had a significant impact ...". Here I need to digress a little.

### The aspect of style

We have here to consider the aspect of 'style', and particularly that of the author. We might suspect that where art is in the service of science, and in this particular instance, that of botany, style becomes irrelevant. And what is style anyway? The term has a horticultural etymology. It derives from the Greek '*stig*' meaning twig or stick, the implement used by scribes for marking clay tablets. The manner of the making of the marks identified the author, hence their style.

Let us consider the original illustration made of *Clivia miniata* for Flowering Plants. On 4 October 1919 the first of Kathleen Lansdell's paintings were sent to London. Rourke records that Kathleen Lansdell was not considered an especially competent botanical artist. The printing was a laborious triangular process conducted between Pretoria, London and Kew. N. E. Brown (1849-1934), senior botanist at Kew Herbarium, was commissioned to check the proofs, and soon expressed concerns regarding the accuracy of some of her plates, and suggested to E. P. Phillips (1884-1967), then senior botanist at the National Herbarium in Pretoria, that herbarium specimens of the subjects illustrated be kept, who in turn passed on this suggestion to I. B. Pole Evans (1879-1968), then Director, a principle still adhered to to-day. Lovell Reeve of London was approached to submit a quotation to undertake the lithographic work and subsequent hand-colouring of the plates. Mr A. L. Soper, Chairman of Reeves wrote that "I am myself inclined to the opinion that every plate should contain a vertical section of the flower, ... sometimes a cross-section may be necessary; and a drawing of the fruit. With these it should be necessary, as a rule, to include illustrations of separate organs ...". This observation will explain the strange state of the original illustration, clearly having a strip



Lansdell's original

added below extending the leaf sheath and peduncle and adding details of a cross section of the ovary, style and stigmas, and bract.

The published version, Plate 13 of Volume 1, is altered again with the three right hand lower flowers omitted, the leaf reduced, so that the cross-section seems inordinately fleshy. The details have been re-arranged symmetrically about the section of the leaf and the peduncle. The colours vary from volume to volume since they are all hand-painted and were only coloured as orders were met, hence distanced from the original also in time.

The species *Clivia miniata* was later illustrated by Cythna Letty (1895-1985), but this time as the variety *citrina*. The differences in style allow us to convince ourselves that while serving the so-called objectivity of science, there remains the aspect of subjective style, and this time one of superior artistic talent.



Depiction of Lansdell's work by separate artists showing differing interpretations of colour and tone.





### Artistic interpretation

Which brings me to the last aspect of depicting plants, and in particular *Clivia*, and that is the question of iconography, and hence an iconology or the interpretation of meaning in the depiction. Strictly speaking, scientific illustrations in general and botanical art in particular, should not contain hidden, tacit or covert meaning. However that very art form is in fact an iconography, arising from the premise that nature can be reduced and presented in analytical, essential, objective truth. But even this objectivity is subject to another of the peculiarities of style, and that is the prevailing fashion. As a cultivated decorative plant the *Clivia* is subject to change in taste and fashion, and its mode of depiction too follows these dictates. 19<sup>th</sup> century gardening catalogues demonstrate this clearly, illustrating the century's taste for the orderly, symmetrical and gaudy.

I am not aware of the *Clivia* being used as an iconographic device. The era of plants as *memento mori*, or reminders of death, had passed by the time the *Clivia* was discovered and introduced to the European households. Katherine Saunders' depiction of the fading yellow is purely a matter of circumstance (see CLIVIA 7, pg. 67). We are lucky to have it. The plant at Kew died.

### The future

As a finale I present the following episode. I approached Gill Condy, resident botanical artist of SANBI, as to the possibility of having the species of the genus *Clivia* illustrated. She declined the commission, saying that she was far too busy, and had the prospect of doing some illustrations of *Clivia* for the stamps issued for the Clivia 2006 conference. She suggested that I approach a young colleague

Gill Condy's Illustrations for new South African Stamps







The above four illustrations are by Gill Condy and will be used on stamps in September this year.

whom she was training, Sibonelo, for the commission. Sibonelo Boy Chiliza was born on the 20<sup>th</sup> of April 1979 of Zulu parents in the Port Shepstone area of KwaZulu-Natal Province. He did his Senior Certificate at the Kwa-Fica High School, Mtwalume. Sibonelo's interest in art was aroused when his cousin, who resided in their family home, spent time drawing. Sibonelo spent time making drawings of his own and this decided him on a career in art. When he applied for studies at the Natal Technicon (now the Durban Institute of Technology) his first choice was for a course in art. He was however precluded from this as direction since art as a subject was not in his school curriculum. He thus pursued his studies in his second career choice, textile design. Ms Jean Powell, who makes the recognition and promotion of talent a personal concern, visited the institution and saw that Sibonelo was using floral motifs in his

design. She recommended him to the circle of botanical artists, in particular Elsa Pooley at the Natal Herbarium. Elsa in turn suggested to the publishers of *Zulu botanical knowledge – an introduction*, that he be commissioned for the line drawings to be used as illustrations. Thereafter groups of benefactors sponsored him to attend a botanical art workshop given by Gill Condy in Pretoria in September 2004. She arranged his appointment as an internee at the Pretoria SANBI in March 2005.

At the time that Sibonelo was approached for the commission of illustrating the six *Clivia* species, *Clivia robusta* (collected by Fanie Venter in the 1970's and misidentified as *C. nobilis*, also used for illustration in *Flowering Plants* – see CLIVIA 7, pg. 58) was then blooming in the collection. He prepared this as a sample. He employs the painstaking technique of coloured pencil, which is time consuming. Since there was the added need

of capturing plants in bloom, the six species have taken exactly a year to prepare. The technique of pencil allows for the capturing of the finest detail, down to miniscule dried plant structures and markings on fruits and leaves, all apparent in these illustrations.

Sibonelo is currently in the African Plant Initiation (API) project as Auxiliary Officer at SANBI in Pretoria. As South Africa's first black botanical artist, he is torch-bearer of the African Renaissance, and his seeing hand assures the future of the art.



Above: *Clivia gardenii* fruit  
Coloured pencil drawings by Sibonelo Boy Chiliza  
Below: *Clivia nobilis* roots



*Clivia caulescens* showing aerial roots

*Clivia mirabilis*



# Photography ..... for the Record

## Ian Coates, United Kingdom

A visual image is vital if you are to keep a proper record of your plants. For most people this means photography. If you are like me, as soon as you get your second plant you will want to cross-pollinate and, if this second plant is of a different species, so much the better. You will want to compare any progeny with the parents to see what has transpired and how to breed further. If you produce a plant which is new and original, then you will want to register it and no description is complete without an illustration.



Pot grown plant with a plain background.

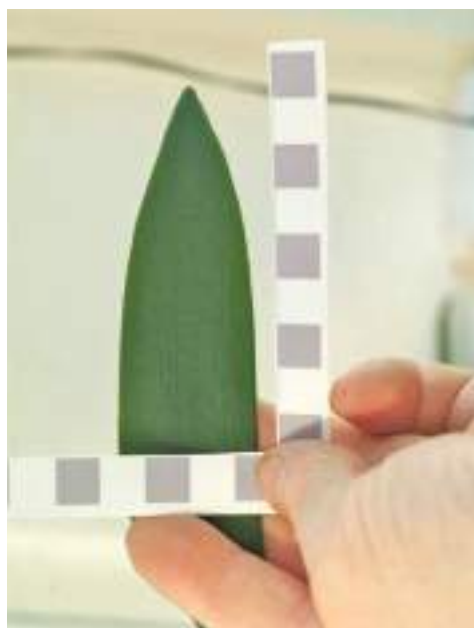
### Equipment

The ideal camera these days is digital. Each image costs nothing, so you can take as many as you like till you get it right, and most models have a close focus facility which you will find useful. However, a simple film camera can be more than adequate with a little practice. Another requirement will be a measuring scale

and you can either make this with the help of a computer or draw one on card. The one I use is marked in centimetres. Bold markings rather than a fine ruler will be easier to see in a photograph. The final desirable item is a colour chart of some kind. If nothing is available, try to include a piece of black and a piece of white paper in your picture of the flower.

### Photography

The main purpose of these pictures is for a record so they need to be true to life rather than of any great artistic merit. It is not only flowers which vary but also leaves. The shape of the tip can help identify a plant and its parents. Be sure to get the leaf square to the camera, so as not to distort its proportions, and place your scale across it. (See instructions for making a scale at the end of the article.)



Picture of leaf with a scale for measuring.



Above: *Clivia* photographed in strong sunlight. Note the high contrast and loss of detail on the flower.

Below: The same *Clivia* shaded from the sun. Note the improved tones and paler, out of focus background.



You will also want an image of the complete plant. One important point here is the selection of background. It does not want to be cluttered so as to obscure the form of the plant. If the plant is growing in a pot, it should be possible to arrange a fairly plain and neutral background, as any strong colour will affect the colour balance of the image.

If the *Clivia* is in habitat, or planted outdoors, it is a good idea to place something such as a board or large card behind it. Where this is not possible, try to photograph with a wide aperture setting on the camera, as this

will throw the background out of focus. A simple but important point is to keep any direct sunlight off the plant. This is easily done using any object as a baffle - or get somebody to stand in the way of the light! By reducing the light falling on the plant, this baffle also leads to a greater exposure, thus lightening the background and further helping the visual separation of the plant.

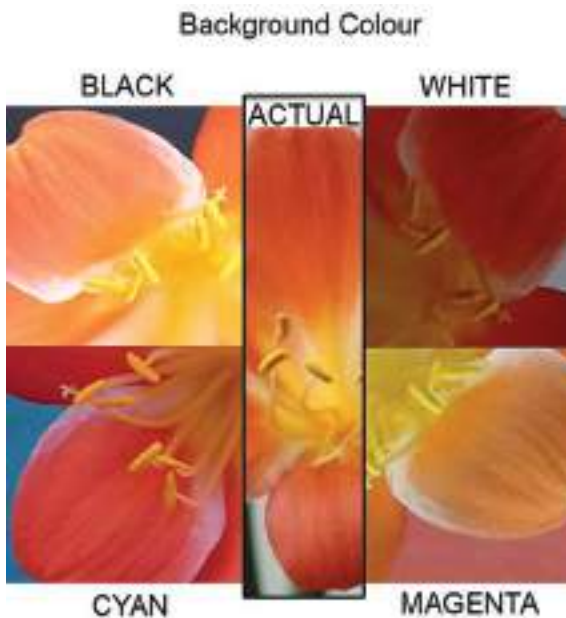
The most interesting and important pictures are those of the flower. Again, avoid a strong colour background which will upset the results regarding both colour and contrast, if taken with an automatic digital camera. Those with computer skills can correct this later, but strong colours will nonetheless tire the eyes of the viewer. As above, shade the bloom, as strong light will produce too high a contrast to be recorded by the camera and will lose detail in the bloom.

Apart from the full umbel also photograph an individual flower both full on and in profile. Include your scale in these pictures and add some form of colour chart, if you have one, in a frontal picture. Even if this chart is not a close colour match, it will form a useful future reference. Ideally, a horticultural colour chart should be used, such as that produced by the RHS ([www.rhs.org.uk](http://www.rhs.org.uk)). Sadly, the cost of this puts it out of range of many people, but the Cape *Clivia* Club have produced a chart in the past which many have. When using your scale or colour chart, try to avoid any shine or shadows which would affect the reference. Apart from the above pictures, I would also photograph any unusual characteristics of the plant. You now have a complete visual record of the plant for future reference and identification.





The same flower on different backgrounds. Note automatic camera 'corrections'.



The same tepal from each of the previous pictures. Note colour, contrast and density changes.

For those who are technically minded, the following is an explanation of why the same flower image photographed against different backgrounds by the same camera can appear to be different in colour and contrast. Each make of camera uses different software to interpret the light falling on the camera sensor (CCD or CMOS). When the camera is in a mode that makes automatic decisions, the 'in camera' processor and software adjusts the shutter speed and aperture as well as the white balance. These decisions, whether automatic or not, will affect the eventual image. The camera software will also interpret the colours it records according to the colour space it works in. Some cameras can change colour space or even have different menu options for recording colour to look natural or more vivid. The bottom line is that the sum of the light reaching the camera lens and sensor, as reflected from the different colours of the subject and its background, will be interpreted and recorded. If, for any reason the light changes, the colours and contrast on the recorded image will also change.



### The full picture

Those with computers might like to resize each image as appropriate, and make a reference sheet for each plant. If you have no computer, merely trim and paste your pictures onto a page.

As your collection increases and you interbreed the plants, you will find such references invaluable. You will also need a page on which to record your written notes on colour, size, parentage etc.!

### Record Album





Flowers viewed against the measuring scale.

The flowers photographed with the centimetre scale and the colour chart make for an excellent record of both colour and size. No photograph is going to record the hue of the flower exactly as it is. The colour chart provides a way to judge the accuracy of the colours in a photo and a reference from which to colour correct in the post-processing of the image.

**Note:** The centimetre scale as shown above can easily be made with a set square, ruler and scissors. Mark up centimetre square blocks on a piece of 300g weight board with a sharp pencil. Colour alternate blocks with a Copic No. 3 grey marker. (Alternatively use a Pantone Marker.) Cut out the right angle shape. All items are easily available from most Art and Paper Shops as well as Stationers.

Photographs by Ian Coates.

Flower photographed with the RHS colour chart.



# The Clivia Society

[www.cliviasociety.org](http://www.cliviasociety.org)

The Clivia Society caters for *Clivia* enthusiasts throughout the World. It is the umbrella body for a number of constituent Clivia Clubs and Interest Groups which meet regularly in a number of South African cities and towns. In addition, the Society has individual members in many countries, some of which also have their own Clivia Clubs. An annual Yearbook and regular Newsletters are published by the Society. For information on becoming a member and / or for details for the following Clivia Clubs and Interest Groups contact the Clivia Society secretary or where appropriate, the International Contacts, at the addresses listed below.

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**INTEREST GROUPS:** Border, Goldfields, Lowveld, Northern KZN, Overberg, Waterberg, Zoutpansberg,

