The miraculous Clivia, an astonishing new species from the arid Northern Cape

Summary

The article discusses a new species of *Clivia* unlike any of the existing summer rainfall taxa in that it is a sun hardy winter growing species from the Northern Cape Province adapted to an arid mediterranean climate. Its tubular bicoloured flowers, orange and green tipped at first becoming orange-red and yellow tipped later, are borne out on shiny orange-red pedicels. These coloured pedicels enhance the scape at flowering but abruptly change to green after pollination. The leaves have a prominent median white stripe on the upper surface.

Introduction

"John, you're interested in the systematics of Clivia, so I think you had better have a careful look at this," said Dr Dee Snijman, a colleague of mine as she laid a pressed dried plant specimen on my lab workbench, one hot afternoon in January 2001. It was what appeared to be, (and indeed was), a tubular-flowered *Clivia* but the locality given on the field ticket, "Oorlogskloof, Nieuwoudtville", in the Northern Cape seemed totally absurd. We had become used to receiving unusual plant material for identification from Wessel Pretorius, Officer-in-Charge of the Oorlogskloof Nature Reserve, yet here was a specimen that defied logic. Clivias simply did not grow in the Northern Cape! Was this a diabolical hoax or a sensational discovery? To our delight the latter proved to be the case.

I showed the specimen to an equally dumbfounded John Winter who has been building up a fine collection of wild-sourced Clivia material at Kirstenbosch. We both agreed: a

personal site visit to view the plants *in situ* was essential, so as to establish the veracity of this record By now it was February and even if the plants were in fruit and not yet in flower, we simply had to see them in their natural habitat.

After receiving a permit from the Northern Cape Department of Nature Conservation, to collect a few live specimens, we set off to meet Wessel Pretorius at Nieuwoudtville, popularly known as “the bulb capital of the world”. February is not the best time to visit this delightful platteland dorp perched on the Bokkeveld escarpment between Van Rhynsdorp and Calvinia, renowned for the world’s most spectacularly speciose display of indigenous bulbs in late winter and spring. As we drove down the dusty main street, with the air temperature at about 35ºC, the sun beating relentlessly on shimmering corrugated iron roofs, I could not help feeling that other than the centre of the Sahara desert there could hardly be a more unlikely place to find a new species of *Clivia.* But the environs of Nieuwoudtville contain such a mosaic of geological systems, such a diversity of landforms, habitats and sheltered refugia, that a huge range of plant species with different ecological requirements find niches for themselves in this area.

Next morning, we were peering over the eastern rim of Oorlogskloof, one of these refugia that has enabled moisture loving plants to survive in an otherwise hostile environment. Oorlogskloof is a spectacular canyon incised through the Bokkeveld escarpment just west of the town of Nieuwoudtville by the now seasonal flow (May–November) of the Oorlogskloof River. About half a kilometre wide and 200 m deep the canyon is edged by a resistant capping of Peninsula Formation Sandstone cliffs. Some 4700 hectares in extent, Oorlogskloof reserve was established as recently as 1983. There is no public vehicular access although an excellent network of hiking trails has recently opened this rugged stretch of countryside to keen hikers, some of whom in all

probability must have seen *Clivia mirabilis* in previous years without realising that it had not been described in scientific literature.

As the sandstone cliff faces have weathered and crumbled over the millenia, tallus screes have formed below them creating a habitat for sparse patches of low, light woodland. It is here on the eastern margin of the canyon that *Clivia mirabilis* makes its home.

Even as Wessel Pretorius guided us down the krans on the morning of 20th February 2001, I could see groups of *Clivia plants* among the huge boulders below. The first thing that struck me was that about half were in full sun, the remainder in very light shade under a sparse tree cover. Clearly this was not only a drought resistant species but one that could take a 6 month roasting under the brutal northern Cape sun with little if any sign of leaf damage. The leaves were also unusual. Each possessed a prominent white stripe down the middle on the upper surface. (Some populations of *Clivia nobilis* also have a median white stripe on their leaves but nothing as prominent as the Oorlogskloof plants). Moreover, the leaf bases were deeply pigmented in rich purple-carmine hues. Several plants bore fruiting heads. The berries were aleady turning from green through yellow to red. They would be ripe within a couple of weeks. Now there was no doubt in my mind. Although we had not yet seen flowering specimens, we were in the presence of a previously unknown species of *Clivia*, growing in a hitherto inaccessable almost virgin habitat, scarcely touched by the hand of man. Most surprising of all, nearly 800 km of karroid semi-desert separated this species from its nearest relative in the Eastern Cape.

Later that year in mid October we returned to Oorlogskloof to study flowering material as well as collect a type specimen from which *Clivia mirabilis* was formally described (Rourke 2002). Its specific epithet (= astonishing, miraculous, to be wondered at), reflects an enduring amazement at the apparently endless surprises nature still has in store for us in this part of South Africa.

Diagnostic Characters

Clivia mirabilis is distinguished by its straight, actinomorphic, bicoloured (orange/yellow) tubular corolla, long drooping pedicels (25–40 mm long) that are orange-red at flowering and green when fruiting; the distinctive single median white striation on the upper surface of the leaves which usually have smooth cartilaginous margins; and the irregularly shaped glebulose-gongyloid berries. The basal part of the leaves forming the leaf sheath is flushed a deep carmine maroon, unlike any other *Clivia* except *C. nobilis* which occasionally produces similarly coloured leaf bases. The orange-red colouration of the pedicels in this species during flowering is a unique character in the genus *Clivia.*

Distribution and Habitat

Apparently confined to the Oorlogskloof Nature Reserve in the Northern Cape, *Clivia mirabilis* is restricted to a small area on the eastern margin of the Oorlogskloof canyon. Populations are known to occur just north of Eland se Kliphuis adjacent to Agterstevlei farm and a little further south around the Driefontein Waterfall. The distance between these sites is approximately 5 km. The species also occurs at a few sites between these two localities.

The margins of the Oorlogskloof canyon are capped with 30 m cliffs of Peninsula Formation Sandstone. This has eroded to form coarse sandstone talus screes below the cliffs that are partly covered in a light woodland of relictual Afromontane evergreen forest elements, principally *Olea europaea* ssp. *africana*, *Maytenus acuminatus*, *Maytenus oleoides*, *Cassine schinoides*, *Halleria lucida* and *Podocarpus elongatus* with additional shade provided by outsize (4m tall) specimens of *Phylica oleoides*. Small groups of *Clivia mirabilis* grow rooted in humus between cracks in the sandstone talus of the rock scree, either as solitary individuals or in small groups. Occasionally some clumps occur in full sun but these tend to have shorter leaves and often show signs of water stress (dried leaf tips). However, the remaining leaves show no signs of sunburn, despite the intense insolation experienced for several months each year. The main population examined extends over several hectares and probably consists of well over 1,000 individuals. Due to the position of these two sites under the eastern cliffs of Oorlogskloof canyon, most plants experience shade until about midmorning after which they are in direct sun.

It is a matter of great surprise that a *Clivia* species is able to survive and thrive in the harsh climatic conditions prevailing in this part of the Northern Cape. The area is characterised by a semi-arid Mediterranean climate with a strictly winter rainfall regime – exactly the opposite climatic conditions experienced by the other four species in this genus. The mean annual rainfall at this site is 414 mm, falling mainly between May and September. Vegetative growth is thus restricted to a brief winter growing period. Situated at an average elevation of between 850–900 m some 100 km inland from the coast, these populations are subject to brief but light frost in winter.

Root System

On excavating several plants in the habitat for cultivation at Kirstenbosch, the enormous root system characteristic of this species was revealed. Large adult plants have a mass of fleshy, succulent roots between half and three quarters of a metre in diameter radiating from the base of the rhizome. Individually these roots are an average 20 mm in diameter. This disproportionally large volume of subterranean biomass gives mature plants an extensive water storage capacity, allowing them to survive the prolonged rainless summers of the Oorlogskloof environment.

Flower colour, development and pollination

Each flower-head bears between 20 and 48 flowers on a purple to carmine flushed peduncle. The general impression of a fully open scape is of bicoloured flowers, orange-red at the base, yellow towards the mouth and with orange-red pedicels. During the development of the flower both perianth and ovary progress through a series of well-marked colour changes. The unopened bud is yellowish but prominently green-tipped and the ovary is also pale green. At flowering the green colouration slowly disappears from the tips of the tepals which take on the same yellow tones as the basal half of the perianth. The pedicels and upper half of the perianth are deep orange-red at this stage. After pollination the yellow colouration disappears and the whole perianth including the ovary takes on a uniform orange/red colour. As the perianth begins to wither, the ovary swells and undergoes an abrupt colour change from orange to bright green, as do the pedicels. No other *Clivia* has pedicels the same colour as the perianth when the flower is fully open.

The purpose of these colour changes is not yet understood but is probably related to pollinator cues. Pollination appears to be by sunbirds. A single sighting of a malachite sunbird probing the perianths was made at Oorlogskloof on 18 October 2001 suggesting that sunbirds could be involved in pollen transfer. However, like the other three tubular-flowered species, *C. mirabilis* may also be a selfer as between 80–90% of the flowers in each umbel are pollinated and produce viable berries. Flowering extends over approximately six weeks, commencing in the first week of October, peaking in mid-October and continuing until about mid-November.

Fruiting

The berries mature more rapidly than in the other *Clivia* species. By the end of February, four months after flowering, the fully developed berries have begun to turn yellow and orange with a few having advanced to the final stages of ripeness in which the pericarp is pinkish and later red. Most berries contain two to three seeds, sometimes one. Occasionally a maximum of seven seeds per berry is produced. The berries have turned red by the end of March and are shed shortly thereafter prior to the onset of the first winter rains in April/May. This rapid autumn maturation of berries is in sharp contrast to the summer rainfall area clivias which mature slowly, usually 12 months for *C. miniata* and *C. gardenii*, about 9 months for *C. caulescens* and *C. nobilis* to co-incide with the commencement of October/November summer rains.

Seed Dispersal and Germination

Berries commence falling passively from the parent plant by late February. By early April the majority of berries have been shed. Germination appears to be rapid in

response to the onset of autumn/early winter rains. At Kirstenbosch seeds sowed on 18 March 2001 had already developed a 10 mm radicle by 10 April 2001.

On germinating, the primary root develops into a swollen, white, succulent cylinder up to 50 mm long, 5–6 mm thick. During the moist winter months (May – September), it swells, accumulating water in its succulent tissue. By October two short (5–10 mm long) leaves have been produced whereafter further vegetative growth of the seedling slows or largely ceases with the onset of summer dormancy (November to April). This rainless phase persists for approximately six months during which time the seedling survives on water reserves stored in the greatly enlarged primary root. Vegetative growth commences again in autumn. Thus the biology of a *C. mirabilis* seedling in its first year is much akin to a winter rainfall area geophyte with the swollen primary root being functionally equivalent to a corm or bulb.

The phenology of the germinating seed described above is clearly an adaptation to a semi-arid mediterranean climatic regime – exactly the reverse of the summer rainfall region *Clivia* species.

Within a few months of germinating, the plumular bud (cotyledon plus first true leaf), becomes densely pigmented with anthocyanins. This prominent development of anthocyanins at the base of the leaves is later evident in the leaf sheaths of adult plants which are heavily suffused with purple-carmine pigments. Why the seedlings of *C. mirabilis* are so densely pigmented with anthocyanins is not clear but it may be a response to the intense levels of sunlight experienced in the natural habitat thereby providing effective screening during the seedlings' critical establishment phase.

Relationships

The distribution ranges of all four previously known *Clivia* species are contiguous or overlap while at many localities different pairs of species occur sympatrically. (*C. nobilis* with *C. miniata*; *C. gardenii* with *C. miniata*; and *C. caulescens* with *C. miniata*.) Geographically, populations of *C. nobilis* in the Eastern Cape, though more than 800 km distant, are the closest spatially to *C. mirabilis.* Moreover, *C. nobilis* also appears to be the closest relative to *C. mirabilis* on morphological grounds. Among these are the tough stiffly erect coriaceous leaves with a median pale striation on the upper surface (some populations of *C. nobilis* occasionally have a faint median striation), and the small seeds.

Breeding Potential

Obviously *Clivia mirabilis* will be of huge interest to breeders on account of its unusual characters. Biologically, its tolerance of intense sunlight should introduce a degree of sun-hardiness to the leaves of its offspring. Coupled with this is its adaptation to an arid winter rainfall climate. Perhaps a line of sun-hardy clivias will eventually be bred that will grow in full sun in mediterranean climates, able to forego watering in summer!

The floral characters, especially the richly coloured pedicels also offer breeding potential in combination with other species.. Speculating any further is an almost hopeless exercise but we may be sure future hybrids will result in character combinations few of us can even imagine at this stage.

Phylogenetic questions

To those of us who have always seen Clivias as belonging to densely forested subtropical environments experiencing a summer rainfall/dry winter climatic regime, *Clivia mirabilis* seems a complete contradiction. Remote and isolated in the arid Northern Cape its very presence in this most unlikely of habitats is a paradox. How did it get there, how long has it been there and how has it survived? These are obvious questions that at once spring to mind.

The heavy fleshy berries are not dispersed by wind. They may be carried short distances by fruit eating birds but in general the seeds germinate within a metre or two of the parent plant. So, long-distance dispersal must be ruled out as a reasonable explanation.

It is more likely that *Clivia mirabilis* is relictual – a survivor of a past phase in the country's climatic history when subtropical vegetation covered much of the interior of South Africa. From the Miocene period about 20 million years before present, increasing aridification eliminated this vegetation type from much of central South Africa leaving survivors like the ancestors of *C. mirabilis* to adapt to the emergence of an increasingly dry climate in the western half of South Africa as the 'proto' Benguela current brought a stream of cold water to the west coast of Africa which ultimately led to the development of a mediterranean type climate (Axelrod & Raven, 1978).

The afromontane forest elements in Oorlogskloof are, like *Clivia mirabilis*, only just surviving in the sheltered microclimate provided by this amazing protected habitat. At

best we can only speculate on the past history of these plants but one thing is certain, they are survivors and as such must command our profound admiration.

Conservation

There will inevitably be a demand from growers and breeders to obtain plants or seeds of *Clivia mirabilis.* At present all populations of this species that are currently known occur in a nature reserve controlled by Northern Cape Nature Conservation, Private Bag X6102, Kimberley. Collecting in Oorlogskloof is strictly controlled. In order to obtain a permit to collect 4 live specimens the National Botanical Institute signed a memorandum of agreement with Northern Cape Conservation which states that "The applicant may not transfer the material or any progeny or derivatives thereof to any third party without the prior informed consent in writing of the Director". This places a responsibility on NBI not to distribute any live material or seeds at this stage. However, we will be making representations to Northern Cape Nature Conservation to allow for the distribution of seed through properly regulated channels at some stage in the future.

Acknowledgements

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References

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Caption:

Johannes Afrika, game guard at Oorlogskloof Nature Reserve who first drew attention to populations of *C. mirabilis* in the reserve.