Phylogenetic relationships of the genus Lachenalia with other related liliaceous taxa

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LIST OF ABBREVIATIONS

µl	Micro Litre
ABI	Applied Biosystems
ARC	Agricultural Research Council
bp	Base pair
CI	Consistency index
cpDNA	Chloroplast DNA
CTAB	Hexadecyltrimethyl Ammonium Bromide
DMSO	Dimethyl Sulfoxide
DNA	Deoxyribonucleic Acid
dNTP	Deoxynucleotide Triphosphate
EDTA	Ethylene Diamintetra Acetic Acid
Ethanol	Ethyl-alcohol
GISH	Genomic *in situ* hybridisation
INDELS	Insertions/Deletions
g	Gravitational Force
IGS	Inter Genic Spacer
$K_2S_2O_5$	Potassium Bisulfide
N	Normal
n	Gametic Chromosome Number
m/v	Mass per Volume
mg/ml	Miligram per Millilitre
mM	Milimolar
NBI	National Botanical Institute
ng	Nanogram
NJ	Neighbour Joining
OD	Optical Density
PAUP	Phylogenetic Analysis Using Parsimony
PCR	Polymerase Chain Reaction
pmol/µl	Picomole per Microlitre
RC	Rescaled Consistency Index
rDNA	ribosomal DNA
RI	Retention Index
RNA	Ribonucleic Acid
SNL	Signal to Noise
TAE	Tris; Acetic Acid; EDTA
Taq. Pol.	*Thermus aquaticus* Super Therm DNA Polymerase
TBR	tree-bisection-reconnection
TRIS	2-amino-2-(hydroxymethyl)-1,3-propanediol
*trn*L	Transfer RNA gene for Leucine
*trn*F	Transfer RNA gene for Phenylalanine
UV	Ultra violet
V	Volts
v/v	Volume per Volume
x	Basic Chromosome Number

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Chapter ONE

Introduction

1.1 HISTORICAL OVERVIEW

Flowering bulbous plants were, throughout the centuries, important to mankind. Not only were they admired for their beauty, but were also associated with mythology, medicine, religion and served as a food supply in certain countries.

The Madonna lily was associated with religious art in the Middle Ages (Eliovson, 1967) and were also painted on the walls of Cretan palaces over 3 000 years ago. The Bedouins used *Urginea maritima* (L.) Baker, the sea onion, to distinguish their boundaries. The courts even used the presence of deep-rooting bulbs as proof of ownership (Eliovson, 1967).

Bulbous plants has been used in medicine and folklore since earliest times. Bulbs have been used in medicine as early as 1554 B.C. as mentioned in the *Papyrus Ebers* of the Middle Empire of Egypt (Barnhoorn, 1995). One such bulb is that of *Urginea maritima* used as a cure for dropsy (Speta, 1980). Since then, numerous medicinal components have been extracted from bulbous plants for the cure of different ailments (Appendix A). Some plants are economically valuable for their medicinal value. Approximately 14% of the plants used for traditional medicine consist of bulbs (Mander, 1997). Primitive tribes use bulbous plants widely for herbal medicines and even witchcraft (Eliovson, 1967). An annual amount of R270 million or 20 000 tons of plant material are harvested, processed and sold as traditional medicine (Gosling, 1998).

Flower essences are used for healing. It works on a similar principle as homeopathic medicine and was introduced in the 1930's by Dr. Edward Bach. It can be used internally as drops under the tongue or in water and externally in massage oils or on the pulse points on the body. These essences are used throughout South Africa as well as in Europe, the United States, Canada, Japan and central and South America. The essences are produced on the slopes of Table Mountain where the wealth of the floral kingdom of the Cape, are exploited (Ball, 1999).

Many of these essences are produce from bulbous species and species with fleshy roots, such as *Agapanthus* L'Her., *Aloe* L., *Zantedeschia* Spreng. (Arum Lily or calla lily), Belladona lily, Bluebell, *Ornithogalum* L., *Clivia* Lindl., *Narcissus* L., *Freesia* Ecklon ex Klatt, *Hyacinthus* L., *Ixia* L., *Watsonia* P.Mill., *Oxalis* L., *Kniphofia* Moench., *Scilla* L., Tiger lily, Tulip Magnolia, Water Lily, *Tulbaghia* L. (wild garlic) and *Dietes grandiflora* N.E.Br. (wild Iris).

The medicinal value of many bulbous plants is reduced by their poisonous nature. *Clivia* seeds are poisonous, as well as the rootstocks of *Gloriosa* L., *Ornithogalum thyrsoides* Jacq., *Haemanthus* L., *Boophone* Herb., *Vallota* R.A.Salisbury ex Herbert, *Homeria* Vent. and *Moraea*

Mill. (Eliovson, 1967). In southern Africa, several other species are poisonous to grazing animals (Speta, 1998). The Bushmen used a bow and poisonous arrow to hunt down their food. *Boophone disticha* (L.f.) Herb. or 'gifbol' is one of the many plants used to produce poison (Porter, 1997).

In addition to its medicinal value bulbs have over the ages been regarded as something sacred and wonderful (Eliovson, 1967). Not only to look at, but also for daily practical uses. A great number of countries have grown bulbs for decorating, from before the Christian era. These include Greece, Egypt, India, China and Korea. Some of the first references to bulbs occur in the Bible where, in the Songs of Solomon, the Rose of Sharon refers to a tulip (*Tulipa sharonensis*), the rose among the thorns is a Lily (*Lilium candidum* L.) and "the desert blooming like a rose" refers to *Narcissus tazetta* L. Lilies were associated with purity and became the flower of the Virgin Mary.

The countryside of the ancient Greeks flourished with flowering bulbs in the spring. This site motivated the artists to use floral motives as designs in paintings on vases and on architectural details (Eliovson, 1967). The classical Greeks cultivated bulbs such as hyacinths, narcissi, ranunculi, gladioli and other bulbous flowers from the 3rd century BC. They made the first mention of bulbs in recorded history (Barnhoorn, 1995). Bulbs have been so important to people, that some were even named after legendary gods: Narcissus, Iris and Hyacinth (Eliovson, 1967). Lilies were, to the Greeks, the symbol of purity and it supposedly arose from the milk that fed the infant Hercules.

Travellers, explorers and collectors have collected bulbs since the 17th and 18th century, because it is easy to transport and has its own food reserves (Eliovson, 1967). Bulbs from the Western Cape became an important part of the world's horticulture industry and numerous genera have been popularised by the Dutch Bulb Growers of the Netherlands. In the 18th century, bulbous plants were found not only in the greenhouses in Holland, but also in England, Austria, Sweden, Italy and France. The Cape flora was especially popular because of its diversity.

A few members of the Hyacinthaceae are also occasionally eaten by humans. In Greece the bulbs of *Muscari comosum* (L.) P.Mill., ironically called the grapehyacinth, are pickled; in France the inflorescences of *Loncomelos pyrenaicus* (Kern.) Holub are used as vegetables, and Bushmen in Africa eat the bulbs of *Ledebouria apertiflora* (Bak.) Jessop and *L. revoluta* (L.f.) Jessop. The western species of *Camassia* Lindl. once yielded a food called quamash or camas by some North American tribes of Indians (Speta, 1998).

The many uses of these bulbous plants unfortunately contributed to the fact that many of these species are today considered to be endangered. Bulbs are destructively harvested,

processed, sliced or chopped and sold for the treatment of various ailments. The plants are harvested without permits and the enforcement of the existing legislation is ineffective in hampering the local and international trade of the bulbs (McCartan & Van Staden, 1999). *Scilla natalensis* Planch. has a special protected conservation status, but there are still approximately 95 tons of illegal *Scilla* bulbs traded (at a cost of R1.89 to R6.80 per kilogram) in Durban annually (McCartan & Van Staden, 1999). *Bowiea volubilis* Harv. & Hook. f. is another popular medicinal species and is sold at a price between R11.74 to R27.80 per kilogram (Mander, 1997). The bulbs of these species are sold at an inclining price but there is a decline in their availability and size (Cunningham, 1988). These actions are reducing the density, distribution and genetic diversity of wild populations (McCartan & Van Staden, 1999).

Today bulbs form an integral part of the world floriculture industry. Bulbs like *Alstroemeria*, *Freesia*, *Gladiolus* L., *Tulipa*, *Narcissus* and *Lilium* L. are some of the most important cut flowers on the Dutch auctions (Information from weekly issues of '*Vakblad voor de Bloemisterij*' Feb-Sept 2003). The areas assigned to ornamental bulb production in 1993 in the Netherlands was approximately 16 000 ha, representing 55% of the world's total production area. The other 45% of the ornamental bulb production areas are in the USA (4 449 ha), the UK (4 300 ha), Japan (1 622 ha), France (1 285 ha) and South Africa (425 ha) (De Hertogh & Le Nard, 1993a). Only small portions of these areas (3%) are used for the production of the genera from the family Hyacinthaceae: *Eucomis* L'Hér. (2 ha), *Galtonia* Decne. (1 ha), *Hyacinthus* (955 ha), *Ornithogalum* (50 ha), *Scilla* (20 ha) and *Urginea* Steinh. (3.2 ha). There are considerable ornamental potential for most of the genera of the family Hyacinthaceae. Many of these have pot-plant potential (i.e. *Hyacinthus*, *Lachenalia* J.Jacq. ex Murray and *Scilla*) and garden-plant potential (*Eucomis*, *Ornithogalum* and *Urginea*) (De Hertogh & Le Nard, 1993a, b; Le Nard & De Hertogh, 1993).

There are approximately 20 000 plants species occurring in South Africa, of which almost 14% (2 700 species) from 15 families can be classified as bulbous plants (Ferreira & Hancke, 1985). And of these, species of genera such as *Eucomis*, *Veltheimia* Gled., *Galtonia*, *Lachenalia* and others are cultivated as ornamentals (Speta, 1998). Although some species such as *Freesia*, endemic to South Africa, are cultivated in other countries, *Lachenalia* is one of the few genera cultivated in its country of origin and exported to other countries.

This dissertation will focus on one of these bulbous genera, *Lachenalia*, but will always try to put it into perspective with other genera.

1.2 A GENERAL OVERVIEW OF THE GENUS *LACHENALIA*

Lachenalia is a small, bulbous plant of the family Hyacinthaceae (Duncan, 1988). The genus name, *Lachenalia*, originated after Jacquin described *Lachenalia tricolor* Thunb. [currently named *L. aloides* var. *aloides* (L.f.) Engl.] in 1787. He named the genus after Werner de Lachenal, a Swiss professor of botany (Barker, 1930). The popular name for this genus is the Cape cowslips or in Afrikaans, "viooltjies", "kalossies" or "naeltjies" (Crosby, 1986; Coertze & Hancke, 1987). The Hyacinthaceae is a predominantly southern African family, comprising 27 genera and approximately 360 species in this area, with *Lachenalia* being the largest genus consisting of approximately 120 species (Duncan, 1992).

Interest in *Lachenalia* increased after the establishment of the Gardens of the Dutch East Indian Company in 1652 (Barker, 1989). This resulted in species appearing in many European gardens. Scientists collected watercolour paintings of *Lachenalia* species, which later served as important scientific documents. These paintings became very valuable family heritages. There are currently seven paintings preserved, of which the most important painting is presently in the *Trinity College Library* in Dublin. This painting resulted from Simon van der Stell's expedition to Namaqualand during 1685/6 and is the earliest colour document of the genus with a definite date. However, the name of this species was first officially published in 1784, a century later. This species, which was collected on route to Namaqualand, was first named *Phormium hirtum* Thunb. and renamed by Thunberg (1794) as *Lachenalia hirta* (Thunb.) Thunb. (Barker, 1989).

It is not known when the first species was introduced into Great Britain, but *L. orchioides* (L.) Ait. was cultivated and had flowered in that country before 1752. This was the first species recorded. From 1752 onwards, new species appeared at irregular intervals, a large addition to the number being made by Masson in 1774. *L. aloides* var. *aloides* (= *L. tricolor*) appeared in 1790, and in 1884 three new species were introduced by Ware, and named by Baker, i.e. *L. fistulosa* Bak., *L. lilacina* and *L. odoratissima*. The first authenticated garden seedling was *L. nelsoni*, which was raised by the late Rev. John Nelson and flowered in 1880 (Moore, 1891).

Lachenalia is endemic in southern Africa with a very wide distribution area from the south-western region of Namibia, south throughout the Northern, Western and Eastern Cape Provinces of South Africa, to as far inland as the south-western Free State. The genus is mainly concentrated in the Mediterranean-type climate areas with a winter rainfall, and the majority of the species follow a winter growth cycle; rapid vegetative growth in autumn and winter,

followed by flowering in late winter and spring, followed by a long dormant period during the hot, dry summer (Ornduff & Watters, 1978; Duncan 1992). All *Lachenalia* species are deciduous, and those occurring in areas of year-round rainfall or predominantly summer rainfall also follow the winter growth cycle. Just a single species, the dwarf *L. pearsonii* (P.E.Glover) W.F.Barker from southern Namibia is known to follow a summer rainfall growth cycle (Duncan, 1992). Different soil types, e.g. humus-rich soil, mineral-rich soil, nutrient-poor soil and limestone, accommodate different species (Duncan, 1988). Most of the species grow in sandy soil, and *L. rubida* Jacq. and *L. bulbifera* (Cyrillo) Engl. (= *L. pendula* Ait.) are found in white sea-sand (Barker, 1930).

Lachenalia consists of species with considerable character and beauty (Crosby, 1986). The Indigenous Bulb Growers Association of South Africa (IBSA) determined in 1985 that the genus *Lachenalia* was the second most popular genus in the world, besides *Gladiolus* (Duncan, 1988). The advantage of this genus is that the most colourful plants are produced by low temperatures (Crosby, 1986), making it suitable for countries with lower temperatures.

As a result of its popularity as houseplant and as export product to overseas countries, this genus has important economical implications for South Africa. Numerous countries have developed an interest in the cultivation of *Lachenalia* and a number of publications on this aspect of *Lachenalia* have been published (Duncan, 1988). Other studies on the genus include the chromosome number and morphological variation in *Lachenalia bulbifera* (Kleynhans & Spies, 1999), the origin of adventitious buds on cultured *Lachenalia* leaves (Niederwieser & Van Staden, 1990) and *Lachenalia* breeding (Lubbinge, 1980; Malan *et al.*, 1983; Lubbinge *et al.*, 1983a, b, c, d; Ferreira & Hancke, 1985; Hancke & Coertze, 1988; Coertze *et al.*, 1992; Kleynhans & Hancke, 2002; Reviewed by Kleynhans, 2004).

A five phase breeding programme for *Lachenalia* was initiated and established in 1965 at the Agricultural Research Council's Roodeplaat Vegetable and Ornamental Plant Institute (ARC-Roodeplaat). Two important considerations in the programme are to earn foreign exchange and to create employment opportunities (Niederwieser *et al.*, 1998). This includes the establishment of a genebank (preserving of biodiversity) and the development and evaluation of hybrids for commercialisation of these bulbs. From 1966, 25 cultivars have been released (Kleynhans, 1997). The aim of hybridizing the genus is to cultivate ideal pot plants. This includes plants with attractive leaves, bigger flowers, more flowers per inflorescence, variation in the shape and orientation of the flower on the inflorescence, more than one inflorescence per plant, a greater colour variety and a longer flowering period (Coertze & Hancke, 1987). The establishment of a successful international flower market for *Lachenalia* hybrids could initiate

other breeding programmes, therefore, increasing the popularity of these and other species (McCartan & Van Staden, 1999).

The genus is mainly distinguished by characters of the perianth, in which there are two distinct rows more or less united into a cup at the base (Moore, 1891). The flowers of the genus are arranged in a spike on a 200 to 250 mm high fleshy stem. The tubular or bell-shaped flowers have colours ranging from shades of red, green, blue, purple, yellow and white (Hancke & Liebenberg, 1990). The attachment, size, shape and colour of the flowers of *Lachenalia* differs (Duncan, 1988). *Lachenalia* has outer tepals that are considerably shorter than the inner tepals. This is in contrast to the other genera from the family Hyacinthaceae where the outer and inner tepals are more or less equal in shape and the outer ones usually being slightly longer (Speta, 1998). *Lachenalia*, together with *Eucomis*, *Veltheimia*, *Polyxena* Kunth, *Ledebouria* Roth, *Barnardia* Lindl. and *Bowiea* Harv. ex Hook.f., have completely syncarpic ovaries and a style with three separate stylar channels (Speta, 1998). Bees and butterflies guarantee cross-pollination (Barker, 1930).

There are six embryo sac types in the family Hyacinthaceae, with *Lachenalia* forming a Helobial endosperm. Other genera with the same type of embryo sac are *Muscari* Mill., *Puschkinia* Adams, *Prospero* Salisb., *Drimiopsis* Lindl. & Paxton, *Veltheimia*, *Eucomis*, *Galtonia*, *Bowiea*, *Urginea* and *Ornithogalum* (Speta, 1998).

The fruit is a loculicidal capsule, which is membranous. The general outline of the capsule is ovoid and more or less triquetrous. The capsules splits open and the seeds fall to the ground where it is spread by ants (Barker, 1930).

The size (5 mm - 35 mm) and shape of the bulbs vary (Duncan, 1988). The leaves in the genus usually occur in pairs, but there are several species with a single leave such as *L. anguinea* Sweet., *L. unifolia* Jacq. and *L. hirta*. Some species, such as *L. contaminata* Ait. and *L. orthopetala* Jacq., may contain as many as eight leaves (Barker, 1930). The leaves also differ in width, length and shape. The leaves can be smooth or hairy. Spots and stripes on the leaves and flower pedicles are common characteristics of this genus. The colour and density of the spots vary between aspects and different localities. Some species growing in the sun will have purple spots on the leaves and no spots when growing in the shade. The pustules of some species vary in size between different localities (Duncan, 1988).

The conservation status of most *Lachenalia* species is such that they are not under immediate threat in the wild. This is either due to their wide distribution and fertile nature (eg. *L. bulbifera* and *L. contaminata*), or to the fact that many of the species are naturally rare, and often occur in relatively inaccessible terrain (eg. *L. buchubergensis* Dinter and *L. schelpei*

W.F.Barker). An increasing number of species can become vulnerable or endangered because of the severe habitat destruction in many parts of the Western Cape Province. The species *L. arbuthnotiae* W.F.Barker is an example of a once very common species on the Cape Flats near Cape Town that is at present restricted to a small area of protected natural habitat. Three species of the west coast of the Western Cape are now under immediate threat in the wild due to agricultural activity: *L. mathewsii* W.F.Barker, *L. viridiflora* W.F.Barker and *L. purpureo-caerulea* Jacq. (Duncan, 1992). Other species that are either extinct or threatened are *L. buchubergensis*, *L. klinghardtiana* Dinter, *L. namibiensis* W.F.Barker, *L. nordenstamii* W.F.Barker, *L. nutans* G.D.Duncan (Golding, 2002). The species *L. polyphylla* Bak. was recently rediscovered in the Western Cape and is critically endangered. The species *L. giessii* W.F.Barker is at a lower risk of extinction (Golding, 2002). Fortunately though, all the above species show horticultural potential, and are in various stages of being established in cultivation (Duncan, 1992).

The genus *Lachenalia*, a member of the family Hyacinthaceae and subfamily Hyacinthoideae (Speta, 1998), is variable and is therefore difficult to delimit (Crosby, 1986). Problems of variability in classification in general, particularly at the species level, were usually ascribed to 'intra-specific variation'. Taxonomists drew very wide specific delimitations, or split the group into small restricted entities. It was only speculated that putative hybrids existed and botanists believed that hybrids do not exist unless they have been proved to exist. Hybridisation was not accounted for in revisions of genera in which we know, or suspect, that hybridisation is continuously taking place (De Winter, 1969). Gene flow fails as a criterion for species definition in plants because of interspecific hybridisation and uniparental reproduction. Species are rather defined using a wide range of evidence that a group of populations forms an independent evolutionary lineage, using mainly morphological data. There are more morphological differences between members of different genera than within a genus (Judd *et al.*, 1999). Evolution is a major source of diversity but it simultaneously blurs the boundary between species. Plant systematic diversity is strongly shaped by breeding systems. Less variation occurs with uniparental reproduction (i.e. by self-fertilization or asexuality) than in groups with biparental reproduction (Judd *et al.*, 1999).

In order to determine the phylogenetic position of *Lachenalia* among the various bulbous plants, it is necessary to give a brief overview of the theoretical aspects of the systematics of the bulbous plants and the methods used to determine phylogenetic relationships.

1.3 SYSTEMATICS

Systematics is important to assist in the understanding of and communication about the natural world. The basic activities of systematics, i.e. classification and naming have been implemented since ancient times to deal with information about the natural world. Plant species are widely used for food, shelter, fibre for clothing and paper, medicines, tools, dyes and other uses. This is partly due to our systematic understanding of the biota of these species (Judd *et al.*, 1999).

Systematics can be used to guide the search for plants with potential commercial importance. The discovery of a new species of the tomato genus (*Solanum* L.) in the Peruvian Andes, is such an example. The new wild relative of the tomato (*Solanum chmielewslkii*) was crossed with a cultivated tomato, thus introducing genes that improved the taste of the tomatoes. Yield, disease resistance and other desirable traits have been introduced in this manner in crops, commercial timber species and horticultural varieties (Judd *et al.*, 1999).

Systematics is dedicated to discovering, organizing, and interpreting biological diversity. It includes the following tasks:

- Taxonomy: The science of discovering, describing, and classifying species or groups of species.
- Classification: The grouping of species, ultimately on the basis of evolutionary relationships.
- Phylogenetic analysis: The discovery of the evolutionary relationships among a group of species (Anonomous, 1994).

To classify and group things appears to be a fundamental human instinct (De Winter, 1969). Plant taxonomy is one aspect of this process. Taxonomy is the science of grouping individuals into species, arranging these species into larger groups, and giving these groups names, thus producing a classification. Classifications are used to organize information about plants (Judd *et al.*, 1999). Taxonomy thus provides a framework for the meaningful expression and synthesis of biological information (Anonymous, 2001). In order to understand plant diversity, one must have a good and reliable system of classification that can be used as a reference system of information (Anonymous, 2001).

An example of taxonomic difficulties on generic level is with *Asparagus* L. The family Asparagaceae oscillated between one and three genera since 1753 and has been changed six

times without any final conclusion on the outcome of the classification (Kleinjan & Edwards, 1999). The same can be said for the genus *Lachenalia* where there is uncertainty whether the genus *Polyxena* are a separate genus or should be included within *Lachenalia* (Van der Merwe, A. – personal communication).

Current classifications usually do not represent phylogenies, but rather the product of a long human history, which makes systematics a history-bound discipline. Botanists have over centuries sought a natural classification, and its principles were first outlined by Caesalpino. A.-L. de Jussieu described in his *Genera plantarumi* of 1789 the genera and families and placed it in classes based on the "natural" method. This Jussiaean foundation is the basis for our current classification (Judd *et al.*, 1999).

One of the reasons why it is necessary to classify, is it has predictive value: An example is the case of taxol and cancer. Taxol, a natural powerful drug agent against ovarian and breast cancer, is derived from the bark of the Pacific Yew (*Taxus brevifolia* Nutt.). The bark of three trees provides sufficient taxol for a single cancer patient, and unfortunately, the trees are killed in the process. Because the evolutionary relationships in the Pacific Yew were known, researchers could examine its close relatives. This led them to discover that a small quantity of leaves from the European Yew (*Taxus baccata* L.) can also be used to synthesize taxol, at a lower cost without harming the European Yew (Anonomous, 1994).

Various methods can be used to contribute to systematic studies. Two methods often used are cytotaxonomy (the use of chromosome numbers and meiotic chromosome behaviour) and molecular systematics (the use of any molecular data to determine the evolutionary history of a taxon).

1.3.1 Cytotaxonomy

There are numerous ways in which karyology (the studying of the nucleus) can be implemented in a systematic study. Karyology include the chromosome number, chromosome morphology (size, structural features and chromosome banding) and meiotic chromosome behaviour. The karyotype consists of the chromosome number, chromosome morphology, the position of the centromere and special banding patterns and is used in systematic investigations as well as supplementing morphological data in plant taxonomy (De Winter, 1969; Judd *et al.*, 1999).

Chromosome numbers are a useful systematic character. Not only may similar chromosome numbers (especially similar basic chromosome numbers) indicate close relationships, but by studying the karyotype of different species, their position in the evolutionary process can be revealed (Greilhuber, 1995). For example the species with the most symmetrical chromosomes in the genus *Paphiopedilum* Pfitz, is the most primitive species (Harding *et al*., 1991).

Chromosome numbers were often regarded as constant for any given species, but are much more variable (De Winter, 1969; Guerra, 2000). Different chromosome numbers within a species occur frequently (Judd *et al.*, 1999). Variation in chromosome number within a genus or even species are the result of different factors such as the presence of accessory or B-chromosomes and the loss or gain of euchromosomes (De Winter, 1969).

Another source of variation in chromosome number in most ornamental plants is evolution, i.e. polyploidy, dysploidy, or aneuploidy. Numerical and structural changes in chromosomes together with a variety of point mutations changes result when chromosomal reorganisation at various levels occurs (Singh, 1991). Structural rearrangements can also occur where a gain and loss of chromosome fragment can lead to an entirely altered karyotype, possessing the original number of chromosomes (Sacristán, 1971; Gould, 1982). This can result in misinterpretation of data concerning the evolutionary processes and phylogenetic relationships. Centric fusion results in the reduction of chromosome number without the loss of genetic material (Ashmore & Gould, 1981; Murata & Orton, 1984).

The formations of polyploid and aneuploid cells or chromosome mosaicism also contribute to variation in chromosome numbers. These formations are a result of errors in mitosis or meiosis (Singh, 1991). Especially in species with many small chromosomes, it is difficult to detect minor deviations from euploid numbers. Pseudo-euploidy may also occur where individual chromosomes are simultaneously gained and lost, which results in an euploid number. These changes are responsible for wide variation occurring in domesticated and ornamental plants (Singh, 1991), and these influencing factors must therefore be considered when using chromosome numbers as an aid in the delimitation of taxonomic groups (De Winter, 1969).

Despite some of the problems associated with chromosome studies, it has successfully been used in assessing relationships between individuals, populations and species (Harding *et al.*, 1991). An example is from the genus *Lantana* L. (family Verbenaceae) with somatic chromosome numbers of 2n = 22, 24, 33, 36, 44, 48, 55 and 72. This genus has two basic numbers (x = 11 and x = 12). It seems, according to meiotic studies, that univalents are formed, indicating that many of the triploids are hybrids. Chromosome numbers were critical data in

resolving the classification problem in this genus (Spies & Stirton 1982a & b; Spies, 1984a & b; Spies & Du Plessis 1987; Judd *et al.*, 1999).

Mitotic or meiotic cell divisions can be used to determine chromosome numbers, but meiotic cell divisions are studied most often because it contains more information than mitosis about relationships of genomes (Harding *et al.*, 1991). The study of chromosomes together with techniques like quantification and identification of DNA, will provide important evidence of their evolution. It will also provide information on how to manipulate them through mutation, chromosome mediated transformation, *in situ* hybridisation etc. to develop and improve ornamental species and hybrids.

1.3.2 Molecular systematics

Molecular systematics is the use of DNA and RNA to infer relationships among organisms. The supporters of molecular systematics thought that molecular data are more likely to reflect the true phylogeny of an organism than morphological data, because they reflect gene-level changes. These changes were thought to be less subject to convergence and parallelism than morphological traits. Molecular data are subject to the same problems as morphological data, but has more molecular characters available. This promotes the interpretation of the data and molecular data are, therefore, widely used for generating phylogenetic hypotheses (Judd *et al.*, 1999).

A wide variety of biological criteria such as morphological similarities were traditionally used to try and deduce relationships among plant groups. Other criteria were similarities with respect to plant secondary metabolites, isozymes, and other protein systems. Methods that permit a direct assay of mutational differences at the level of DNA have great promise for systematic biology (Clegg & Durbin, 1990). That is why, during the last half of the twentieth century, molecular genetics and biochemistry were becoming increasingly important as tools for understanding evolution, thus resulting in a rapid incline in applying macromolecular techniques and data for plant systematic studies (Judd *et al*., 1999; Crawford, 2000).

Many different molecular techniques have been implemented, i.e. protein-techniques (serology, amino acid sequencing, enzyme electrophoresis) and DNA-techniques {RFLPs (Restriction Fragment Length Polymorphisms), RAPDs (Random Amplified Polymorphic DNA), AFLPs (Amplified Fragment Length Polymorphisms), and sequencing of the DNA}.

However, of all the "new" data sources that became available during the last 50 years, the impact of DNA data on plant molecular systematics is phenomenal (Crawford, 2000).

Such an example is the use of restriction site analyses to generate maps of individual genes or entire genomes (Judd *et al.*, 1999). Restriction endonucleases are also used for analyses of molecular differences among DNA samples (Clegg & Durbin, 1990). The restriction site analysis of the chloroplast genome (cpDNA) is popular because of the relatively straightforward methodology to generate useful information, compared to the time-consuming and cost effectiveness of other methods such as amino acid sequencing and DNA-DNA hybridisation (Crawford, 2000). Restriction site studies can be used for studying variation in the chloroplast genome and in ribosomal RNA spacers. These studies are also useful in assessing variation among PCR fragments (Judd *et al.*, 1999).

Molecular data have, in many cases, supported the monophyly of groups that were recognized based on morphology (e.g. Poaceae, Fabaceae and Rosaceae). Molecular data have also allowed the placement of taxa whose relationships were known to be problematic. An example is the traditional placement of the Hydrangeaceae in or near the Saxifragaceae, although it was clear that the two were unrelated. Molecular data indicated that there was a strong alternative for the placement of the Hydrangeaceae in the order Cornales (Judd *et al.*, 1999). Other work also strongly supported the utility of DNA studies in biosystematic research (Palmer 1987; Ritland & Clegg 1987; Clegg & Durbin, 1990).

The sequencing of DNA is a popular technique often used by systematisists. By sequencing DNA the order of nucleotides of a total gene, parts of genes or noncoding regions are determined (Judd *et al.*, 1999). The sequences can be obtained with the PCR (polymerase chain reaction) method or by cloning a fragment of DNA. The PCR method is easier to use and eliminates the need for molecular cloning. The PCR method allows the production of DNA fragments suitable for sequencing in an overnight series of reactions, decreasing the time from having crude DNA to preparing a complete DNA sequence (Clegg & Durbin, 1990).

Analysis of DNA sequences allows one to compare bases individually. This results in much lower levels of homoplasy than site mapping, where changes at any of six positions can cause a site loss (Palmer *et al.*, 1988). Base-to-base comparisons of nucleotides also afford the highest resolution of inherited mutations in DNA molecules and can be applied to higher-order plant systematics. Advances in computer technology and innovations for the manipulation of nucleic acids permit phylogenetic analysis of homologous sequences of DNA from a large number of organisms (Duval *et al.*, 1993).

Some of the reasons for the choice of sequences as the primary data for classification are:

- Their scope ('level of universality') is much greater and the sequences do not replace morphological character but supplement them (Penny *et al.*, 1990). DNA sequence data are also independent of other biological characters, in the sense that no assumptions about relationships are necessary to infer phylogenies from sequence data (Clegg & Zurawski, 1990).
- Sequences that are appropriate for the time of divergence of a group being studied can be selected. For taxa which have diverged more recently, faster evolving sequences are required and slower evolving sequences are needed for older groups.
- Sequence data possesses a large number of potential characters.
- There is more knowledge about the genetic mechanisms responsible for nucleotide change than for morphological characters (Penny *et al*., 1990).
- The problem of length mutations are avoided by sequencing a gene, and a greater phylogenetic distance are gained, since many genes are more conserved than the genome as a whole (Palmer *et al*., 1988).

In 1993, DNA sequencing studies already accounted for about 50% of all molecular systematic investigations (Sanderson *et al.*, 1993). Presently, the sequencing of DNA is frequently and successfully used in systematic studies, but there can be a few problems associated with the use of sequencing in systematic studies.

The first problem that can occur with sequencing is to obtain the sequence (Crawford, 2000). There are several reasons why amplification cannot occur, for example "dirty" DNA, not using the optimum amplification cycles etc. Secondly, the polymerase chain reaction (PCR) technique, that is used to amplify the DNA fragment, may introduce occasional errors. This could affect the phylogeny. This is especially true when the sequences are very similar. This potential problem is, however, overcome by sequencing both strands of the area (Judd *et al.*, 1999).

A third problem is that direct sequencing will not generally reveal the minor variants of the sequence if they are present, especially in highly repetitive genes such as ribosomal genes. Many copies are often not identical, and direct sequencing cannot distinguish between alleles of the same gene. If a base differs between two alleles, it will be impossible for the automated sequencer to determine which allele has which base at a specific position. This problem can be overcome by cloning the PCR products (Judd *et al.*, 1999).

Not only may there be problems with obtaining the sequences, but also with the analyses of the data. Certain critical decisions in the alignment of the sequence cannot be determined by the

alignment programmes (Crawford, 2000). This human intervention makes the alignment not objective and allows errors to occur.

Other problems with the analyses may occur with the final tree building step. These problems can be divided into three groups: 'sampling error' (where the sequence is too short or the sequence does not represent the whole genome), 'methodological problems' (such as ignoring INDELS – insertion or deletion event) and 'human errors' (typing errors, etc.) (Penny *et al.*, 1990).

It is necessary to do thorough research on the different genomes and genes suitable for sequencing, before a sequencing study is initiated.

A plant cell contains three different types of genomes namely nuclear, plastid and mitochondrial and each of these are inherited in a different manner (Harding *et al.*, 1991). The plastid and mitochondrial genomes are usually inherited uniparently (mostly maternal in angiosperms). The nucleus is inherited biparentally (Judd *et al.*, 1999). The inheritance and control of expression of the nuclear genome has been studied the most. It is the largest genome and contains the majority of horticultural important genes (Harding *et al.*, 1991). The mitochondrial genome is between 200-2500 kbp and the chloroplast genome is between 135-160 kbp (Judd *et al.*, 1999).

Each genome has specific advantages and disadvantages and each presents somewhat different technical problems. It is clear that the investigator is faced with two major choices. First, the appropriate genome or gene must be chosen to best address the specific biosystematic question at hand and, second, the appropriate molecular method must be selected. Different genes evolve at markedly different rates and provide varying degrees of genetic resolution among plant groups. It is important to select a molecule that provides the appropriate degree of genetic resolution (as measured in mutational change) for the groups to be investigated. The molecular study of some genes is demanding in technical expertise (e.g. most plant single-copy nuclear genes). If the goal is to collect data on a large number of plant lineages, then it is important to choose a molecule, which can be easily assayed (Clegg & Durbin, 1990).

There are several reasons why the use of mitochondrial genome (mtDNA) is limited for biosystematic studies. Firstly, the mitochondrial genome is very large and is therefore more difficult to isolate pure mtDNA (Palmer 1988). Secondly, the mitochondrial genome is circular and rearranges itself regularly. Many rearrangements can occur within the same cell, and can, therefore, not be used to infer relationships between species.

The molecule most often chosen for plant biosystematic research is the chloroplast genome (cpDNA) (Clegg & Durbin, 1990). The average length of the cpDNA is about 150 kbp in angiosperms and accounts for less than 0.1% of the genetic complement of plants. The chloroplast genome (cpDNA) has dominated studies on plant molecular evolution. There are several reasons for the focus on this single, circular organelle (Curtis & Clegg, 1984):

- It is an abundant component of total cellular DNA (Palmer *et al*., 1988; Clegg & Zurawski, 1990; Clegg *et al*., 1997). It is thus relatively easy to extract, purify, analyse (Clegg & Zurawski, 1990) and characterise cpDNA. It is also relatively easy to clone and sequence chloroplast-encoded genes (Clegg & Durbin, 1990).
- It has a conservative rate of nucleotide substitution. This slow rate of molecular evolution of cpDNA (Zurawski and Clegg, 1987; Palmer *et al.*, 1988; Clegg *et al.*, 1997) is ideal for studying plant phylogenetic relationships at or beyond the family level (Clegg & Zurawski, 1990), thus among major taxonomic groups (e.g. orders, subclasses, classes and phyla) (Clegg & Durbin, 1990). Conservative rates of cpDNA evolution have both a technical and a fundamental advantage: The fundamental advantage is that the cpDNA sequence change is appropriate in resolving relationships at deep levels of evolution (Clegg & Zurawski, 1990). Land plant cpDNA as a whole has a low rate of nucleotide substitution, but there are rate differences among specific chloroplast genes (Palmer *et al*., 1988). And despite its conservative mode of evolution, numerous cases of intraspecific variation have been reported (reviewed by Soltis *et al.*, 1991).
- There is extensive background of molecular information on the chloroplast genome (Clegg & Zurawski, 1990), such as the molecule structure, evolution, and organisation of the chloroplast genome (Clegg & Durbin, 1990). Complete DNA sequences of three cpDNA genomes are already known (Clegg & Zurawski, 1990).

The chloroplast genome consists of coding and noncoding regions. The noncoding regions tend to evolve more rapidly than the coding regions (Wolfe *et al.*, 1987; Zurawski & Clegg, 1987; Wolfe & Sharp, 1988; Clegg & Zurawski, 1991). Noncoding regions of cpDNA may be more appropriate for working at lower taxonomic levels because the smaller size of the regions has more informative sites to be analyzed (Gielly & Taberlet, 1994).

Mutations are responsible for evolution in the chloroplast. Two types of mutations occur in cpDNA – point mutations (single nucleotide pair substitutions) and rearrangements, with several kinds of rearrangements recognized. The most frequent mutations in noncoding regions are point mutations and insertions/deletions (INDELS) (Palmer *et al.*, 1988).

INDELS probably arise from slipped-strand mispairing during replication (Goldenberg *et al.*, unpublished data). Many INDELS also seems to be associated with short direct repeats (Zurawski *et al.*, 1984). Particular noncoding regions may, due to this association of INDELS with direct repeats, experience higher rates of these mutations because of local sequence features. It also seems probable that INDELS may recur at specific sites, thus contributing to homoplasy in evolutionary studies (Goldenberg *et al*., unpublished data).

INDELS accelerates the divergence of noncoding regions (Zurawski *et al.*, 1984) and accumulate in noncoding regions at a rate that is at least equal to nucleotide substitutions (Curtis & Clegg, 1984; Wolfe *et al*., 1987; Zurawski & Cle gg, 1987; Clegg & Zurawski, 1990).

Although point mutations can profitably be used for phylogenetic studies at all taxonomic levels (Palmer *et al*., 1988), the systematic use of noncoding INDELS can become very useful below the family level (Palmer, 1987; Palmer *et al.*, 1988; Clegg *et al.*, 1991).

Chloroplast DNA data is an important new tool for the reconstruction of plant phylogenies between closely related species (Clegg *et al*., 1997). Noncoding sequences of cpDNA have the ability to resolve plant phylogenies at the intrageneric level. Both nucleotide substitutions and INDELS in noncoding cpDNA were successfully used to determine the phylogenetic relationship among species of the genus *Gentiana* (Gielly & Taberlet, 1994).

The typical chloroplast genome of land plants consists of approximately 120 genes. These genes encode for four ribosomal RNAs (rRNA), 30-31 transfer RNAs (tRNA), approximately 55 proteins of known function, and about 30 unidentified proteins (Palmer *et al.*, 1988). The number of protein coding genes is approximately 100 in addition to rRNA and tRNA genes (Sugiura, 1992). The average chloroplast genome has about 120 kb of unique sequences. This is enough to encode 120 genes if an average gene contains about 1 kb (Sugiura, 1992). The chloroplast gene products function primarily in photosynthesis and in transcription-translation (Palmer *et al.*, 1988).

The tRNA genes are scattered over the chloroplast genome in land plants. There are 20-40 tRNA genes present on the chloroplast genome (Sugiura, 1992). Long single introns (0.5-2.5 kb) are present in six chloroplast tRNA genes from land plants. Chloroplast introns can be classified into four groups on the basis of the intron boundary sequences and secondary structures. The intron of *trn*L belongs to group I. This group can be folded with a secondary structure typical to that of fungal mitochondrial genes (Sugiura, 1992).

Another family of genes often used in plant biosystematics is the nuclear-encoded ribosomal RNAs (rDNA). This family of genes have randomly repeated arrays of 18S and 26S subunit

sequences. Frequently, the tandem arrays occur at two or more genomic locations as blocks and there are often a thousand or more repeating units per block. The molecular evolution of nuclear ribosomal DNA (rDNA) is complicated because different regions of the basis-repeating unit evolve at different rates (Clegg & Durbin, 1990).

With all these different genes or gene systems to investigate, the biosystematist are confronted with a wide range of choices. Two major criteria should be applied: first, ease of assay, and second, level of genetic resolution. When these criteria are applied, the chloroplasts genome tends to be the molecule of choice, especially if the objective is to investigate relationships at or above the family level (Clegg & Durbin, 1990). It is also useful on species level (Fig. 1.1) and the *trn*L intron has successfully been used to solve the relationships among eight species of *Gentiana* (Gielly & Taberlet, 1994, 1996). The *trn*L-*trn*F region was in several studies also used to determine relationships between species (Many references, including: Taberlet *et al.*, 1991; Gielly & Taberlet, 1996; Fennel *et al.*, 1998; Reeves *et al.*, 2001; Berry *et al.*, 2004; Mols *et al.*, 2004).

With the choice of which genome to use, it is important to decide which gene is the most appropriate to use for this study. Genes accumulate mutations at different rates. This is because the gene products (RNA or protein) differ in how many changes they can tolerate and still function. Histones, for example, cease to work with many amino acid replacements and do not accumulate mutations frequently. The internal transcribed spacer (ITS) can, however, still fold properly with many nucleotide replacements. This occurrence has implications for the use of particular genes in phylogenetic reconstruction (Judd *et al.*, 1999).

Genes that are often used in sequencing studies include the chloroplast genes *rbc*L, *atp*B (Hoot *et al.*, 1995), *ndh*F (encoding for subunit F of NADP dehydrogenase), *mat*K (a maturase gene in the intron separating the coding region of *trn*K) and the nuclear genes *rpo*A, *rpo*C2 (encoding for the α and β" subunits of RNA polymerase II) and the internal transcribed spacer region (*ITS*) (Judd *et al.*, 1999). All these genes provide optimal phylogenetic results at different taxonomical levels (Zurawski *et al.*, 1984; Doebley *et al.*, 1990; Soltis *et al.*, 1990; Wilson *et al.*, 1990; Jansen *et al.*, 1991; Bousquet *et al.*, 1992b) and above (Albert *et al.*, 1992; Baldwin, 1992; Bousquet *et al.*, 1992a; Gaut *et al.*, 1992; Chase *et al.*, 1993).

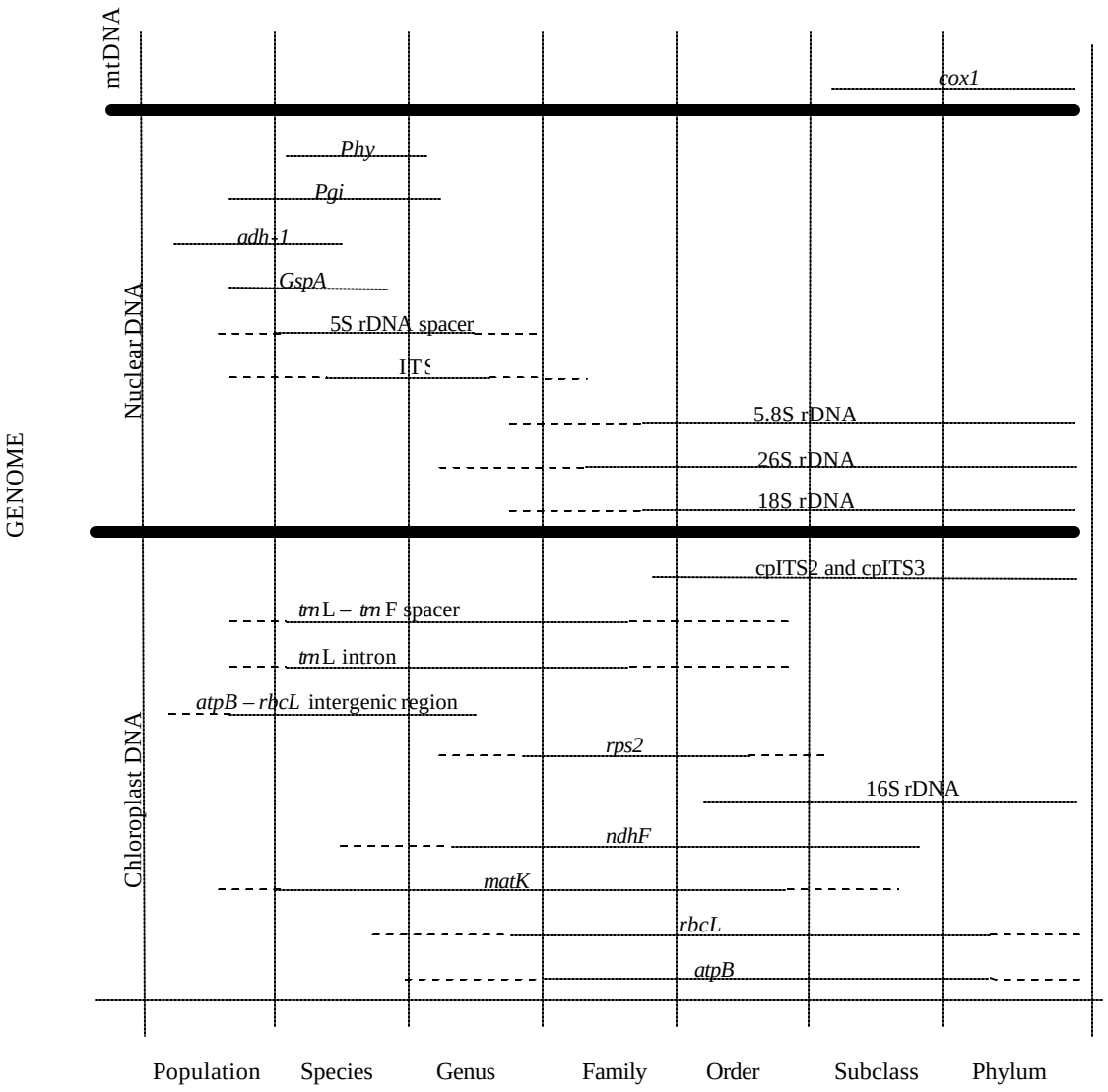


Figure 1.1: The approximate taxonomic level on which resolution is obtained in various angiosperms. Dotted lines indicate lower or no resolution in some taxa (From Soltis & Soltis, 1998).

It is wise to sequence and compare more than one gene or genes from all three genomes. This ensures a more reliable organismal phylogeny and helps overcome potential problems arising from using single gene sequence data (Qui *et al.*, 1999). The nuclear genes are subjected to polyploidy and were therefore not used in this study.

The *trn*L-F region is situated in the chloroplast genome and consists of the *trn*L (UAA) intron and the intergenic spacer (IGS) between the *trn*L (UAA) 3' exon and the *trn*F (GAA) gene. This region is useful for inferring plant phylogenies between closely related taxa:

- The universal primers are placed in highly conserved tRNA genes (Bayer & Starr, 1998) and can be used on a wide taxonomic range of plant species.
- These noncoding regions are small enough to sequence the entire region without the use of internal primers (Gielly & Taberlet, 1994). The *trn*L intron range from 350-600 bp and the *trn*L-*trn*F spacer range from 120-350 bp in the monocots and dicots (Soltis & Soltis, 1998).
- There is a large number of INDELS providing additional phylogenetic information (Bayer & Starr, 1998).

Primers for the *trn*L-F region (Fig. 1.2) were initially introduced by Taberlet *et al.* (1991) and were proven to be suitable for amplification across a broad taxonomic range from algae to bryophytes, vascular cryptogams, gymnosperms, and angiosperms. After this, several phylogenetic studies followed, demonstrating the utility of the *trn*L-F region to reconstruct phylogeny at the family level (Van Ham *et al.*, 1994), the intergeneric level (Gielly & Taberlet, 1996; Gielly *et al.*, 1996) and the generic level (Böhle *et al.*, 1996). Sequences from the last two studies were, however, combined with the internal transcribed spacer (ITS), situated in the genomic DNA, to obtain the best resolution.

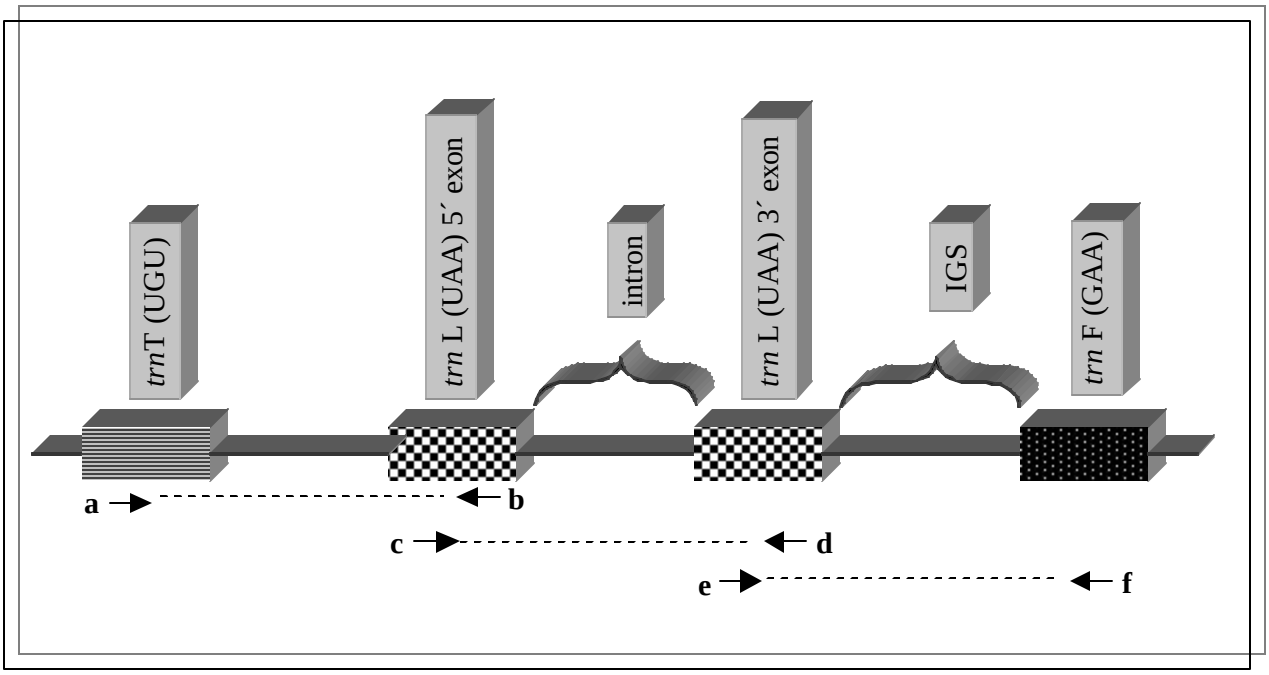


Figure 1.2: A schematic representative of the *trn* genes of the chloroplast. Primers a and b amplifies the intergenic spacer (IGS) between *trnT* and the *trnL* 5' exon. Primers c and d amplifies the *trnL* intron. Primers e and f amplifies the intergenic spacer between the *trnL* 3' exon and *trnF*.

In years to follow, sequences of the *trn*L-F region were successfully used in solving phylogeny on various taxonomic levels (Bayer & Starr, 1998; Fennel *et al.*, 1998; Stedje, 1998; Meerow *et al.*, 1999; Molvray *et al.*, 1999; Fay *et al.*, 2000; Asmussen & Chase, 2001; Bradford, 2001; Richardson *et al.*, 2001; Hodkinson *et al.*, 2002; Van der Bank *et al.*, 2002; Mayer *et al.*, 2003). It was also used for the phylogeny on a variety of Liliaceous genera, such as *Ornithogalum*, *Drimia*, *Drimiopsis*, *Scilla* and *Aloe* (Fangan *et al.*, 1994).

The *trn*L genes on the chloroplast genome encode for different leucine transfer RNA (tRNA) anticodons (Huang & Liu, 1992), i.e. *trn*L-UAA encodes for Leu-tRNA with a UAA anticodon, *trn*L-CAA for Leu-tRNA (CAA) and *trn*L-UAG for Leu-tRNA (UAG). The *trn*F genes encode for Phenylalanine with a GAA anticodon, i.e. *trn*F-GAA encodes for Phe-tRNA (GAA) (Sugiura, 1992).

In comparison, the *trn*L intron evolves almost at the same rate as the IGS (Zurawski & Clegg, 1984; Clegg & Zurawski, 1990; Gielly & Taberlet, 1994). The intron is a group I intron and is supposed to be less variable than the IGS because of its secondary structure and its catalytic properties. The evolution of the intron and the IGS are, however, very similar (Kuhsel *et al.*, 1990; Gielly & Taberlet, 1994). This could be explained by the hypothesis that the loop structures that are formed by regions of complementary sequences, are not subject to the same evolutionary constraints as are the stems. These nine stem-loop structures that are formed, represents a large part of the sequence (Gielly & Taberlet, 1994).

Both the spacer region and the IGS are suitable for inferring phylogenetic relationships at or below the family level. It was observed in the variable parts of the intron, that the similarities between species of the same family ranged between 0.55 and 0.94, suggesting that this region is an excellent tool for phylogenetic analyses at or below the family level (Fangan *et al.*, 1994). Another study indicated that species sampled from different geographical regions, had intraspecific variation in the IGS. The IGS thus also harbour a variation most suitable for phylogenetic inference at lower systematic levels (Fangan *et al.*, 1994).

Comparing the *trn*L-F region with other genes, it was observed that the *trn*L intron and *trn*L-F spacer evolves at a rate that is 1 to 1.28 times faster than *ndh*F (Bayer & Starr, 1998). The *ndh*F region provided more resolution in the tribal relations in Asteraceae than did the chloroplast sequence *rbc*L (Bayer & Starr, 1998). In another comparative study, the chloroplast genes *rbc*L and the *trn*L intron sequence for the same species showed parallel patterns of variation in the two regions (Fangan *et al.*, 1994). The *trn*L intron evolves 1.93 times and the IGS 11.72 times faster than *rbc*L (Gielly & Taberlet, 1994). The *trn*L-F region, thus, evolves

faster than *ndh*F and *rbc*L, but it is necessary to use the total *trn*L-F region for phylogenetic analysis, instead of using either the intron or the IGS region separately.

The level of divergence in the *trn*L-*trn*F data set is similar to that of *rbc*L for Thermidaceae (Fay *et al.*, 1996) and Orchidaceae (Whitten *et al.*, 1996). However, the *trn*L region evolves about three times faster than *rbc*L in Iridaceae. In the fern family Ophioglossaceae, the *trn*L-*trn*F intergenic spacer is about one-third the size of *rbc*L, with sequence divergences for the spacer three to five times higher than sequence divergence for *rbc*L for the same taxa. Phylogenetic analyses of *rbc*L and *trn*L-*trn*F spacer sequences produced almost identical topologies with similar branch lengths (Soltis & Soltis, 1998).

The use of these regions can, however, be reduced by the presence of long series of Ts (or As), especially in the intergenic spacer, thus presenting a serious limitation to the use of the intergenic spacer in phylogenetic studies. Some problems may arise with sequence alignment because of the length mutations. The more distant the taxa, the more doubtful the alignment (Gielly & Taberlet, 1994).

In conclusion, the *trn*L intron and the *trn*L-F intergenic spacer may represent an ideal sequence for phylogenetic reconstruction at the family level. Although it provides levels of resolution similar to those of longer gene sequences, it requires much less labour to generate data (Bayer & Starr, 1998; Berry *et al.*, 2004; Mols *et al.*, 2004).

1.3.3 Phylogenetics/cladistics

Cladistics started as a way to determine phylogenetic relationships in insects (Hennig, 1966). It determines the most probable way of evolution and describes the evolution pattern as branches of a tree (cladogram) by using apomorphic (derived) character states (Crawford, 1990) or, to simplify, it is the study of the pathways of evolution (Li, 1997).

However, plesiomorphic (primitive) character states are not useful for producing branching patterns and only synapomorphies (derived character states shared by two or more taxa) are cladistically informative. Autapomorphies (derived character states present in only one taxon) are also of no value in assessing relationships (Crawford, 1990).

A matched pair at a position, implies that no substitution of the nucleotides has occurred between two sequences; a mismatched pair implies that a one substitution has occurred since the diversion; and a gap in one of the sequences implies that a deletion or an insertion has occurred

at that specific position in the sequence. An alignment represents a specific hypothesis about the evolution of sequences (Li, 1997).

Insertions/deletions (INDELS) make an important part of the sequence divergence observed at the intra- and intergeneric levels. They occur at least as often as nucleotide substitutions, as reported elsewhere (Wolfe *et al.*, 1987; Zurawski & Clegg, 1987; Clegg & Zurawski, 1990). Long INDELS (up to 350 bp) are relatively common and make sequence alignment difficult at interfamilial levels and more or less impossible at the interordinal levels. Within Asparagales, some groups/families are more problematic than others in this respect, notably Alloideae (Alliaceae) and Orchidaceae (Fay *et al.*, 2000).

The methods to construct phylogenetic trees can be placed into several categories: distance matrix methods (including compatibility), parsimony methods and the maximum likelihood method (Nei, 1987; Felsenstein, 1988). During this study the distance matrix (Neigbour Joining [NJ]) and parsimony methods were used; only the tree(s) [cladogram(s)] requiring the fewest changes (most parsimonious) was used.

Parsimony can, however, under certain conditions give incorrect phylogenies. It may happen when the rate of change has been very high in certain branches relative to other branches in a tree. These higher rates of change will increase the probability of parallel changes in these branches. The more characters used, the greater are the chance of having parallel changes. On the contrary, branches with much lower rates of change and fewer parallel character state changes will have many fewer cladistically informative changes (Felsenstein, 1978, 1983).

The Wagner parsimony is the most commonly used for molecular data (Felsenstein, 1982; Nei, 1987) and was used in this study as well. With this method the most parsimonious tree is the one with the fewest total changes and reversion of character states are allowed. Both forward and reverse changes are allowed to occur, compared to Dollo parsimony where only the occurrence of reverse changes is permitted (Crawford, 1990).

Dollo parsimony is based on the idea that complex character states arise rarely but these character states can be lost much more easily during evolution (Crawford, 1990). Dollo parsimony is used with regard to restriction site gains and losses in DNA (DeBry & Slade, 1985).

The principle of maximum parsimony searches for a tree that requires the smallest number of evolutionary changes to explain the differences observed among the Operational Taxonomic Unit (OTU) under study. Such a tree is called a maximum parsimony tree. Often more than one

tree with the same minimum number of changes is found, so that no unique tree can be inferred (Li, 1997).

Several methods for constructing consensus cladograms have been developed. The most commonly used are Adams consensus (Adams, 1972), strict consensus (Nelson, 1979) and majority consensus (Margush & McMorris, 1981). The consensus tree, being less resolved than any of the cladograms from which it is derived, sacrifices explanatory power (Farris 1983). Miyamoto (1985) also points out that consensus trees do not represent parsimonious solutions to character state change. Whereas consensus trees usually indicate robust groups of taxa, they reveal little about process, as in character state change. Many phylogenetic analyses give conflicting or competing results, in the form of several equally most parsimonious trees or incongruent results from different data sets. Congruence is the main criterion on which to evaluate such cladograms and to judge the performance of different kinds of data and the sensitivity of different methods of analysis (West & Faith, 1990).

The consensus tree summarises information that is common to all data sets and therefore ignores parts of the tree for which conflicting data are available (Hillis, 1987). In contrast, the combination of data sets results in an evaluation of the strength of the conflicting data, and the stability of the corroborated data.

A larger, combined data set as well as an inclusion of additional taxa do not increase the time and lower the probability of finding trees closest to the shortest length, but makes it faster and more feasible (Hillis, 1996; Soltis *et al.*, 1998).

An increase in the number of taxa used, usually contributes to the resolution of a phylogeny (Hillis, 1996; Graybeal, 1998). Combining data sets showed increased resolution and reliability (Kluge, 1989; Chase & Cox, 1998; Savolainen *et al.*, 2000; Barrett *et al.*, 1991; Reeves *et al.*, 2001; Olmstead & Sweere, 1994; Hoot *et al.*, 1995; see Bull *et al.*, 1993 for a review). The statistical methods for testing phylogenies are not well developed for two reasons. First, although phylogenetic reconstruction has long been recognized as a problem in statistical inference (Edwards & Cavalli-Sforza, 1964), few authors have formulated the problem in a statistical framework. Indeed, most current methods yield one or a few trees and do not provide information concerning the confidence level of estimated phylogenies. Second, the problem is extremely complex, largely because the number of possible alternative trees is large even when only a moderate number of taxa are involved. For this reason, most current statistical tests are heuristic when more than five taxa are involved (Li, 1997).

Statistical tests can be classified as analytical or resampling. Resampling methods (e.g., the bootstrap and the jackknife) resample the data to infer empirically the variability of the estimate

obtained by a tree-making method (Li, 1997). For most taxonomists, the more characters that support a group, the more confident they become of the relationship. The other way of viewing support is through one of the methods of estimating "internal" support, commonly by employing the bootstrap (Felsenstein, 1985b), the jackknife (Farris *et al.*, 1996) or Bremer support (Bremer, 1994; also known as the "decay index").

In phylogenetic study, bootstrap (Felsenstein, 1985a) is the most popular resampling method (Li, 1997), and has frequently been used as a means to estimate the confidence level of phylogenetic hypothesis (Felsenstein & Kishino, 1993; Li & Zharkikh, 1995; Li, 1997). Theoretical and simulation studies (Zharkikh & Li, 1992a, b, 1995; Felsenstein & Kishino, 1993; Hillis & Bull, 1993) have, however, showed that the bootstrap technique usually gives underestimates of the confidence level of a phylogenetic hypothesis (Li, 1997). Another problem associated with the concept of bootstrapping phylogenetic trees, is that the characters used do not constitute a random sample of all possible characters. This implies that the bootstrap samples from such a set of characters are a biased representation of a larger character universe (West & Faith, 1990).

1.4 THE PHYLOGENETIC POSITION OF *LACHENALIA*

The majority of bulbous plants were traditionally divided into three plant families, i.e. Amaryllidaceae, Iridaceae and Liliaceae. More information on these divisions is necessary to understand the position of the plants used during this study. All these families belong to the monocotyledons and to understand the position of *Lachenalia*, a brief overview of the monocots is necessary.

There were a few main changes in ideas about relationships in the years prior to the advent of phylogenetic methodology. Some of the differences between the current monocotyledons and dicotyledons were already evident to Theophrastus in 300 B.C., but John Ray was the first to make a major distinction between the two (Judd *et al.*, 1999).

Some of the most important classifications of the monocotyledons were Lindley (1853), Bentham & Hooker (1883), Engler (1892), Hutchinson (1934, 1959), Takhtajan (1969), Cronquist (1968), Thorne (1976), Stebbins (1974), Huber (1969, 1977), Dahlgren (1975),

Cronquist (1981), Dahlgren & Clifford (1982); Dahlgren *et al.* (1982, 1985) and Goldblatt (1995).

Later classifications were usually based on molecular data. Based on molecular data the monocots now consist of 2 superorders, 12 orders and 51 families (Angiosperm Phylogeny Working Group – APG, 1998). Of importance for this study is the superorder Lilianae which consists of three orders, Asparagales, Liliales and Dioscoreales (Table 1.1) (Leistner, 2000; Rudall *et al.*, 2000).

Table 1.1: A list of the orders, families, and number of genera of the monocotyledons in southern Africa based on morphological data (Leistner, 2000).

Order	**Families in southern Africa**	**Number of genera in southern Africa**
Alismatales	Alismataceae	5
	Hydrocharitaceae	5
	Juncaginaceae	1
	Limnocharitaceae	1
	Zannichelliaceae	3
	Zosteraceae	1
Arales	Acoraceae	1
	Araceae (classified under Alismatales by Judd, 1999)	6
	Lemnaceae	4
Arecales	Arecaceae	5
Asparagales	Agapanthaceae	1
	Agavaceae	1
	Alliaceae	3
	Amaryllidaceae	18
	Anthericaceae	2
	Asparagaceae	1
	Asphodelaceae	10
	Dracaenaceae	2
	Eriospermaceae	1
	Hyacinthaceae	27
	Hypoxidaceae	6
	Iridaceae	32
	Luzuriagaceae	1
	Tecophilaeaceae	2
Commelinales	Commelinaceae	7
	Xyridaceae	1
Cyperales	Cyperaceae	40
Poales	Poaceae	191
Dioscoreales	Dioscoreaceae	1
	Smilacaceae (classified under Liliales by Judd, 1999)	1
Eriocaulales	Eriocaulaceae	2
Haemodorales	Pontederiaceae	4
Juncales	Juncaceae	2
	Prioniaceae	1
Liliales	Burmanniaceae	1
	Colchicaceae	12
	Haemodoraceae	3
	Lanariaceae	1
	Liliaceae	1
	Velloziaceae	2
Najadales	Aponogetonaceae	1
	Cymodoceaceae	2

	Najadaceae	1
	Potamogetonaceae	1
	Ruppiaceae	1
Orchidales	Orchidaceae (classified under Asparagaceae by Judd, 1999)	52
Restionales	Flagellariaceae	1
	Restionaceae	19
Typhales	Typhaceae	1
Zingiberales	Cannaceae	2
	Musaceae	1
	Strelitziaceae	1
	Zingiberaceae	3

1.4.1 The order Asparagales

The monophyly of the order Asparagales is supported by cladistic analyses based on morphology, *rbcL*, and *atpB* sequences (Chase *et al.*, 1995a, b; Conran, 1989; Rudall *et al.*, 1997). The order consists of 30 families and ca. 26 800 species. The major families are Orchidaceae, Hypoxidaceae, Iridaceae, Amaryllidaceae, Alliaceae, Hyacinthaceae, Lomandraceae, Agavaceae, Asparagaceae, Convallariaceae, Asphodelaceae and Hemerocallidaceae (Judd *et al.*, 1999). The inclusion of genera in the different families varies between different authors (Table 1.2).

A basal assemblage (the "lower" Asparagales) includes five families, which are characterized by simultaneous microsporogenesis. A specialized clade (the "higher" Asparagales), which includes Alliaceae, Amaryllidaceae, Hyacinthaceae, Agavaceae, Asparagaceae and Convallariaceae, has successive microsporogenesis (a cell plate is laid down immediately after the first meiotic division and another in each daughter cell after the second meiotic division. Alliaceae, Amaryllidaceae and Hyacinthaceae may form a clade based on their bulbous rootstock and scapose inflorescences (Judd *et al.*, 1999). Asparagales *sensu* APG (1998) are a well-circumscribed and strongly monophyletic group. This is supported by a study where four plastid DNA regions were sequenced. Better bootstrap values were, however, obtained and well-supported groupings of families were identified (Fay *et al.*, 2000).

Table 1.2: A comparison between the classifications of Perry (1985) and Leistner (2000) of the subclass Liliidae. The genera represented in this study are indicated with *.

Order	**Family**	**Genus (Perry, 1985)**	**Genus (Leistner, 2000)**
Asparagales	Agapanthaceae	—	*Agapanthus*
	Alliaceae	*Agapanthus*, *Tulbaghia** and *Allium* L.	*Allium* L., *Nothoscordum** Kunth, *Tulbaghia*
	Amaryllidaceae	—	*Amaryllis* L., *Ammocharis* Herb., *Apodolirion* Baker, *Boophone*, *Brunsvigia* Heist., *Carpolyza* Salisb. *Clivia*, *Crinum* L., *Crossyne* Salisb.,

			Cybistetes Milne-Redh. & Schweick., *Cyrtanthus* Aiton., *Gethyllis* L., *Haemanthus*, *Hessea* Herb., *Nerine* Herb., *Pancratium* L., *Scadoxus** Raf. and *Strumaria* Jacq.
	Asparagaceae	*Myrsiphyllum* Willd. and *Protasparagus** L.	*Asparagus*
	Aspodelaceae	*Aloe**, *Anthericum*, *Astroloba* Uitewaal, *Bulbine** Wolf, *Bulbinella** Kunth, *Caesia*, *Chlorophytum*, *Gasteria** Duval, *Haworthia** Duval, *Kniphofia**, *Poellnitzia* Uitewaal and *Trachyandra** Kunth	*Aloe*, *Astroloba*, *Bulbine*, *Bulbinella*, *Chortolirion* A.Berger, *Gasteria*, *Haworthia*, *Kniphofia*, *Poellnitzia* and *Trachyandra*
	Dracaenaceae	*Dracaena* L. and *Sansevieria** Thunb.	*Dracaena* and *Sansevieria*
	Eriospermaceae	*Eriospermum** Jacq. ex Willd.	*Eriospermum*
	Hyacinthaceae	*Albuca** L., *Amphisiphon* W.F.Barker, *Androsiphon* Schltr., *Bowiea**, *Daubenya* Lindl., *Dipcadi** Medik., *Drimia** Jacq., *Eucomis**, *Hyacinthus*, *Lachenalia**, *Ledebouria**, *Litanthus* Harv., *Massonia** Thunb. ex Houtt., *Neopatersonia* Schonland, *Ornithogalum**, *Polyxena**, *Pseudogaltonia* (Kuntze) Engl., *Rhadamanthus** Salisb., *Schizobasis** Baker, *Scilla**, *Tenicroa* Raf., *Thuranthos** C.H.Wright, *Urginea**, *Veltheimia** and *Whiteheadia** Harv.	*Albuca*, *Amphisiphon*, *Androsiphon*, *Bowiea*, *Daubenya*, *Dipcadi*, *Drimia*, *Drimiopsis**, *Eucomis*, *Galtonia**, *Lachenalia*, *Ledebouria*, *Litanthus*., *Massonia*, *Neobakeria* Schltr., *Neopatersonia*, *Ornithogalum*, *Polyxena*, *Pseudogaltonia*, *Rhadamanthus*, *Schizobasis*, *Scilla*, *Tenicroa*, *Thuranthos*, *Urginea*, *Veltheimia* and *Whiteheadia*
	Hypoxidaceae	—	*Empodium* Salisb., *Hypoxis* L., *Pauridia* Harv., *Rhodohypoxis* Nel, *Saniella* Hilliard & B.L.Burtt and *Spiloxene* Salisb.
	Iridaceae	—	*Aristea* Aiton, *Babiana* Ker Gawl., *Bobartia* L., *Chasmanthe* N.E.Br., *Crocosmia* Planch., *Devia* Goldblatt & J.C.Manning, *Dierama* K.Koch, *Dietes* Salisb. ex Klatt, *Duthieastrum* M.P.de Vos, *Ferraria* Burm. ex Mill., *Freesia*, *Geissorhiza* Ker Gawl., *Gladiolus*, *Hesperantha* Ker Gawl., *Ixia*, *Klattia* Baker, *Lapeirousia* Pourr., *Melasphaerula* Ker Gawl., *Micranthus* (Pers.) Eckl., *Moraea*, *Nivenia** Vent., *Pillansia* L.Bolus, *Radinosiphon* N.E.Br., *Romulea* Maratti, *Sparaxia* Ker Gawl., *Syringodea* Hook.f., *Thereianthus* G.J.Lewis, *Tritonia* Ker Gawl., *Tritoniopsis* L.Bolus, *Watsonia*, *Witsenia** Thunb. and *Xenoscapa* (Goldblatt) Goldblatt & J.C.Manning.
Liliales	Colchicaceae	*Androcymbium* Willd., *Baeometra* Salisb. ex Endl., *Neodregea* C.H.Wright, *Onixotis* Raf., (*Dipidax*), *Ornithoglossum** Salisb., *Wurmbea* Thunb., *Gloriosa**, *Littonia* Hook, *Sandersonia* Hook., *Hexacyrtis* Dinter and *Iphigenia* Kunth	*Androcymbium*, *Baeometra*, *Camptorrhiza* Hutch., *Gloriosa*, *Hexacyrtis*, *Iphigenia*, *Littonia*, *Neodregea*, *Onixotis* Raf., *Ornithoglossum*, *Sandersonia* and *Wurmbea*
	Liliaceae	—	*Lilium*

1.4.2 The family Hyacinthaceae

This study focus on the family Liliaceae *sensu lato* (at present the family Hyacinthaceae), which has been divided into sub-families according to the habit (e.g. climbers, herbs, trees and shrubs), underground parts (e.g. bulbs, corms, stem tubers, tuberous roots), inflorescences (e.g. umbel or raceme) and fruits (capsule or berry) (Judd *et al.*, 1999). The family Hyacinthaceae consists mostly of bulbous plants, are rarely rhizomatic and have one to many leaves. The leaf blades shed after 2-8 months at a preformed area at the apex of the bulb (Speta, 1998). The leaves are basal and the inflorescence a simple raceme. The perianth segments are free or united at the base and the fruit are a capsule (Perry, 1985). Presently the Hyacinthaceae comprises approximately 1 000 species and 70 genera (Pfosser & Speta, 1999). The greatest diversity of this family is in South Africa and the Mediterranean, extending to North Western Europe, Central Asia and East Asia (Speta, 1998).

The inclusion of the family Hyacinthaceae in the Liliaceae *sensu lato* was questioned because of anatomical (Fuchsig, 1910) and embryological (Schnarf, 1929; Wunderlich, 1937; Buchner, 1948) studies. The family Hyacinthaceae is subdivided into five major groups based on characters including pistil structure, seed morphology, bracts, prophylls, karyology, phytochemistry and molecular evidence (Speta, 1998). Four of the five groups are supported by molecular evidence (Chase *et al.*, 1995a; Fay & Chase, 1996; Pfosser & Speta, 1999).

1. Subfam. Chlorogaloideae (North America) Speta (1998).

   Schoenolirion Torrey ex E.M.Durand; *Hastingsia* S.Watson; *Camassia*; *Chlorogalum* (Lindl.) Kunth

2. Subfam. Oziroëoideae (Andine in South America) Speta (1998)

   Oziroë Raf.

3. Subfam. Urgineoideae (South Africa to the Mediterranean, Arabia, India and Burma) Speta (1998)

   [*] *Bowiea*; **Schizobasis* Baker; *Igidia* Speta; *Urgineopsis* Compton; **Rhadamanthus* Salisb.; **Litanthus* Harvey; *Rhadamanthopsis* (Obermeyer) Speta; **Thuranthos* C.H.Wright; **Tenicroa* Raf.; **Drimia* N.J.Jacq ex Willd.; **Urginea*

4. Subfam. Ornithogaloideae (South Africa to southern France, Arabia and India) Speta

[*] Genera of the South African family Hycinthaceae. Genera of the South African Hyacinthaceae that are not listed above: *Neopatersonia* Schonland, *Neobakeria* Schltr. (Leistner, 2000).

(1998)

Stellarioides Medicus; *Coilonox* Raf.; **Albuca* L.; **Pseudogaltonia* (Kuntze) Engler; **Dipcadi* Medicus; **Galtonia*; *Zahariadia* Speta; *Melomphis* Raf.; *Cathissa* Salisb.; *Eliokarmos* Raf.; *Loncomelos* Raf.; *Honorius* S.F.Gray; **Ornithogalum*

5. Subfam. Hyacinthoideae (South Africa to East Asia, India, North-West Europe, and Central Asia) Link (1829).

Merwilla Speta; *Schizocarphus* Merwe; *Pseudoprospero* Speta; **Eucomis*; *Avonsera* Speta; **Ledebouria*; **Drimiopsis*; *Resnova* Merwe; **Veltheimia*; **Whiteheadia* Harvey; **Amphisiphon* Barker; **Androsiphon* Schltr.; **Daubenya* Lindl.; **Massonia* Houtt.; **Polyxena*; **Lachenalia*; *Barnardia*; *Autonoë* (Webb & Berth.) Speta; *Oncostema* Raf.; *Hyacinthoides* Medicus; *Brimeura* Salisb.; *Tractema* Raf.; *Hyacinthella* Schur; *Alrawia* (Wendelbo) K.Persson & Wendelbo; *Prospero*; *Puschkinia*; *Othocallis* Salisb.; *Fessia* Speta; *Pfosseria* Speta; *Hyacinthus*; *Nectaroscilla* Parl.; *Chouardia* Speta; *Schnarfia* Speta; *Zagrosia* Speta; *Muscari*; *Bellevalia* Lapeyr.; **Scilla* (Speta, 1998).

The Hyacinthaceae (excluding subfamily Chlorogaloideae) forms a monophyletic lineage within the order Asparagales (Fay & Chase, 1996; Pfosser & Speta, 1999; Fay *et al.*, 2000). Within the subfamily Hyacinthoideae two clades are present; the first combines the Indian and African genera south of the Sahara, and largely coincides with the delimitation of the tribe Massonieae Baker (with the significant inclusion of the sub-Saharan species previously placed in the genus *Scilla*). The second clade includes the Mediterranean and Asian genera, corresponding to the tribe Hyacintheae Dumort (Pfosser & Speta, 1999). Further division of the tribe Massonieae into the subtribes Ledebouriinae and Massoniinae (Müller-Doblies & Müller-Doblies, 1997) is not supported by the molecular data. The poor congruence between morphological and other characters within Hyacinthaceae has also made generic circumscriptions very difficult. One of the consequences of this has been the recognition of a large number of genera that are poorly defined morphologically (Speta, 1998; Manning & van der Merwe, 2002).

1.4.3 The genus *Lachenalia*

The delimitation within the genus *Lachenalia* and between other genera is vague. Most of the species have distinguishable differences and new species are described on a regular basis, but

a few "complicated" species overlap with each other and with species from other genera. An example is the species *Lachenalia pusilla* Jacq. that looks different from other *Lachenalia* species, but more similar to members of the genus *Polyxena*. Could it be that there is continuous hybridisation in the genus, explaining the variation in the genus, the formation of new species and the isolation barriers (Ferreira & Hancke, 1985) among several species in *Lachenalia*? The variation in the chromosome numbers could also be an indication that hybridisation contributed to the origin of certain species, as is the hypothesis for the genus *Ornithogalum* (Johnson & Brandham, 1997). Variation within the genus impedes the classification of the species. The genus needs a taxonomical revision because of the newly discovered species and the variation within the species (Duncan, 1988).

The closest relative of the genus *Lachenalia* is the British bluebell or hyacinth (Crosby, 1986) and the genus is closely related to *Polyxena*, a small endemic genus from the Western Cape Province (Duncan, 1992). Four attempts were made to subdivide the genus. The genus consisted of 42 species when Baker (1897) made the first attempt to divide it into five subgenera: *Eulachenalia*, *Brachyscypha*, *Orchiops*, *Chloriza* and *Coelanthus* (Table 1.3). This classification proved to be unnatural in most cases and was redivided by Crosby (1986) into subgeneric classes, based on phenotypical appearance, biological relationships obtained from chromosome studies and hybridisation experiments. The five groups were named after certain typical species (Crosby, 1986): *Lachenalia aloides* group, *L. orchioides* group, *L. unicolor* group, *L. unifolia* group and the *L. pusilla* group (Table 1.3).

Table 1.3: Comparison of the subdivisions of the genus *Lachenalia* by Baker (1897), Crosby (1986), Duncan (1988) and Duncan in Manning *et al.* (2002).

Species	**Baker (1897 - 42 sp.): subgenera**	**Crosby (1986 - 33 sp.): subgroups**	**Duncan (1988 - 88 sp.): subgroups**	**Duncan (2002 - 80 sp.): groups**
L. alba				Group 5
L. algoensis		*L. aloides*		Group 3
L. aloides		*L. aloides*	Subgroup 1f	Group 3
L. aloides cv Pearsonii		*L. aloides*		
L. aloides var. *aurea*		*L. aloides*	Subgroup 1f	
L. aloides var. *luteola*		*L. aloides*		
L. aloides var. *nelsonii*		*L. aloides*		
L. aloides var. *quadricolor*		*L. aloides*	Subgroup 1f	
L. aloides var. *vanzyliae*		*L. aloides*	Subgroup 1f	
L. aloides var. (Cape Peninsula)			Subgroup 1f	
L. aloides var. (Cape Point)			Subgroup 1f	
L. aloides var. (Durbanville)			Subgroup 1f	
L. aloides var.			Subgroup 1f	

(Piketberg)				
L. aloides var.			Subgroup 1f	
(Riebeek-Kasteel)				
L. aloides var. *aloides*			Subgroup 1f	
L. ameliae				Group 2
L. angelica			Subgroup 1f	
L. anguinea	Chloriza	*L. unifolia*	Subgroup 2d	Group 4
L. arbuthnotiae		*L. orchioides*		Group 2
L. attenuata				Group 5
L. aurioliae				Group 5
L. bachmanii	Chloriza	*L. unicolor*		Group 5
L. barkeriana			Subgroup 2b	Group 1
L. bolusii			Subgroup 1f	Group 5
L. bowieana (=*L. nervosa*)	Chloriza			
L. bowkeri	Orchiops			Group 2 & 5
L. buchubergensis				
L. bulbifera		*L. aloides*	Subgroup 1f	Group 3
L. campanulata	Chloriza	*L. unicolor*		
L. capensis				Group 2
L. carnosa	Chloriza	*L. unicolor*		
L. comptonii		*L. unifolia*	Subgroup 2b	Group 4
L. concordiana				
L. congesta				Group 2
L. contaminata	Chloriza	*L. unicolor*		Group 1
L. convallarioides	Chloriza			
L. cooperi	Chloriza			
L. dasybotrya			Subgroup 1e	
L. dehoopensis			Subgroup 1e	Group 5
L. doleritica				Group 5
L. duncanii			Subgroup 2d	
L. elegans		*L. orchioides*		Group 2
L. esterhuysenae			Subgroup 2d	
L. fistulosa	Chloriza			Group 2
L. framesii		*L. unicolor*		
L. giessii			Subgroup 1f	
L. gillettii			Subgroup 2c	Group 4
L. glaucophylla			Subgroup 2d	
L. haarlemensis			Subgroup 2c	Group 4
L. hirta	Chloriza		Subgroup 1f	Group 5
L. hirta var. *exserta*			Subgroup 1f	
L. hirta var. *hirta*			Subgroup 1f	
L. isopetala	Chloriza		Subgroup 1e	Group 5
L. juncifolia	Chloriza	*L. unifolia*	Subgroup 2d	Group 4
L. karooica				Group 4
L. klinghardtiana			Subgroup 2c	
L. kliprandensis				
L. lactosa				Group 5
L. latifolia	Chloriza		Subgroup 2c	
L. latimerae			Subgroup 2d	Group 4
L. leipoldtii				Group 4
L. leomontana			Subgroup 1f	Group 5
L. lilacina	Chloriza			
L. liliflora	Orchiops	*L. unicolor*	Subgroup 1e	Group 5
L. longibracteata		*L. orchioides*		Group 2 & 5
L. macgregoriorum			Subgroup 2d	Group 4
L. margaretae			Subgroup 1e	Group 5

L. marginata				Group 2
L. marlothii				Group 2
L. martinae				Group 5
L. mathewsii			Subgroup 2c	Group 5
L. maximiliani				Group 2
L. mediana	Chloriza	*L. unifolia*	Subgroup 1e	Group 5
L. mediana var. *mediana*			Subgroup 1e	
L. mediana var. *rogersii*			Subgroup 1e	
L. minima				
L. moniliformis			Subgroup 2d	Group 1
L. montana			Subgroup 2d	Group 4
L. muirii				Group 2
L. multifolia			Subgroup 2d	Group 1
L. mutabilis		*L. orchioides*		Group 2
L. namaquensis		*L. unicolor*		
L. namibiensis			Subgroup 1f	
L. neilii				Group 5
L. nervosa	Chloriza			Group 4
L. nordenstamii			Subgroup 2d	
L. obscura				Group 2
L. orchioides	Orchiops	*L. orchioides*		Group 2
L. orchioides var. *glaucina*		*L. aloides*		
L. orchioides var. *orchioides*	Orchiops			
L. orthopetala	Orchiops	*L. unicolor*	Subgroup 1e	Group 1
L. pallida	Chloriza	*L. unicolor*	Subgroup 1e	Group 5
L. patula	Chloriza & Orchiops		Subgroup 1f	
L. pearsonii			Subgroup 1f	
L. peersii			Subgroup 1f	Group 5
L. pendula	Eulachenalia			
L. perryae				Group 5
L. physocaulos			Subgroup 2b	Group 4
L. polyphylla	Chloriza		Subgroup 2d	Group 1
L. polypodantha			Subgroup 2d	
L. purpureo-caerulea	Chloriza		Subgroup 2c	Group 4
L. pusilla	Brachyscypha	*L. pusilla*	Subgroup 2c	Group 1
L. pustulata	Chloriza	*L. unicolor*	Subgroup 2d	Group 5
L. reflexa	Coelanthus	*L. aloides*		Group 3
L. rhodantha (=*L. campanulata*)	Chloriza			
L. rosea	Chloriza	*L. orchioides*	Subgroup 1f	Group 5
L. rubida	Eulachenalia	*L. aloides*	Subgroup 1e	Group 3
L. salteri			Subgroup 2c	Group 4
L. sargeantii			Subgroup 1f	Group 3
L. schelpei				Group 5
L. splendida		*L. unicolor*	Subgroup 2a	Group 4
L. stayneri			Subgroup 2d	Group 4
L. thomasiae				Group 4
L. trichophylla	Orchiops & Chloriza			Group 2
L. tricolor	Eulachenalia			
L. undulata	Orchiops			Group 2
L. unicolor	Chloriza	*L. unicolor*	Subgroup 2d	Group 4
L. unicolor var. *fragrans*		*L. unicolor*		
L. unifolia	Chloriza	*L. unifolia*	Subgroup 1f	Group 5

L. unifolia var. *schlechteri*			Subgroup 1f	
L. unifolia var. *unifolia*			Subgroup 1f	
L. unifolia var. *wrightii*			Subgroup 1f	
L. variegata				Group 2
L. ventricosa			Subgroup 2a	Group 4
L. verticillata		*L. unicolor*		
L. violacea	Chloriza	*L. unicolor*	Subgroup 2d	Group 4
L. viridiflora		*L. aloides*	Subgroup 1e	Group 3
L. whitehillensis			Subgroup 2d	Group 4
L. youngii	Chloriza		Subgroup 1e	Group 5
L. zebrina			Subgroup 2d	Group 4
L. zeyheri	Chloriza	*L. unicolor*	Subgroup 1e	Group 5

The third attempt to subdivide the genus was made by Duncan (1988), who classified the species according to the position of the stamens. The species were subdivided according to the type of inflorescence into two groups. Species from the first group have included stamens that can protrude just beyond the tip of the perianth. The second group has species with the stamens shortly exerted to well exerted beyond the tip of the perianth (Table 1.3).

In a final attempt, the genus was grouped into five groups (Duncan in Manning *et al.*, 2002) (Table 1.3). Group 1 – "Leaves 3 to many, oblong or linear to subterete; flowers pedicellata, white or brownish blue, tepals subequal and similar, anthers usually exerted." Group 2 – "Flowers, at least the lowermost, sessile or subsessile with pedicels to 1 mm long, exceptionally longer but then bracts conspicuously developed or leaf with star-shaped hairs, and anthers included." Group 3 – "Flowers (15-)20-35 mm long, either suberect or nodding; anthers included or shortly exerted." Group 4 – "Anthers well exerted, stamens more than 2 mm longer than the tepals." Group 5 – "Anthers included or shortly exerted, stamens to 2 mm longer than the tepals."

A classification can be constructed in many ways, for example, on the basis of their medicinal properties, their preferred habitat or their phylogeny. A phylogeny based classification can be produced by determining the phylogeny or evolutionary history of organisms, and then basing the classification on this history (Judd *et al.*, 1999).

As already indicated several methods exist to conduct a phylogenetic study. Two of these have been used in this study, i.e. cytotaxomomy and molecular systematics. However, it is necessary to determine to what extent these methods have already been applied to *Lachenalia* and related taxa.

1.4.3.1 Cytotaxonomy in the Hyacinthaceae

Chromosome numbers vary in the Angiosperms from n = 2 {found in four monocot species (two Poaceae, one Hyacinthaceae and one Cyperaceae) and two dicots (Asteraceae)} (Vanzela *et al.*, 1996) to approximately 300 (Uhl, 1978; Johnson *et al.*, 1989). Reported cases of chromosome variation include *Allium turcicum* (Johnson, 1994) and *Ornithogalum* species (Johnson & Brandham, 1997). In *Crocus* species, which display one of the largest variations in chromosome number observed (2n = 6-64), aneuploidy and B-chromosomes are responsible for some infraspecific variants (Brighton, 1977). Most of these cases are related to species or cytotypes with different ploidy levels combined with hybridisation, as observed in many *Crocus* species (Ørgaard *et al.*, 1995). The importance of such aneuploids to the origin of a new evolutionary branch has never been clearly demonstrated (Guerra, 2000).

The karyology of the family Hyacinthaceae are highly diverse, well studied and is an excellent example of the taxonomic importance of karyology. Chromosome numbers are constant in some of the species and variation in chromosome number has also been observed within several species, in particular *Ornithogalum luschanii* Stapf. (2n = 22, 28, 59, 60 and 76) and *O. narbonense* L. (2n = 14, 16, 18, 22, 24, 36 and 46). The explanation is that intra-specific polyploidy occurs, but it can also be due to fundamental differences in basic chromosome number (Cullen & Ratter 1967; Johnson & Brandham, 1997). Other explanations for the problems with the cytology and taxonomy of the genus *Ornithogalum* can be due to aneuploidy and the difficulty to identify B-chromosomes. B-chromosomes are common and easily identified in certain species such as *O. narbonense*, but are in other species very similar to the normal chromosomes and are thus difficult to distinguish. Variation in chromosome number may occur because of these factors and the true chromosome numbers in these plants can therefore be inaccurate. Finally, natural hybridisation may contribute to the cytotaxonomic complexities of *Ornithogalum* (Johnson & Brandham, 1997).

Another example of variation in chromosome number occurs within the genus *Lachenalia*. Basic chromosome numbers of x = 7 and 8 are the most frequent in *Lachenalia*, Numbers of x = 7 – 13 and 15 were observed, and analysis of the karyotypes of all these basic numbers indicate that structural diploids are produced with twice the chromosome number. For example, the number 2n = 20 represents a diploid based on x = 10 rather than a tetraploid based on x = 5. It could be possible that the diploids with 2n = 30 (x = 15) are allotetraploids derived from the doubling of chromosome number of a hybrid between taxa with x = 7 and x = 8 (Johnson & Brandham, 1997). Polyploidy is also frequently encountered (Moffett, 1936; Sato, 1942;

Therman, 1956; De Wet, 1957; Federov, 1969; Ornduff & Watters, 1978; Crosby, 1986; Hancke & Liebenberg, 1990; Hancke , 1991; Johnson & Brandham, 1997; Kleynhans, 1997; Hamatani *et al.*, 1998; Kleynhans & Spies, 1999; Spies *et al.*, 2000; Minnaar , 2004).

B-chromosomes were observed in several *Lachenalia* species: *L. aloides* var. *quadricolor* (n = 7 + 0-1B) (Hancke & Liebenberg, 1990); *L. anguinea* (2n = 30 + 2B) (Johnson & Brandham, 1997); *L. contaminata* (2n = 16 + 0-1B) (Johnson & Brandham, 1997); *L. reflexa* (2n = 14 + 0-2B) (Hancke & Liebenberg, 1990); *L. obscura* W. F. Barker (2n = 18 + 0-1B) (Johnson & Brandham, 1997). *Lachenalia* plants with extra chromosomes do not have any phenotypic abnormalities. The variation in basic chromosome numbers is not due to trisomy or partial trisomy, but because of B-chromosomes. The chromosomes of *L. aloides* have large amounts of centric heterochromatin. Large inert centric fragments could, therefore, have evolved in some of the species (Hancke & Liebenberg, 1990).

Chromosome studies were also successfully used in delimitating *Lachenalia* into five subgroups according to similar chromosome numbers. These groupings can be used as a reference for breeding (Crosby, 1986). Basic information such as chromosome variation, assist the breeder in predicting success or failure of interspecific hybridisation. Variability in a gene pool is needed to secure successful flower breeding (Harding *et al.*, 1991). But different chromosome numbers between species often create some reproductive isolation through reduced fertility of hybrids and leads to the creation of a species boundary (Judd *et al.*, 1999).

The significant variation in chromosome numbers observed in *Lachenalia* may be attributed to several factors: erroneous counts, the presence of B-chromosomes and/or the misidentification of specimens. Many chromosome number errors are recorded in the literature. Most large taxa include in their records some miscounts which, when not identified, may led to serious misinterpretation of data. Several authors, like Arends *et al.* (1982) and Goldblatt and Takei (1993), have excluded miscounts of previous works and their own. Other cytotaxonomists used every chromosome count recorded in a particular group, in an effort to provide a thorough review (Guerra, 2000).

The most fundamental concept in cytotaxonomy is the basic chromosome number, therefore this should be determined for *Lachenalia*. The main assumption is that natural groups are monophyletic and started as a single population with a single karyotype (with the exception of some polyploidy species, which are by default derived species). This implies that each natural species, genus or family has a single original base number. In many genera and even in higher categories this number has been conserved with no or only small minor changed. However,

during the evolution of some groups, the original base number has undergone changes through polyploidy and dysploidy to such an extent that it has become hardly identifiable (Guerra, 2000).

The literature clearly indicates that *Lachenalia* has different basic chromosome numbers, i.e. 5, 6, 7, 8, 9, 10, 11 & 13. In addition to these different basic chromosome numbers, B-chromosomes have been described in *Lachenalia* and polyploidy is present. The evolution of the different basic chromosome numbers in this genus has not been studied. Chromosome numbers of more than half the species of this genus is still unknown. Additional cytogenetic studies are essential to address these questions.

1.4.3.2 Molecular studies in the Hyacinthaceae

Molecular systematic studies of the Hyacinthaceae have been published. Unfortunately no major study of this kind included the majority of the *Lachenalia* species. Therefore there exists a need for an extensive molecular systematic study of this large genus. The considerable size of the genus prohibits the inclusion of more than one gene for the scope of this study. This limitation should be kept in mind throughout the rest of this dissertation.

1.5 AIM OF THE STUDY

The aims of this study are:

1. To determine and/or confirm the basic chromosome numbers of *Lachenalia* .
2. To determine the ploidy levels present in different *Lachenalia* accessions.
3. To determine whether the *trn*L-F region can be used in determining phylogenetic relationships in *Lachenalia*.
4. To determine at what taxonomic level *trn*L-F will give the best results in a phylogenetic study of the bulbous plants.
5. To determine phylogenetic relationships within *Lachenalia*.
   - Can the genus be subdivided into classes or subgenera?
   - What is the phylogenetic relationship between species with the same basic chromosome numbers?
   - How many true species are there in the genus and whether the genus is a hybrid swarm (because of hybridisation and sterility problems)?
   - Which one of the following classifications best represents a natural classification of the genus: Baker (1897), Crosby (1986), Duncan (1988) or Duncan (2002)?
6. To determine the phylogenetic position of *Lachenalia* among the bulbous plants.
7. To determine whether the different basic chromosome numbers in *Lachenalia* correspond with monophyletic groups obtained from a molecular systematic study of a chloroplast DNA region.
   - Is there a correlation between the topology of the cladogram and chromosome numbers?
8. How did the basic chromosome numbers within the genus evolve?

Chapter TWO

Materials & Methods

2.1 MATERIALS

The plant material used for the cytogenetic and molecular studies (Table 2.1) was collected in their natural habitat or obtained from several sources (National Botanical Institute [NBI], Kirstenbosch; NBI, Pretoria; Agricultural Research Council [ARC], Roodeplaat and several commercial nurseries). The leaves were collected in a saturated solution of sodium chloride and hexadecyltrimethyl ammonium bromide (CTAB) (Rogstad, 1992). Herbarium specimens are kept in the Geo Potts Herbarium, Bloemfontein, the National Herbarium, Pretoria (PRE) and/or ARC, Roodeplaat. Additional sequences for the molecular studies were obtained from Genbank (http://www.ncbi.nlm.nih.gov/Genbank) (Table 2.2).

Carmine (Unilab), fuchsin (Unilab), orcein (Sigma Cat. No. O 7380) and euparal (Unilab) mountant were used for the cytogenetic study. Sand, purified by acid (Merck laboratory supplies) and 2-Beta-mercapto-ethyl-alcohol (Unilab) were used for deoxyribonucleic acid (DNA) extraction. Sterile water (SABAX) was used as DNA dissolvent, and for the molecular reactions.

Triton X-100 (Saarchem), *Thermus aquaticus* Super Therm DNA polymerase (Taq. Pol.) with 10 x Buffer (Southern Cross Biotechnology LPI-801, LPI-455), magnesium chloride [Saarchem] and the *trn* sequence primers (Integrated DNA Technologies, Inc.) [designed according to Taberlet *et al.* (1991)], were used for the polymerase chain reactions (PCR). DNA molecular marker VI (pBR328 DNA cleaved with *Bgl*I and *Hinf*I) [Boehringer Mannheim Cat. No. 1062590] was used as reference markers for the genomic DNA as well as the amplification products on agarose gels (Techcomp LTD.).

Either the ABI prism® BigDye™ Terminator cycle sequencing ready reaction kit (Applied Biosystems Incorporated) or the Amersham DYEnamic ET terminator cycle sequencing kit (Amersham Pharmacia Biotech, product code US81050, US81060, US81070) were used for the reactions.

Other chemicals used were of analytical or electrophoretic grade.

Table 2.1: Material: List of specimens used for the cytogenetic ([1]) and/or the molecular ([2]) studies with their localities and voucher specimen numbers. Species are alphabetically arranged and specimens are listed according to their locality from north to south and from west to east.

***Albuca* L. sp.**

FREE STATE.–2925 (Jagersfontein): Fauresmith (-CB), *Spies 7117*[2].

***Asparagus laricinus* Burch.**

Ex hort., *Spies 7128*[2].

***Bowiea volubilis* Harv. ex Hook.f.**

Ex hort., *Spies 7134*[2].

***Drimia altissima* L.f.) Ker Gawl.**

Unknown, *Spies 7308*[2].

***Eriospermum cooperi* Baker**

FREE STATE.–2828 (Bethlehem): Witsieshoek Holiday Resort (-DB), *Spies 7434*[2].

***Eucomis autumnalis* (Mill.) Chitt.**

KWAZULU NATAL.–2931 (Stanger): Durban (-CC), *Spies 7298*[2].

***Gloriosa superba* L.**

Unknown, *Spies 7122*[2].

***Lachenalia alba* W.F. Barker ex G.D. Duncan**

NORTHERN CAPE.–3119 (Calvinia): Nieuwoudtville (-AC), *K. Steiner 1366*[2].

***L. algoensis* Schönland**

EASTERN CAPE.–3425 (Skoenmakerskop): St. Francis Bay (-AA), *C. Logie s.n.*[2].

L. aloides* (L.f.) Engl. var. *aloides

WESTERN CAPE.–3318 (Cape Town): Malmesbury (-BC), *G. Duncan 282*[2].

***L. aloides* (L.f.) Engl. var. *aurea* (Lindl.) Engl.**

WESTERN CAPE.–3319 (Worcester): Bainskloof (-AC), *G. Duncan 363*[2], *Spies 7060*[1].

***L. aloides* (L.f.) Engl. var. *luteola* var. nov. G.D.Duncan**

WESTERN CAPE.–3418 (Simonstown): Chapman's Peak (-AB), *H. van Zijl s.n.*[2].

***L. aloides* (L.f.) Engl. var. *nelsonii* var. nov. G.D.Duncan**

WESTERN CAPE.–3318 (Cape Town): Voorberg jail, Porterville, *Spies 7061*[1]. 3418 (Simons Town): Kommetjie (-AB), *G. Duncan 89*[2].

***L. aloides* (L.f.) Engl. var. *quadricolor* (Jacq.) Engl.**

WESTERN CAPE.–3318 (Cape Town): Langebaan (-AA), *G. Duncan* 152[2]; Darling (-AD), *Spies 7062*[1].

***L. aloides* (L.f.) Engl. var. *vanzyliae* W.F. Barker**

WESTERN CAPE.–3218 (Clanwilliam): Piketberg (-DA), *M. Thomas s.n.*[2]. 3318 (Cape Town): De Rust (-BD), *Spies 7063*[1].

***L. ameliae* W.F. Barker**

WESTERN CAPE.–3320 (Montagu): Montagu (-CC), *C. Malan 90*[2].

***L. angelica* W.F. Barker**

NORTHERN CAPE.–2917 (Springbok): Springbok (-DB), *G. Duncan 244*[2].

***L. anguinea* Sweet**

WESTERN CAPE.–3118 (Vanrhynsdorp): Klawer (-DC), *K. Steiner s.n*[2].

***L. arbuthnotiae* W.F.Barker**

WESTERN CAPE.–3318 (Cape Town): Cape Town Airport (-CD), *G. Duncan 94*[2].

***L. attenuata* W.F.Barker ex G.D.Duncan**

NORTHERN CAPE.–3220 (Sutherland): Sutherland (-BC), *R. Saunders s.n*[2].

***L. aurioliae* G.D.Duncan**

WESTERN CAPE.–3222 (Beaufort West): Beaufort West (-BC), *G. Duncan 394*[2].

***L. bachmanii* Baker**

WESTERN CAPE.–3218 (Clanwilliam): Piketberg (-DA), *D. Snijman 906*[2].

***L. barkeriana* U.Müll.-Doblies, B.Nord. & D.Müll.-Doblies**

WESTERN CAPE.–3118 (Vanrhynsdorp): Bitterfontein (-AB), *G. Duncan 440*[2].

***L. bolusii* W.F.Barker**

NORTHERN CAPE.–2917 (Springbok): Bulletrap (-BD), *G. Duncan 256*[2].

***L. bowkeri* Baker**

EASTERN CAPE.–3323 (Willowmore): Misgund (-CD), *P. Vorster 3029*[2].

***L. buchubergensis* Dinter**

NAMIBIA.–2816 (Oranjemund): Numees (-BD), *J. Lavranos s.n.*[2].

***L. bulbifera* (Cirillo) Engl.**

WESTERN CAPE.–3317 (Saldanha): Saldanha (-BB), *G. Duncan 90*[2]. 3419 (Caledon): Pearly Beach (-CB), *Spies 7064*[1].

Unknown, *Spies 6932*[1].

***L. campanulata* Baker**

EASTERN CAPE.–3226 (Fort Beaufort): Katberg Pass (-BC), *G. Duncan 403*[2].

***L. capensis* W.F.Barker**

WESTERN CAPE.–3418 (Simons Town): Simons Town (-AB), *G. Duncan 139*[2].

***L. carnosa* Baker**

NORTHERN CAPE.–3017 (Hondeklipbaai): Kamieskroon (-BB), *G. Duncan 185*[2]. 3018 (Kamiesberg): Road between Garies and Leliefontein (-AB), *Spies 6934*[1].

***L. comptonii* W.F.Barker**

WESTERN CAPE.–3319 (Worcester): Ceres (-AD), *G. Duncan 107*[2].

Unknown, *Spies 7066*[1].

***L. concordiana* Schltr. ex W.F.Barker**

NORTHERN CAPE.–3119 (Calvinia): Calvinia (-BD), *M. Thomas s.n*[2].

***L. congesta* W.F.Barker**

NORTHERN CAPE.–3220 (Sutherland): Komsberg Pass (-DB), *J. Manning s.n*[2].

***L. contaminata* Aiton**

WESTERN CAPE.–3318 (Cape Town): Darling (-AD), *G. Duncan 321*[2].

***L. convallarioides* Baker**

EASTERN CAPE.–3326 (Grahamstown): Grahamstown (-BC), *A. Dold 1018*[2].

***L. dasybotrya* Diels**

NORTHERN CAPE.–3119 (Calvinia): Calvinia (-BD), *M. Thomas 8*[2].

***L. dehoopensis* W.F.Barker**

WESTERN CAPE.–3420 (Bredasdorp): De Hoop Nature Reserve (-AD), *A. Scott s.n*[2].

***L. doleritica* G.D.Duncan**

NORTHERN CAPE.–3119 (Calvinia): Calvinia (-BD), *M. Thomas s.n*[2].

***L. duncanii* W.F.Barker**

NORTHERN CAPE.–3018 (Kamiesberg): Kliprand (-DA), *G. Duncan 189*[2].

L. elegans* W.F.Barker var. *elegans

NORTHERN CAPE.–3119 (Calvinia): Nieuwoudtville (-AC), *G. Duncan 426*[2].

***L. elegans* W.F.Barker var. *flava* W.F.Barker**

WESTERN CAPE.–3319 (Worcester): Ceres (-AD), *R. McMaster s.n*[2].

***L. elegans* W.F.Barker var. *membranacea* W.F.Barker**

WESTERN CAPE.–3118 (Vanrhynsdorp): Vanrhynsdorp (-DA), *G. Duncan 96*[2].

***L. elegans* W.F.Barker var. *suaveolens* W.F.Barker**

WESTERN CAPE.–3118 (Vanrhynsdorp): Vanrhynsdorp (-DA), *K. Hiemstra 415*[2].

***L. fistulosa* Baker**

WESTERN CAPE.–3318 (Cape Town): Signal Hill (-CD), *G. Duncan 303*[2]. 3418 (Simons Town): Houtbaai (-AB), *Spies 6936*[1].

***L. framesii* W.F.Barker**

WESTERN CAPE.–3118 (Vanrhynsdorp): Vanrhynsdorp (-DA), *R. Jangle s.n*[2].

***L. giessi* W.F.Barker**

NAMIBIA.–2516 (Helmeringhausen): Helmeringhausen (-DD), *G. Williamson s.n*[2].

2716 (Witputz): Rosh Pinah (-DD), *J. Lavranos 19917*[2].

L. gilettii W.F.Barker

WESTERN CAPE.–3218 (Clanwilliam): Piketberg (-DA), *C. Taswell-Yates s.n*[2].

***L. haarlemensis* Fourc.**

NAMIBIA.–2219 (Sandfontein): Haarlem (-AB), *P. Perry 3258*[2].

***L. hirta* (Thunb.) Thunb.**

WESTERN CAPE.–3218 (Clanwilliam): 3 km. from Elandsbaai (-AD), *Spies 6858*[1]. 3219 (Wupppertal): Between Pakhuis Pass and Biedou Valley, Clanwilliam district (-AA), *Spies 6859*[1]; 10 km north of Citrusdal (-CA), *Spies 7381*[1]. 3418 (Simons Town): Wuppertal (-BB), *M. Botha s.n*[2].

Unknown, *Spies 6860*[1].

***L. inconspicua* G.D.Duncan**

NORTHERN CAPE.–2917 (Springbok): Springbok (-DB), *G. Duncan 381*[2].

***L. isopetala* Jacq.**

NORTHERN CAPE.–3119 (Calvinia): Calvinia (-BD), *P. Perry 3065*[2].

***L. juncifolia* Baker**

WESTERN CAPE.–3319 (Worcester): Ceres (-AD), *G. Duncan 450*[2].

Unknown, *Spies 7077*[1], *7380*[1].

L. juncifolia* Baker var. *juncifolia

WESTERN CAPE.–3421 (Riversdale): Still Bay (-AD), *P. Bohnen 40314*[2].

***L. karooica* W.F.Barker ex G.D.Duncan**

FREE STATE.–2925 (Jagersfontein): Fauresmith (-CB), *G. Duncan 367*[2].

***L. klinghardtiana* Dinter**

NAMIBIA.–2816 (Oranjemund): Richtersveld (-AA), *F. Paterson s.n*[2].

***L. lactosa* G.D.Duncan**

WESTERN CAPE.–3419 (Caledon): Kleinmond (-AC), *G. Duncan 417*[2].

***L. latimerae* W.F.Barker**

WESTERN CAPE.–3320 (Montagu): Touwsberg (-DB), *P. Winter s.n*[2].

***L. leomontana* W.F.Barker**

WESTERN CAPE.–3420 (Bredasdorp): Swellendam (-AB), *M. Botha s.n*[2].

***L. liliflora* Jacq.**

WESTERN CAPE.–3318 (Cape Town): Durbanville (-DC), *R. Jangle 270*[2].

Unknown, *Spies 6937*[1].

***L. magregoriorum* W.F.Barker**

NORTHERN CAPE.–3119 (Calvinia): Nieuwoudtville (-AC), *W. Barker 9766*[2].

***L. margaretea* W.F.Barker**

WESTERN CAPE.–3218 (Clanwilliam): Pakhuis Pass (-BB), *F. Paterson s.n*[2].

L. marginata* W.F.Barker subsp. *marginata

WESTERN CAPE.–3218 (Clanwilliam): Pakhuis Pass (-BB), *G. Duncan 194*[2].

***L. marginata* W.F.Barker subsp. *neglecta* Schltr. ex G.D.Duncan**

WESTERN CAPE.–3218 (Clanwilliam): Clanwilliam (-BB), *G. Duncan 238*[2].

***L. marlothii* W.F.Barker ex G.D.Duncan**

NORTHERN CAPE.–2917 (Springbok): Bulletrap (-BD), *Symmonds s.n*[2].

***L. martinae* W.F.Barker**

WESTERN CAPE.–3218 (Clanwilliam): Clanwilliam (-BB), *G. Duncan 141*[2].

***L. mathewsii* W.F.Barker**

WESTERN CAPE.–3217 (Vredenburg): Vredenburg (-DD), *G. Duncan 200*[2].

Unknown, *Spies 6938*[1].

***L. maximiliani* Schltr. ex W.F.Barker**

WESTERN CAPE.–3418 (Simonstown): Wuppertal (-BB), *G. Duncan 284*[2].

***L. mediana* Jacq.**

WESTERN CAPE.–3319 (Worcester): Brandwag (-AC), *Spies 7086*[1].

L. mediana* Jacq. var. *mediana

WESTERN CAPE.–3318 (Cape Town): Kuilsrivier (-DC), *G. Duncan 298*[2].

***L. mediana* Jacq. var. *rogersii* (Baker) W.F.Barker**

WESTERN CAPE.–3318 (Cape Town): Darling (-AD), *Spies 7079*[1]*;* Porterville (-BB), *T. Toerien s.n.*[2].

***L. minima* W.F.Barker**

WESTERN CAPE.–3118 (Vanrhynsdorp): Bitterfontein (-AB), *G. Duncan 171*[2].

***L. moniliformis* W.F.Barker**

WESTERN CAPE.–3319 (Worcester): Worcester (-CB), *P. Perry 795*[2].

***L. muirrii* W.F.Barker**

WESTERN CAPE.–3420 (Bredasdorp): Bredasdorp (-CA), *C. Hilton-Taylor s.n*[2].

***L. multifolia* W.F.Barker**

WESTERN CAPE.–3319 (Worcester): Ceres (-AD), *D. Snijman 1215*[2].

***L. mutabilis* Sweet**

WESTERN CAPE.–3219 (Wuppertal): Kouberg (-AA), *R. Saunders 188*[2].

***L. namaquensis* Schltr. ex W.F.Barker**

NORTHERN CAPE.–2917 (Springbok): Kosies (-BA), *N. van Berkel 273*[2].

***L. namibiensis* W.F.Barker**

NAMIBIA.–2616 (Aus): Numis (-AA), *P. Bruyns 7217*[2].

***L. neilii* W.F.Barker ex G.D.Duncan**

NORTHERN CAPE.–3119 (Calvinia): Nieuwoudtville (-AC), *G. Duncan 596*[2].

***L. nervosa* Ker Gawl.**

WESTERN CAPE.–3420 (Bredasdorp): Swellendam (-AB), *M. Botha s.n*[2].

Unknown, *Spies 7360*[2].

***L. nordenstamii* W.F.Barker**

NORTHERN CAPE.–2918 (Gamoep): Aggeneys (-BB), *P. Desmet 2431*[2].

***L. obscura* Schltr. ex G.D.Duncan**

NORTHERN CAPE.–3220 (Sutherland): Sutherland (-BC), *J. Lavranos s.n.*[2].

***L. orchioides* (L.) Aiton var. *glaucina* (Jacq.) W.F.Barker**

WESTERN CAPE.–3421 (Riversdale): Riversdale (-AB), *P. Bohnen 8493*[2].

L. orchioides* (L.) Aiton var. *orchioides

WESTERN CAPE.–3318 (Cape Town): Potsdam (-DC), *P. Allen s.n.*[2].

***L. orthopetala* Jacq.**

WESTERN CAPE.–3318 (Cape Town): Durbanville (-DC), *G. Duncan 262*[2].

***L. pallida* Aiton**

WESTERN CAPE.–3318 (Cape Town): Potsdam (-DC), *Spies 7089*[1]. 3319 (Worcester): Tulbagh (-AC), *G. Duncan 357*[2].

***L. patula* Jacq.**

WESTERN CAPE.–3318 (Cape Town): Moedverloor (-AD), *R. Jamieson 60*[2].

***L. pearsonii* (P.E.Glover) W.F.Barker**

NAMIBIA. Unknown locality, *P. Bruyns 3554*[2].

***L. peersii* Marloth ex W.F.Barker**

WESTERN CAPE.–3419 (Caledon): Onrus (-AC), *G. Duncan 280*[2].

***L. perryae* G.D.Duncan**

WESTERN CAPE.–3319 (Worcester): Hex River Pass (-BD), *J. Forrester s.n.*[2].

***L. physocaulos* W.F.Barker**

WESTERN CAPE.–3319 (Worcester): Robertson (-DD), *G. Duncan 288*[2].

***L. polyphylla* Baker**

WESTERN CAPE.–3319 (Worcester): Gouda (-AC), *G. Duncan 348*[2].

***L. polypodantha* Schltr. ex W.F.Barker**

NAMIBIA.–2816 (Oranjemund): De Toonberg, Richtersveld (-AA), *R. Rourke 2091*[2].

***L. purpureo-caerulea* Jacq.**

WESTERN CAPE.–3218 (Clanwilliam): Piekenierskloof Pass (-DB), *Spies 6939*[1]. 3318 (Cape Town): Darling (-AD), *K. Hiemstra 192*[2].

***L. pusilla* Jacq.**

WESTERN CAPE.–3218 (Clanwilliam): Aurora (-CB), *G. Duncan 210*[2].

***L. pustulata* Jacq.**

WESTERN CAPE.–3318 (Cape Town): Darling (-AD), *M. Thomas 106*[2].

***L. reflexa* Thunb.**

WESTERN CAPE.–3318 (Cape Town): Dassenberg vlakte (-BC), *Spies 7090*[1]; Potsdam (-DC), *G. Hansford s.n.*[2]. 3322 (Oudtshoorn): Between Oudtshoorn and Mossel Bay (-CC), *Spies 7091*[1].

***L. rosea* Andrews**

WESTERN CAPE.–3419 (Caledon): Greyton (-BA), *M. Hofmeyer s.n*[2].

***L. rubida* Jacq.**

WESTERN CAPE.–3418 (Simonstown): Kommetjie (-AB), *G. Duncan 91*[2]; 60km from Faure turn off, Cape Town area (-BB), *Spies 7093*[1]

***L. salteri* W.F.Barker**

WESTERN CAPE.–3419 (Caledon): Elim (-DA), *L. Nicklin 136*[2].

***L. sargeantii* W.F.Barker**

WESTERN CAPE.–3420 (Bredasdorp): Bredasdorp (-CA), *G. Duncan 436*[2].

***L. schelpei* W.F.Barker**

NORTHERN CAPE.–3119 (Calvinia): Calvinia (-BD), *G. Duncan 401*[2].

***L. splendida* Diels**

WESTERN CAPE.–3118 (Vanrhynsdorp): Vanrhynsdorp (-DA), *B. Wiese s.n*[2].

***L. stayneri* W.F.Barker**

WESTERN CAPE.–3319 (Worcester): Worcester (-CB), *F. Stayner s.n*[2].

***L. thomasiae* W.F.Barker ex G.D.Duncan**

WESTERN CAPE.–3218 (Clanwilliam): Clanwilliam (-BB), *G. Duncan 350*[2].

***L. trichophylla* Baker**

NAMIBIA.–2316 (Nauchas): Garies (-CD), *K. Steiner s.n*[2].

***L. unifolia* Jacq.**

NORTHERN CAPE.–3017 (Hondeklipbaai): On the way to Soebatsfontein in the Kammieskroon district (-BA), *Spies 6866*[1]*;* Soebatsfontein road, 5 km from Kamieskroon (-BB), *Spies 6878*[1], *6879*[1], *6881*[1].

WESTERN CAPE.–3118 (Wuppertal): road between Klawer and Clanwilliam (-BB), *Spies 6898*[1]. 3218 (Clanwilliam): Clanwilliam botanical gardens (-BB), *Spies 6864*[1]; Pale isheuwel (-BC), *Spies 6861*[1]. 3318 (Cape Town): Yzerfontein (-AC), *G. Duncan 253*[2]; Darling (-AD), *Spies 6867*[1]; Voorberg jail, Porterville (-BB), *Spies 6872*[1]; Dasklip Pass (-BB), *G. Duncan 346*[2]; Jonkershoek forestry station (-DD), *Spies 6874*[1], *6891*[1]. 3319 (Worcester): Witzenberg (-AC), *Spies 6863*[1]; North of Gouda (-AC), *Spies 6871*[1]; On the Ceres side of Bainskloofpas (-CA), *Spies 6892*[1].

Unknown, *Spies 6886*[1], *6882*[1], *6887*[1], *6889*[1].

L.* cf. *unifolia

WESTERN CAPE.–3318 (Cape Town): Tienie Versveldt Nature Reserve, Darling (-AD), *Spies 6899*[1], *6902*[1].

***L. valeriae* G.D.Duncan**

NORTHERN CAPE.–2917 (Springbok): Komaggas (-DC), *J. Lavranos 28585*[2].

***L. variegata* W.F.Barker**

WESTERN CAPE.–3318 (Cape Town): Brackenfell (-DC), *H. Crous 541*[2].

Unknown, *Spies 7097*[1].

***L. ventricosa* Schltr. ex W.F.Barker**

WESTERN CAPE.–3118 (Vanrhynsdorp): Klawer (-DC), *G. Duncan 191*[2].

***L. verticillata* W.F.Barker**

NORTHERN CAPE.–2917 (Springbok): Steinkopf (-BD), *D. Müller-Doblies 88125*[2].

***L. violacea* Jacq.**

NORTHERN CAPE.–3017 (Hondeklipbaai): Road between Garies and Kamieskroon (-BB), *Spies 7101*[1]; Soebatsfontein road, 8 km from Kamieskroon (-BB), *Spies 7104*[1].

WESTERN CAPE.–3118 (Vanrhynsdorp): Klawer (-DC), *G. Duncan 190*[2].

***L. viridiflora* W.F.Barker**

WESTERN CAPE.–3218 (Clanwilliam): St. Helena Bay (-CC), *G. Duncan 410*[2]. 3318 (Cape Town): Stanford (-DC), *Spies 7098*[1].

***L. whitehillensis* W.F.Barker**

WESTERN CAPE.–3320 (Montagu): Whitehill (-BA), *G. Duncan 242*[2].

***L. youngii* Baker**

WESTERN CAPE.–3423 (Knysna): Storms River (-BB), *R. McMaster s.n*[2].

***L. zebrina* Baker forma *densiflora* forma nov. G.D.Duncan**

NORTHERN CAPE.–3119 (Calvinia): Calvinia (-BD), *N. Du Plessis s.n*[2].

L. zebrina* Baker forma *zebrina

Unknown, *Ex hort. Kirstenbosch*[2].

***L. zeyheri* Baker**

Ex hort Kirstenbosch[2]*;* Uknown, *Spies 7099*[1].

***Lachenalia* sp. nov 1 G.D.Duncan**

WESTERN CAPE.–3218 (Clanwilliam): Piketberg (-DA), *G. Duncan146*[2].

***L.* sp. nov. 2 G.D.Duncan**

WESTERN CAPE.–3319 (Worcester): Bainskloof Pass (-CA), *G. Duncan 428*[2].

***L.* sp. nov. 3 G.D.Duncan**

WESTERN CAPE.–3320 (Montagu): Whitehill (-BA), *G. Duncan 243*[2].

***L.* sp. nov. 4 G.D.Duncan**

NORTHERN CAPE.–3220 (Sutherland): Tankwa-Karoo National Park (-CB), *G. Duncan 455*[2].

***L.* sp. nov. 5 G.D.Duncan**

NORTHERN CAPE.–3220 (Sutherland): Komsberg (-DB), *G. Duncan 460*[2].

L. sp. nov. 6 G.D.Duncan

WESTERN CAPE.–3118 (Vanrhynsdorp): Vanrhynsdorp (-DA), *B. Wiese s.n*[2].

***L.* sp. nov. 11 G.D.Duncan**

NORTHERN CAPE.–2917 (Springbok): Kleinsee (-CA), *G. Duncan 445*[2].

***Ledebouria revoluta* (L.f.) Jessop**

GAUTENG.–2528 (Pretoria): Roodeplaat District (-CB), *Spies 7287*[2].

***Massonia depressa* Houtt.**

WESTERN CAPE.–3219 (Wuppertal): Kouberg (-AA), *G. Duncan 382*[2].

***M. echinata* L.f.**

NORTHERN CAPE.–3119 (Calvinia): Nieuwoudtville (-AC), *J. Manning s.n*[2].

***M. jasminiflora* Burch. ex Baker**

FREE STATE.–2925 (Jagersfontein): Fauresmith (-CB), *Spies 7115*[2].

***M. pustulata* Jacq.**

Unknown, *Spies 7467*[2].

***Ornithogalum longibracteatum* Jacq.**

Ex hort., *Spies 7132*[2].

***Ornithoglossum viride* (L.f.) Aiton**

NORTH WEST.–2624 (Vryburg): Vryburg (-DC), *Spies 7135*[2].

***Polyxena corymbosa* (L.) Jessop**

WESTERN CAPE.–3318 (Cape Town): Milnerton (-CD), *M. Simmons s.n*[2].

***P. ensifolia* (Thunb.) Schönland**

NORTHERN CAPE.–3018 (Kamiesberg): Leliefontein (-AB), *G. Duncan 427*[2].

***P. longituba* A.M.van der Merwe**

NORTHERN CAPE.–3220 (Sutherland): Sutherland (-BC), *J. Manning s.n*[2].

***P. maughanii* W.F.Barker**

NORTHERN CAPE.–3119 (Calvinia): Nieuwoudtville (-AC), *A. de Villiers s.n*[2].

***P. odorata* (Hook.f.) Baker**

FREE STATE.–2925 (Jagersfontein): Fauresmith (-CB), *Spies 7116*[2].

***P. pauciflora* (W.F.Barker) A.M.van der Merwe & J.C.Manning**

WESTERN CAPE.–3318 (Cape Town): Langebaan (-AA), *G. Duncan 170*[2].

***Sansevieria aethiopica* Thunb.**

Ex hort., *Spies 7465*[2].

***Scadoxus membranaceus* (Baker) Friis & Nordal**

WESTERN CAPE.–3218 (Clanwilliam): Voorberg jail, Porterville (-BB), *Spies 7246*[2].

***Schizocarpus nervosus* (Burch.) Van der Merwe**

Unknown, *Spies 7305*[2].

***Trachyandra* Kunth sp.**

NAMIBIA.–2816 (Oranjemund): Kodas Mine ruins, Richtersveld (-AA), *AMV638*[2].

***Veltheimia capensis* (L.) DC.**

WESTERN CAPE.–3321 (Ladismith): Ladismith (-AD), *G. Duncan 132*[2].

Table 2.2: Material: List of species of which sequences were obtained from Genbank (http://www.ncbi.nlm.nih.gov/Genbank), with their Genbank "voucher number".

	***trn*L intron**	***trn*L-*trn*F intergenic spacer**
Albuca nelsonii	AJ232468.1	AJ232591.1
A. shawii	AF117012.1	AF117042.1
Albuca sp.	AJ232467.1	AJ232590.1
Aloe bakeri	AJ290254.1	AJ290288.1
Aloe vera	AJ290255.1	AJ290289.1
Bulbine semibarbata	AJ290259.1	AJ290293.1
B. succulenta	AJ290260.1	AJ290294.1
B. wiesei	AJ290261.1	AJ290295.1
Bulbinella cauda-felis	AJ290262.1	AJ290296.1
Bowiea volubilis	AJ232454.1	AJ232577.1
Dipcadi fulvum	AJ232479.1	AJ232602.1
D. viride	AJ232476.1	AJ232599.1
Drimia calcarata	AJ247496.1	AJ247497.1
D. elata	Z99135.1	Z99136.1
D. fugax	AJ247498.1	AJ247499.1
D. undata	AJ247512.1	AJ247513.1
Drimiopsis botryoides	Z99139.1	Z99140.1
D. barteri	Z99137.1	Z99138.1
D. maculata	AJ232502.1	AJ232625.1
Eriospermum cf. abyssinicum	AJ247494.1	AJ247495.1
Galtonia candicans	AJ232472.1	AJ232595.1
G. princeps	AJ232474.1	AJ232597.1
G. viridiflora	AJ232596.1	AJ232473.1
Gasteria liliputiana	AJ290264.1	AJ290298.1
Haworthia subfasciata	AJ290265.1	AJ290299.1
Kniphofia uvaria	AJ290267.1	AJ290301.1
Ledebouria cordifolia	Z99143.1	Z99144.1
L. revoluta	X74576.1	X74584.1
L. socialis	AJ232501.1	AJ232624.1
L. somalensis	Z99150.1	Z99151.1
L. urceolata	Z99148.1	Z99149.1
Muscari comosum	AJ232546.1	AJ232669.1
Nivenia corymbosa	AJ290287.1	AJ290321.1
Nothoscordum bivalve	AF117024.1	AF117052.1
Ornithogalum amphibolum	AJ232493.1	AJ232616.1
O. angustifolium	AJ232497.1	AJ232620.1
O. fimbriatum	AJ232491.1	AJ232614.1
O. gussonei	AJ232489.1	AJ232612.1
O. longibracteatum	AF117008.1	AF117037.1
O. montanum	AJ232490.1	AJ232613.1
O. pannonicum	AJ232496.1	AJ232619.1
O. pascheanum	AJ232492.1	AJ232615.1
O. tenuifolium	Z99152.1	Z99153.1
O. umbellatum	AJ232495.1	AJ232618.1
O. wiedemannii	AJ232494.1	AJ232617.1
Polyxena calcicola	AJ232506.1	AJ232629.1
Rhadamanthus sp.	AJ232458.1	AJ232581.1
Schizobasis intricata	AJ247490.1	AJ247491.1
Schizobasis sp.	AJ247492.1	AJ247493.1
Scilla lazulina	Z99155.1	Z99156.1
S. nervosa	Z99157.1	Z99158.1
S. peruviana	Z99159.1	Z99160.1
Thuranthos indicum	AJ232455.1	AJ232578.1
Trachyandra sp.	AJ290270.1	AJ290304.1
Tulbaghia violaceæ	AF116999.1	AF117030.1
Urginea sp.	AJ232459.1	AJ232582.1
U. undulata	AJ232463.1	AJ232586.1
Veltheimia bracteata	AJ232503.1	AJ232626.1
Whiteheadia bifolia	AJ232504.1	AJ232627.1
Witsenia maura	AJ290286.1	AJ290320.1

2.2 METHODS

2.2.1 Mitosis

The bulbs were stored at room temperature in paper bags until root formation initiated. The bulbs were placed on either a hydro-gel medium (Deco-gel^{TM}), pebbles or gravel with water for 24 to 48 hours until the roots were between 10 and 20 mm long. The gel, pebbles or gravel replaced the soil substrate to create a clean and protected environment for root formation. Actively growing roots were cut at the base of the bulbs and arrested for 24 hours at 4ºC in ice-cold tap water and fixed in Carnoy's (1886) fixative [ethyl-alcohol (ethanol):chloroform:acetic acid 6:3:1 v/v/v] for 24-36 hours. The root tips were stored at 4ºC in 70% (v/v) ethyl-alcohol for further use.

For the microscope analyses, the roots were macerated for 7 minutes at 60ºC in 1N hydrochloric acid (1N HCl) and the root tips were stained in the dark at 4ºC for 2 hours with leuco-basic fuchsin [1 g basic fuchsin; 30 ml 1N HCl; 3 g potassium bisulfide ($K_2S_2O_5$); 0.5 g decolorizing carbon) (Darlington & La Cour, 1976). The roots were then stored in 30% (v/v) ethyl-alcohol.

The tip of a root was placed on a microscope slide in a drop of 1:1 diluted aceto-orcein [2.2 g orcein in 100 ml glacial acetic acid (Darlington & La Cour, 1976)] for 20 minutes. A drop of acetic acid (45% v/v) was added after 20 minutes. Excessive liquid was removed with filter paper and the root fragmented with a needle. A cover slip was pre-treated with Mayer's albumen [25 ml albumen, 25 ml glycerine and 0.5 g sodium salicylate (Darlington & La Cour, 1976)]. The cover slip was placed onto the root tip with the albumen on the inside for the chromosomes to stick to. Enfolding the slide with filter paper and tapping the cover slip gently with the handle of a needle, the cells and chromosomes were spread. The slide was briefly studied under the microscope to detect any mitotic cell divisions and to determine whether the chromosomes were well spread.

Usable slides were placed upside down in acetic acid (45% v/v). After the cover slip floated off while the slides were placed in 100% ethyl-alcohol. The cover slip was dehydrated in an ethyl-alcohol series, i.e. 70%, 80% and 100% (v/v) for a few seconds each. The cover slip was mounted on the slide with Euparal (Bowen, 1956) and dried for at least three days on a hot plate at 60°C. The slides were analyzed on a Nikon Microphot-FXA microscope and the chromosomes of at least 20 suitable cells were studied and counted.

The cells were photographed with a 35 mm Nikon camera (using Pan-F 35-mm (ASA 50) monochrome films) attached to a Nikon Microphot-FXA photomicroscope.

The films were developed in Agfa Rodinal film developer (2% v/v) for 12 minutes at 20°C, then rinsed with tap water, fixed in Ilford rapid film fixer (7% v/v) for 10 minutes and rinsed with tap water for 20 minutes. Films were dried overnight at room temperature.

Ilford Multigrade IV RC DE LUXE paper was used for the photo development. The photos were developed in Ilfospeed developer (10% v/v), stopped with diluted acetic acid (0.5% v/v) and fixed in Ilford Hypam fixative for 5 minutes. The photos were rinsed for 20 minutes and dried on a hot plate.

2.2.2 Meiosis

Meiosis occurs during the development of the inflorescence inside the bulb of *Lachenalia* species. The inflorescence was, therefore, removed by cutting the bulbs when the first signs of inflorescence were visible between the sheaths of the leaves. They were fixed in Carnoy's (1886) fixative for 24 hours and stored in ethyl-alcohol (70% v/v).

One anther per flower was removed and placed on a slide with a drop of 2% (m/v) aceto-carmine [0.5 g carmine; 45 ml glacial acetic acid (Darlington & La Cour, 1976)]. The anther was fragmented with a needle and a drop of ferri-acetate was added to intensify the colouring. After covering the anther with a cover slip, the slide was enfolded in filter paper and the anther was squashed with the back of a needle.

The slide was analyzed under a microscope and if suitable stages were observed, it was frozen with liquid carbon dioxide, dehydrated in ethyl-alcohol and permanently mounted with Euparal (Bowen, 1956). The slides were dried on a hotplate for at least three day's and at least 20 cells per meiotic stage were analyzed and photographed (see 2.2.1).

2.2.3 DNA extraction

A preliminary study was performed to determine the method best suited for extracting DNA from the material used in this study. The extractions were based on a method described by Rogstad (1992). For this preliminary experiment, leaves stored in saturated CTAB for 7 months, 1 month, 2-4 hours and fresh leaves were used. Either sand (purified by acid) or liquid nitrogen

was used to grind the leaf material. The best results were obtained from leaves stored for at least one month and by using sand in the extraction process.

Prior to the extraction, CTAB (3% m/v) and 0.2% (m/v) 2-Beta-mercapto-ethyl-alcohol was added to the extraction buffer (pH 8) (100 mM Tris-HCl; 25 mM EDTA; 1.4 M NaCl) and preheated to 65°C. Approximately 1 g of plant material was cut into a mortar.

Purified sand (0.1-0.2 g), as well as 1 ml of the preheated extraction buffer, were added to the leaf material. The mixture was ground with a pestle until it formed a paste. Preheated extraction buffer was added, aiding in the transfer of the paste to a test tube.

The leaf material-extraction buffer mixture was incubated in a preheated water bath at 65°C for ± 60 minutes. Longer times in the water bath could result in the denaturation of the DNA. The test tubes were vortexed briefly every 10-15 minutes. One volume of chloroform:iso-amylalcohol (24:1 v/v) was added after 60 minutes and thoroughly mixed. The test tubes were centrifuged for 5 minutes at 3 000 *g* and the supernatants were transferred to a clean test tube. The DNA was precipitated with cold (-20°C) absolute ethyl-alcohol with 3 M sodium acetate (25:1) for at least 60 minutes at -20°C or overnight at 4°C. The test tubes were centrifuged at 10 000 *g* for 10 minutes, the supernatant discarded and the pellet washed with 70% (v/v) ethyl-alcohol, containing 10 mM ammonium acetate. The test tubes were centrifuged for 5 minutes at 10 000 *g*, the supernatant discarded and the pellet allowed to dry at room temperature until all alcohol evaporated. The DNA was dissolved (overnight at 4°C) in 20-100 µl sterile water, depending on the size of the pellet. RNAse (0.5 µl RNAse per 100 µl DNA) was added to the test tubes, together with sterile water, to remove any RNA. The DNA was transferred to micro-tubes and stored at -20°C.

2.2.4 Gel electrophoresis

The DNA was loaded onto a 1% (m/v) agarose gel {1% (m/v) agarose; 1x TAE buffer [50x TAE (48.44 g Tris; 11.42 ml acetic acid; 2.92 g EDTA)] with pH8; ethidium bromide (10 mg/ml)]}, run at 100V for 45 minutes and visualized under UV light. The genomic DNA was photographed with the Gel Doc 1000 system using the software program Molecular analyst® Software 1.4.1. (Bio Rad Laboratories).

2.2.5 Taguchi optimisation

The Taguchi method (Cobb & Clarkson, 1994) was used to determine the volumes of the reaction components to acquire optimum pre-sequence performance. This eliminates the time-consuming procedure where each reaction component is optimised separately. If the component volumes are not optimised, it can result in the appearance of dimerisation, mis-incorporation and mismatch extension of primer template duplexes (Cobb & Clarkson, 1994). The PCR pre-sequence reactions consist of five reaction components. For the Taguchi optimisation, the volumes of the 5x buffer [10x buffer (500 µl); gelatine (1 mg); dNTPs (10 µl of each); triton X-100 (5 µl)] and Taq. Pol. were kept constant for each reaction. The other three components (25 mM magnesium chloride, primer *c*- & *d* [50 pmol/µl mixture containing both primers]; DNA template) had three variable volumes. Primer *c* was used as the forward primer and primer *d* as the reverse primer (Taberlet *et al.*, 1991).

The number of reactions to be used (E) was calculated with the equation $E = 2k + 1$, where *k* represents the number of factors to be tested (Cobb & Clarkson, 1994). In this study there were three components or factors to be tested. Seven reactions were, therefore, needed. Because seven is not a factor of three, nine different reactions were prepared, containing both the constant and variable components. The variable components were added orthogonally, i.e. three different concentrations were added in three different combinations to the nine micro-tubes (Table 2.3). The reactions were diluted with sterile water to total reaction volumes of 10 µl. The reactions were briefly vortexed, centrifuged and left at 4°C for at least 30 minutes before amplification.

Table 2.3: Taguchi optimisation: This table was used to compile the Taguchi reaction and indicates the different component combinations. **A**, **B** and **C** represents the volumes. Similar letters in a column represents the same volume. The numbers in brackets are the volumes (µl) used for the Taguchi optimisation. The last column is the volume in µl of sterile water used to dilute each reaction to a volume of 10 µl.

Reaction #	5 x Buffer	Taq. Pol.	$MgCl_2$	Primers	DNA	H_2O
1	**A** (2)	**A** (0.1)	**A** (0.3)	**A** (0.2)	**A** (0.5)	7 µl
2	**A** (2)	**A** (0.1)	**A** (0.3)	**B** (0.5)	**B** (1.0)	6.1 µl
3	**A** (2)	**A** (0.1)	**A** (0.3)	**C** (1.0)	**C** (1.5)	5.1 µl
4	**A** (2)	**A** (0.1)	**B** (0.5)	**A** (0.2)	**C** (1.5)	5.8µl
5	**A** (2)	**A** (0.1)	**B** (0.5)	**B** (0.5)	**A** (0.5)	6.4 µl
6	**A** (2)	**A** (0.1)	**B** (0.5)	**C** (1.0)	**B** (1.0)	5.4 µl
7	**A** (2)	**A** (0.1)	**C** (0.7)	**A** (0.2)	**B** (1.0)	6.1 µl
8	**A** (2)	**A** (0.1)	**C** (0.7)	**B** (0.5)	**C** (1.5)	5.2 µl
9	**A** (2)	**A** (0.1)	**C** (0.7)	**C** (1.0)	**A** (0.5)	5.7 µl

The DNA was amplified in a Perkin Elmer GeneAmp PCR system 9600 using the following cycles: denaturation (94°C for 3 minutes); 40 cycles of denaturation (94°C for 30 seconds), annealing (50°C for 30 seconds), elongation (72°C for 90 seconds) and cooling/storing (4°C).

The PCR products were loaded onto a 1% (m/v) agarose gel and visualized with ethidium bromide under UV light and photographed (see 2.2.4).

The fragments were scored according to the intensity of the fragment, with 1 being the lowest score (no fragment visible) and five the highest (brightest fragment). The intensity of the fragment is an indication of the yield of each reaction. The effects of each individual component on amplification could be estimated by calculating the *signal-to-noise* (SNL) values for each variable component: $SNL = -10 \log [1/n \sum 1/y^2]$; where n = the number of levels (different concentrations); y = yield (the score given for each reaction) (Cobb & Clarkson, 1994).

To refine the optimum concentration, a graph was drawn from the SNL values for each variable component. The maximum of each curve indicated the optimum concentration for that particular component.

2.2.6 DNA concentration

The DNA quantities were measured with a Cary 3 UV-visible spectrophotometer (Varian) and the DNA concentrations were determined with the formula: DNA concentration = OD x 50 x dilution, where the dilution is the volume DNA / the total volume.

2.2.7 Sequencing using the polymerase chain reaction (PCR) technique

2.2.7.1 *trn*L-F amplification

The non-coding *trn*L-F region of the chloroplast genome, consist of the *trn*L-(UAA)-intron, and the intergenic spacer (IGS) between the *trn*L-(UAA)-3'-intron and *trn*F-(GAA) gene (Pfosser & Speta, 1999). This area was amplified in a single PCR reaction using primers *c* and *f* (Table 2.4) (Fangan *et al.*, 1994). These synthetic primers are used to prime the synthesis of two

complementary strands of DNA at the opposite end of the region (Clegg & Durbin, 1990) using a thermo stable polymerase enzyme obtained from a thermophillic bacterium (*Taq*I polymerase).

Table 2.4: *trn*L-F PCR amplification and sequence primers: The sequences of the primers used to amplify the non-coding *trn*L-F region of the chloroplast genome. Primers *c* and *d* amplify the *trn*L-(UAA)-intron. Primers *e* and *f* amplify the intergenic spacer between *trn*L-(UAA)-3'-intron and the *trn*F-(GAA) gene (Taberlet *et al.*, 1991). Primers *c* and *f* amplify the total region and were used for the PCR amplification reactions. Primers PS1 - PS4 are nested primers used only for the final sequence reactions (Pfosser & Speta, 1999).

Primer	Primer sequence	Amplification direction
Primer *c*	5' - CGA AAT CGG TAG ACG CTA CG - 3'	Forward primer for the *trn*L-(UAA)-intron
Primer *d*	5' - GGG GAT AGA GGG ACT TGA AC - 3'	Reverse primer for the *trn*L-(UAA)-intron
Primer *e*	5' - GGT TCA AGT CCC TCT ATC CC - 3'	Forward primer for the intergenic spacer
Primer *f*	5' - ATT TGA ACT GGT GAC ACG AG - 3'	Reverse primer for the intergenic spacer
Primer *PS1*	5' - CTA CGG ACT TAA TTG GAT TGA GC - 3'	Forward nested primer for the *trn*L-(UAA)-intron
Primer *PS2*	5' - GGG GAT AGA GGG ACT TGA AC - 3'	Reverse nested primer for the *trn*L-(UAA)-intron
Primer *PS3*	5' - GGT TCA AGT CCC TCT ATC CC - 3'	Forward nested primer for the intergenic spacer
Primer *PS4*	5' - AGG ATT TTC AGT CCT CTG CTC - 3'	Reverse nested primer for the intergenic spacer

The component volumes for the amplification were determined by the Taguchi optimisation (see 2.2.5). The components and their volumes were: 5x sequencing buffer (2 µl), 25 mM magnesium chloride (0.5 µl), 50 pmol primer (0.25 µl of each), 5U/µl Taq. Pol. (0.1 µl), sterile H_2O (5.9 µl) and DNA (1 µl). The reactions were prepared under sterile conditions, briefly vortexed, centrifuged and left for at least 30 minutes at 4°C. A negative control was included with each set of samples.

Different families, genera and even species needed different cycling conditions for successful amplification, but for the majority samples, especially the genus *Lachenalia*, touchdown cycles (Don *et al.*, 1991) were carried out: The DNA was initially denatured (3 minutes at 94°C), followed by eight sets of cycles (denaturation, primer annealing and elongation), each repeated twice. For each set, the denaturation and primer annealing temperatures were constant at 94°C and 72°C respectively, but the primer annealing temperature declined by 2°C per set. A final polymerization step for 3 minutes at 72°C followed as described by Bogler & Simpson (1996).

The PCR products were visualized on a 1% agarose gel (see 2.2.4).

2.2.7.2 *trn*L-F sequencing

The PCR product concentrations for the sequence reactions depended on the size to be sequenced. The average size of the *trn*L-F intron of the Family Hyacinthaceae is 515–592 bp and for the *trn*L-F intergenic spacer it is 342–408 bp (Pfosser & Speta, 1999). According to these sizes, the PCR product concentrations needed to be 5–20 ng for the ABI kit and 85.7–100 ng for the Amersham Pharmacia Biotech kit. Dilutions for the sequence reactions were, however, estimated because of the small volume (10 µl) of the PCR products available. The dilutions of the PCR pre-sequence reactions were between 1:2 and 1:10.

Instead of using the same primers as with the amplification procedure, nested primers were used for the sequencing. This is a more reliable method that enhances the quality of the sequence reactions (Fangan *et al.*, 1994). The nested primers have a different base pair constitution than those used for the amplification reactions and their annealing sites are situated inward from the *c* and *f* primer annealing sites. Nested primers *PS1*, *PS2*, *PS3* and *PS4* (Table 2.4) designed by Pfosser & Speta (1999), were used to sequence the entire *trn*L-F region.

Either the ABI kit or the Amersham Pharmacia Biotech kit was used for the sequence reactions.

2.2.7.2.1 *ABI kit*

For the ABI kit, either half reactions or quarter reactions with a total volume of 20 µl for each were prepared for the sequence reactions (Table 2.5). A positive control [pGEM 3Zf(+)] was included for each set of samples.

The cycles for the ABI reactions were: 25 cycles of denaturation, primer annealing and extension (Table 2.5). The products were purified using ethyl-alcohol precipitation, where 16 µl deionized water and 64 µl 95% ethyl-alcohol was added to the product. The micro-tubes were briefly vortexed and left at room temperature for 15 minutes to precipitate the extension products. The micro-tubes were centrifuged for 20 minutes at 10 000 *g* where after the supernatant was aspirated using a vacuum and discarded. A volume of 250 µl ethyl-alcohol (70% v/v) was added to the micro-tubes, briefly vortexed and centrifuged for 10 minutes at 10 000 *g*. The supernatant was again aspirated with a vacuum and the samples were dried in the Perkin Elmer GeneAmp PCR system 9600 at 90°C for 1 minute.

Table 2.5: Protocols for different sequencing kits: Summary of the sequencing protocols for the ABI kit (¼ and ½ reactions) and the Amersham Pharmacia Biotech kit (full reactions), as well as the cycling conditions and after sequencing cleanup.

Sequence procedures		**ABI**		**Amersham pharmacia biotech**
		¼ Reaction	**½ Reaction**	**Full Reaction**
PCR reagents	Premix	2 µl	4 µl	8 µl
	Primer (50 pmole/µl)	3.2 µl	3.2 µl	5 µl
	5 x buffer	3 µl	2 µl	—
	Sterile water	5.8 µl	9.8 µl	4 µl
	DMSO (dimethyl sulfoxide)	—	—	2 µl
	PCR template	6 µl	1 µl	1 µl
PCR cycles		25 cycles: denaturation (10 sec @ 96°C) primer annealing (5 sec @ 50°C) extension (4 minutes @ 60°C)		25 cycles: denaturation (20 sec @ 95°C) primer annealing (15 sec @ 50°C) extension (1 minute @ 60°C)
PCR product cleanup	Step 1 (adding precipitate)	Add 16 µl deionised water & 64 µl ethyl-alcohol (95% v/v) to product		Add 2 µl sodium acetate/EDTA buffer & 80 µl ethyl-alcohol (95% v/v) to product
	Step 2 (precipitation)	Leave at room temperature for 15 minutes		—
	Step 3 (centrifuge)	Centrifuge at 10 000 *g* for 20 minutes		Mix & centrifuge at ~10 000 *g* for 15 minutes
	Step 4 (discard)	Discard the supernatant		Discard the supernatant
	Step 5 (wash)	Wash the pellets with ethyl-alcohol (70% v/v)		Wash the pellets with ethyl-alcohol (70% v/v)
	Step 6 (centrifuge)	Vortex briefly and centrifuge for 10 minutes at 10 000 *g*		Centrifuge briefly
	Step7 (discard)	Discard the supernatant		Discard the supernatant
	Step 8 (dry)	Dry the pellets in a Perken Elmer GeneAmp PCR system 9600 for 1 minute at 90°C		Air-dry the pellets for 2-5 minutes

2.2.7.2.2 *Amersham Pharmacia Biotech kit*

For the Amersham Pharmacia Biotech kit, full reactions were prepared with a total volume of 20 µl (Table 2.5). The reactions were kept for at least 30 minutes at 4°C before amplification. Amplification was performed in the Perkin Elmer thermo cycler (Table 2.5), where after the total volume of the sequence product (20 µl) was transferred to a 1.5 µl volume micro-tube. A volume of 2 µl (1/10 volume) sodium acetate/EDTA buffer was added to each micro-tube, followed by 80 µl of ethyl-alcohol (95% v/v). The micro-tubes were thoroughly mixed using a vortex mixer and centrifuged for 15 minutes at ~10 000 *g*. The supernatant was carefully discarded by aspiration using a vacuum. The pellets were washed with ethyl-alcohol (70% v/v) and briefly centrifuged. The supernatant was removed by aspiration and the pellets were air-dried for 2-5 minutes. The base pair sequence for each sample was determined with the ABI model 377 automated prism sequencer.

2.2.8 Data analysis

2.2.8.1 Editing and alignment

*Trn*L-F is composed of two distinct and potentially functionally different regions. It, however, has a low level of variation despite of its noncoding nature. This implies that it is more practical to combine the entire region into a "non-coding" data set (Reeves *et al.*, 2001).

The forward and reverse strands of the amplified regions were compared and edited on an iMac Macintosh computer with the program AutoAssembler™ version 1.4.0. (AutoAssembler™ DNA sequence Assembly Software 1993, Applied Biosystematics, Inc.). Consensus sequences were exported to text format and aligned using the IBM program ClustalX version 1.8.1 (Thompson *et al.*, 1997). The sequences were manually re-aligned, using the basic principle of maximizing the number of matched pairs between two sequences (or minimize the number of mismatched pairs), while keeping the number of gaps as small as possible (Li, 1997). The boundaries for the *trn*L-F region was determined by comparing it to other sequences of liliaceous taxa obtained from Genbank, published by Pfosser and Speta (1999).

The *trn*L-F region of 140 plants from 16 genera and 7 different families was sequenced. The genera were as follows: 1 *Albuca* (Hyacinthaceae), 1 *Bowiea* (Hyacinthaceae), 1 *Drimia* (Hyacinthaceae), 1 *Eriospermum* (Eriospermaceae), 1 *Eucomis* (Hyacinthaceae), 115 *Lachenalia*

(Hyacinthaceae), 1 *Ledebouria* (Hyacinthaceae), 5 *Massonia* (Hyacinthaceae), 1 *Ornithoglossum* (Colchicaceae), 7 *Polyxena* (Hyacinthaceae), 1 *Asparagus* (Asparagaceae), 1 *Sansevieria* (Dracaenaceae), 1 *Scadoxus* (Amaryllidaceae), 1 *Schizocarpus* (Hyacinthaceae), 1 *Trachyandra* (Asphodelaceae) and 1 *Veltheimia* (Hyacinthaceae). An attempt was made to sequence as many representatives from each family as possible, but because of limited availability of certain material, 61 sequences from 30 genera were obtained from Genbank (Table 2.2).

Two data sets were used to construct the cladograms. The first included only sequences of the genera *Lachenalia*, *Polyxena* and *Massonia* (Appendix B). The second data set consisted of the sequences of the Liliacious plants as well as 30 randomly chosen *Lachenalia* species (Appendix C). Both of these sets included INDELS scored as binary characters by the computer program GAPCODER (Young & Healy, 2003). It is recommended that only those potentially phylogenetically informative INDELS greater than 2 bp in length should be included (Lloyd & Calder, 1991; Van Ham *et al.*, 1994), because most of the homoplasy in insertion/deletion events is accounted for by smaller INDELS. The program GAPCODER includes INDELS as small as 1 bp.

2.2.8.2 Phylogenetic analysis using PAUP

The two data sets were transferred to a Macintosh computer and analyzed using the parsimony algorithm of the software package PAUP* version 4.02b: (*Phylogenetic analyses using parsimony*: Swofford, 2002). The two cladistical methods used for the analysis were the parsimony method (Wagner parsimony) and neighbour joining (NJ) as part of the distance matrix methods (Farris, 1981).

For the parsimony method, a heuristic search was performed. The program converts the data set to a data matrix, and in turn determines the maximum parsimony through the minimum length cladogram, by subjecting the matrix to a heuristic search. The heuristic search was executed in the following manner. The outgroup was chosen and only informative characters were chosen for the search. Regions that were difficult to align were excluded from the analysis, as well as regions containing uncertainties (mainly the beginning and end of the region). The data characters were all of type unordered, all having an equal weight. Gaps were treated as missing. The starting trees were obtained via stepwise addition, using 1 000 replicates of random taxon-additions (Pfosser & Speta, 1999) in order to find islands of equally most parsimonious

trees (Maddison, 1991) with 1 tree held at each step. The branch-swapping algorithm was not chosen in the first search.

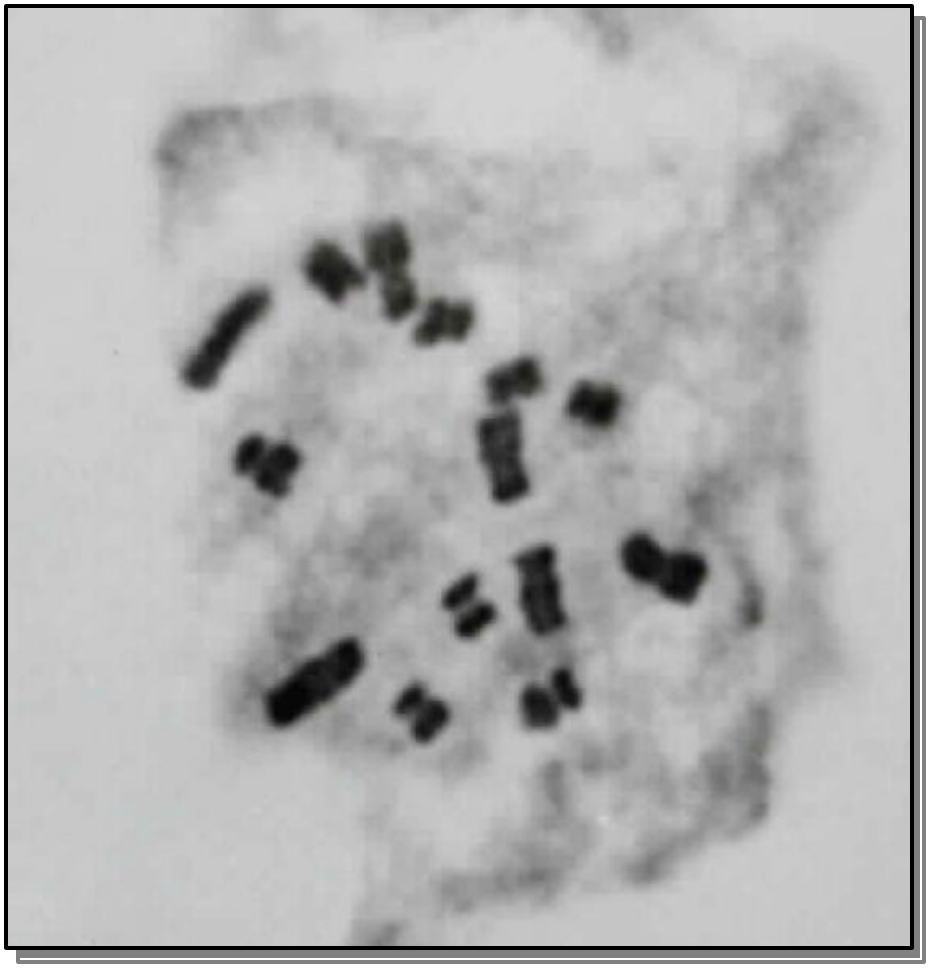
A second heuristic search was performed on the trees obtained from the first, using the branch swapping algorithm, tree-bisection-reconnection (TBR) under the Fitch criterion (unordered states and equal weights: Fitch, 1971) (Pfosser & Speta, 1999), steepest descent option in effect. A maximum of 10 000 trees were saved for both heuristic searches.

Finally, to determine the branch support for the heuristic search, bootstrap (Felsenstein, 1985a) analyses with fast-heuristic search were performed using 1 000 bootstrap replicates. In addition Jackknife (Lanyon, 1985) values were determined from 1 000 replicates.

A strict consensus tree (Sokal & Rohlf, 1981) and Adams consensus was generated for the final heuristic search. The phylogenetic information in the parsimony analysis was assessed with the consistency index (C.I.; Kluge & Farris, 1969), the retention index (R.I.; Farris, 1989) and the tree length. The G/C contents were determined in PAUP.

The NJ tree was produced with “Break ties” set to randomly with the initial seed set at 1.

Chapter THREE



Results

3.1 CYTOGENETICS

Forty nine *Lachenalia* specimens, representing 19 species and six subspecific taxa, were cytogenetically studied. Somatic chromosome numbers of 2n = 14, 16, 18, 20, 22, 24, 28, 42 and 44 were observed in mitotic studies and gametic chromosome numbers of n = 7, 9, 11, 13 and 21 were observed in meiotic studies (Table 3.1 & Figs. 3.1-5).

Table 3.1: Somatic chromosome numbers of *Lachenalia* specimens observed during this study with their voucher numbers and localities.

Voucher	2n	n
L. aloides* var. *aurea		
Spies 7060	14	
L. aloides* var. *nelsonii		
Spies 7061	14	
L. aloides* var. *quadricolor		
Spies 7062	14	
L. aloides* var. *vanzyliae		
Spies 7063	28	
Spies 7064	28	
Spies 6932	42	21
L. carnosa		
Spies 6934		8 + 0-2B
L. comptonii		
Spies 7066		10
L. fistulosa		
Spies 6936	14	
L. hirta		
Spies 6858	22	
Spies 6859	22	
Spies 7381	22	
Spies 6860	c22	
L. juncifolia		
Spies 7077	22	
Spies 7380	22 & 44	
L. liliflora		
Spies 6937	16	
L. mathewsii		
Spies 6938	14	
L. mediana		
Spies 7086		9
L. mediana* var. *rogersii		
Spies 7079		13
L. pallida		
Spies 7089	16	
L. purpureo-caerulea		

Spies 6939	14	
L. reflexa		
Spies 7090	14	
Spies 7091	14	
L. rubida		
Spies 7093	14	
L. unifolia		
Spies 6866	22	
Spies 6878	22 & 44	
Spies 6879, 6881	22	
Spies 6864	22	
Spies 6861	20	
Spies 6867	22	
Spies 6872	22 & 44	
Spies 6898	22	
Spies 6874, 6891	22	11

Spies 6863	22	
Spies 6871	22, 44 & c. 80	
Spies 6892	22	
Spies 6886, 6882, 6887, 6889	22	
L.* cf. *unifolia		
Spies 6899, 6902	22	
L. variegata		
Spies 7097	28	
L. violacea		
Spies 7101		7
Spies 7104		7
L. viridiflora		
Spies 7098	14	
L. zeyheri		
Spies 7099	22	

A somatic chromosome number of 2n = 2x = 14 or gametic chromosome number of n = x = 7 was observed in *L. aloides* var. *aurea*, *L. aloides* var. *nelsonii*, *L. aloides* var. *quadricolor*, *L. fistulosa*, *L. mathewsii* (Fig. 3.5), *L. purpureo-caerulea*, *L. reflexa*, *L. rubida*, *L. violaceae* and *L. viridiflora*. Multiples of seven were observed in *L. aloides* var. *vanzyliae* (2n = 4x = 28), *L. bubifera* (n = 3x = 21; 2n = 4x = 28 & 2n = 6x = 42) (Fig. 3.1 & 5) and *L. variegata* (2n = 4x = 28).

In *L. mediana* (Fig. 3.3) a gametic chromosome number of n = x = 9 was observed, as well as n = x = 13 in *L. mediana* var. *rogersii* (Fig. 3.3). *Lachenalia comptonii* had a gametic chromosome number of n = x = 10.

Somatic chromosome numbers of 2n = 2x = 16 for *L. liliflora* and *L. pallida* (Fig. 3.5) and 2n = 2x = 22 for *L. hirta* (Fig. 3.5), *L. juncifolia* (Fig. 3.5) and *L. zeyheri* were observed, as well

as a gametic chromosome number of n = x = 11 for *L. unifolia* (Fig. 3.4). A somatic chromosome number of 2n = 4x = 44 was also observed in *L. juncifolia*.

Different somatic chromosome numbers were observed in different accessions of *L. unifolia* (2n = 20, 22, 44 and c. 80) (Fig. 3.5).

B-chromosomes were present in the meiotic cells of *L. carnosa*, having a chromosome number of n = 8 + 0-2B (Fig. 3.1). All mitotic and meiotic cells appeared normal, except for the B-chromosomes present in *L. carnosa*. The few abnormalities observed were present in a minority of cells studied of any specimen.

3.2 MOLECULAR SYSTEMATICS

DNA was extracted from 63 specimens of liliaceous plants and 180 *Lachenalia* specimens. Due to the large number of specimens, only 165 of the 243 specimens were amplified, excluding duplicates of species and excessive outgroup species, not closely related to *Lachenalia*. Forty eight of the liliaceous specimens and 117 of the *Lachenalia* specimens were successfully amplified. Only 16 specimens could not be amplified. The 165 specimens amplified were sequenced and 140 provided good results (they produced sequences in both directions for editing purposes) for the phylogenetic analysis.

The optimum volumes for the reaction components needed for the amplification of the DNA were obtained by using the Taguchi method (Table 3.2). The graph drawn from the SNL values for each variable component resulted in the optimum volumes being: 25mM magnesium chloride ($MgCl_2$) = 0.5 µl; 50 pmole primer = 0.5 µl; DNA = 1.0 µl (Fig. 3.6).

The 140 taxa used in the phylogenetic analysis include [1 species of *Albuca* (Hyacinthaceae), 1 *Bowiea* (Hyacinthaceae), 1 *Drimia* (Hyacinthaceae), 1 *Eriospermum* (Eriospermaceae), 1 *Eucomis* (Hyacinthaceae), 115 *Lachenalia* (Hyacinthaceae), 1 *Ledebouria* (Hyacinthaceae), 5 *Massonia* (Hyacinthaceae), 1 *Ornithoglossum* (Colchicaceae), 7 *Polyxena* (Hyacinthaceae), 1 *Asparagus* (Asparagaceae), 1 *Sansevieria* (Dracaenaceae), 1 *Scadoxus.*

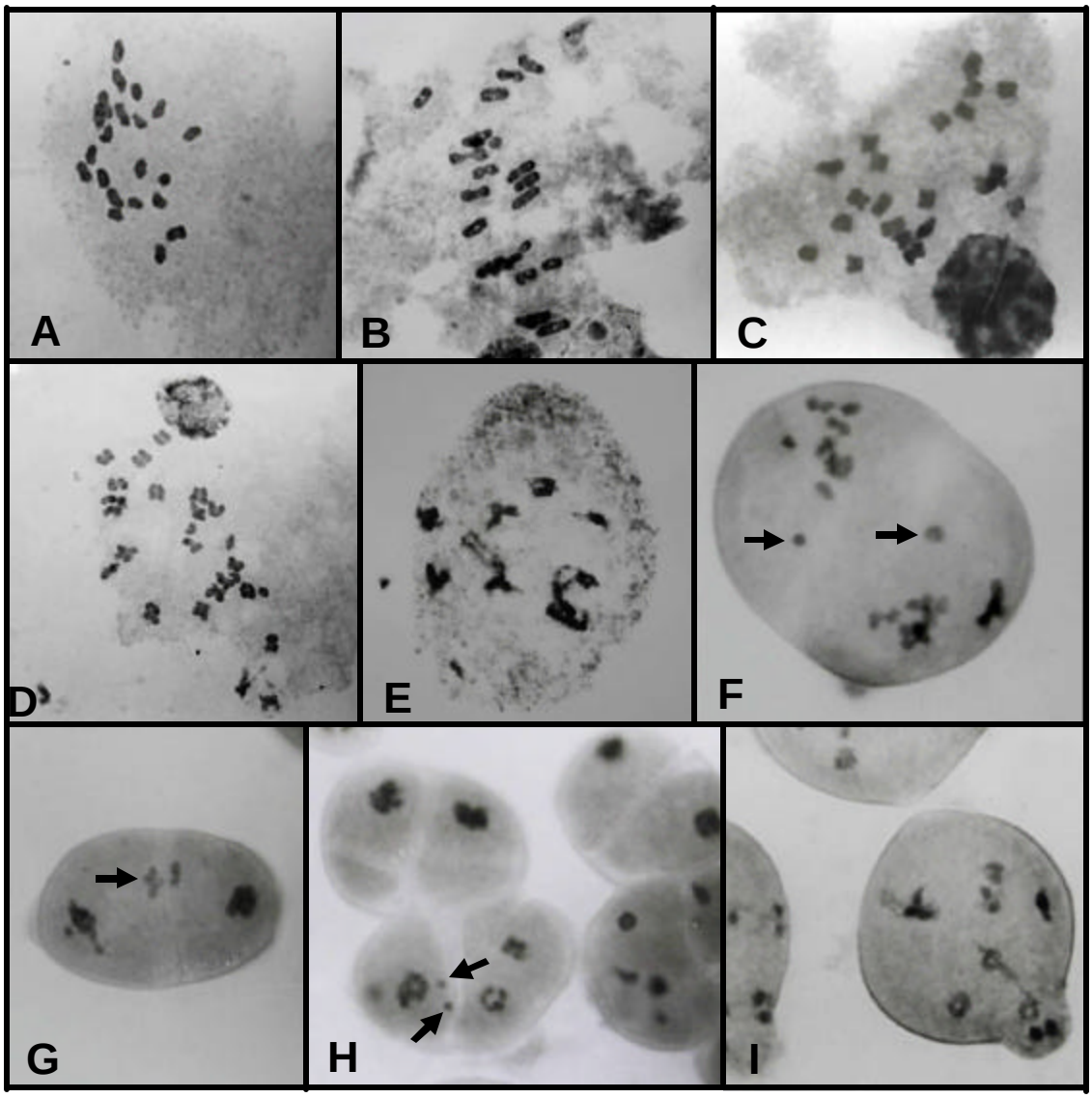


Figure 3.1: Photographs of meiotic chromosome in the genus *Lachenalia*. A-D, *L. bulbifera* (*Spies 6932*) with n = 3x = 21; E-I, *L. carnosa* (*Spies 6934*) with n = x = 8 + 0-2B; E, G & H, Telophase I stages with one to two B-chromosomes present in each cell (indicated with arrows).

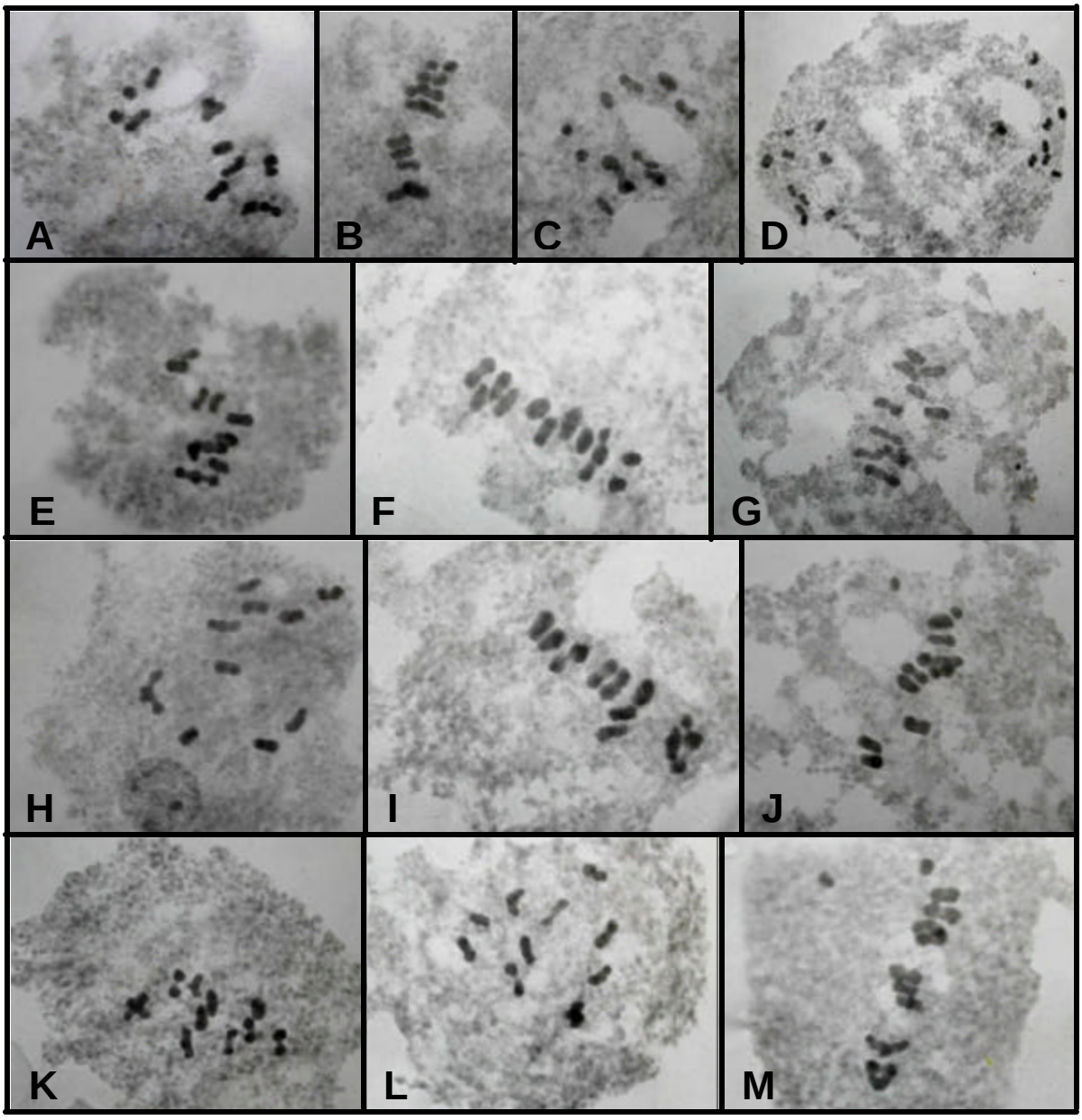


Figure 3.2: A-M, meiotic chromosomes of *L. comptonii* (*Spies 7066*) with n = x = 10.

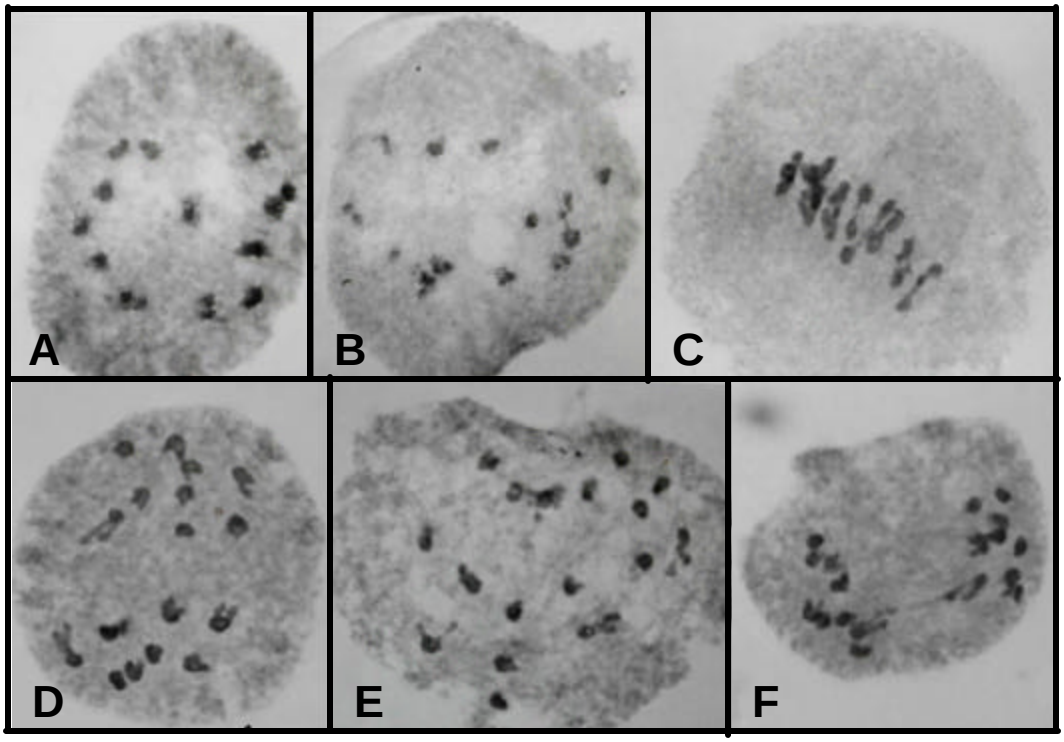


Figure 3.3: Meiotic chromosomes in the genus *Lachenalia* . A & B, *L. mediana* var. *rogersii* (*Spies 7079*) with n = x = 13; C – F, *L. mediana* (*Spies 7086*) with n = 9.

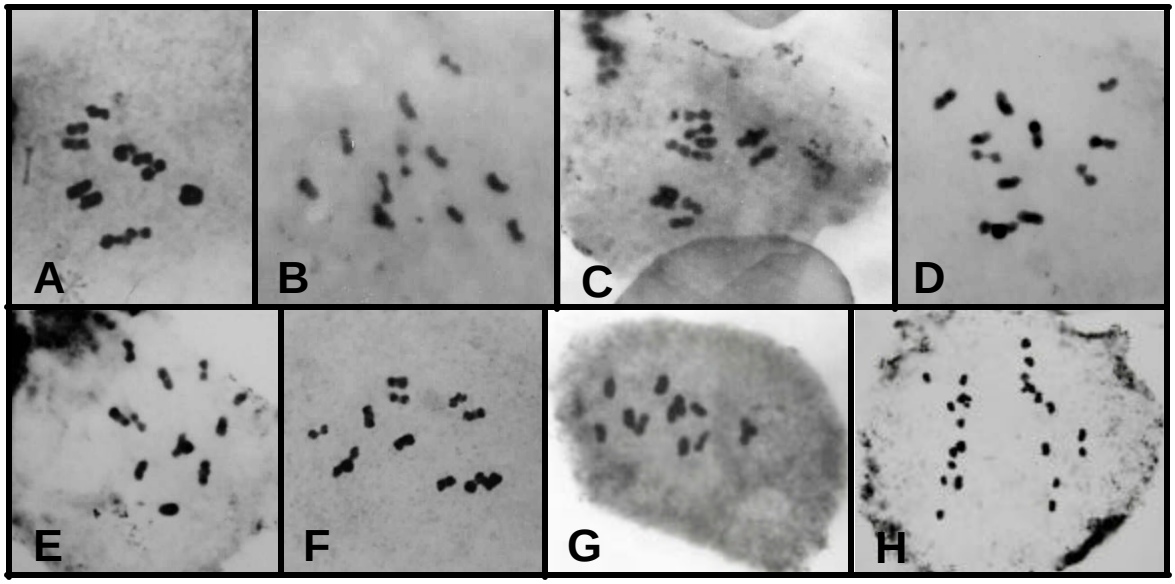


Figure 3.4: A-H, meiotic chromosomes of *L. unifolia* var. *unifolia* (*Spies 6891*) with n = x = 11.

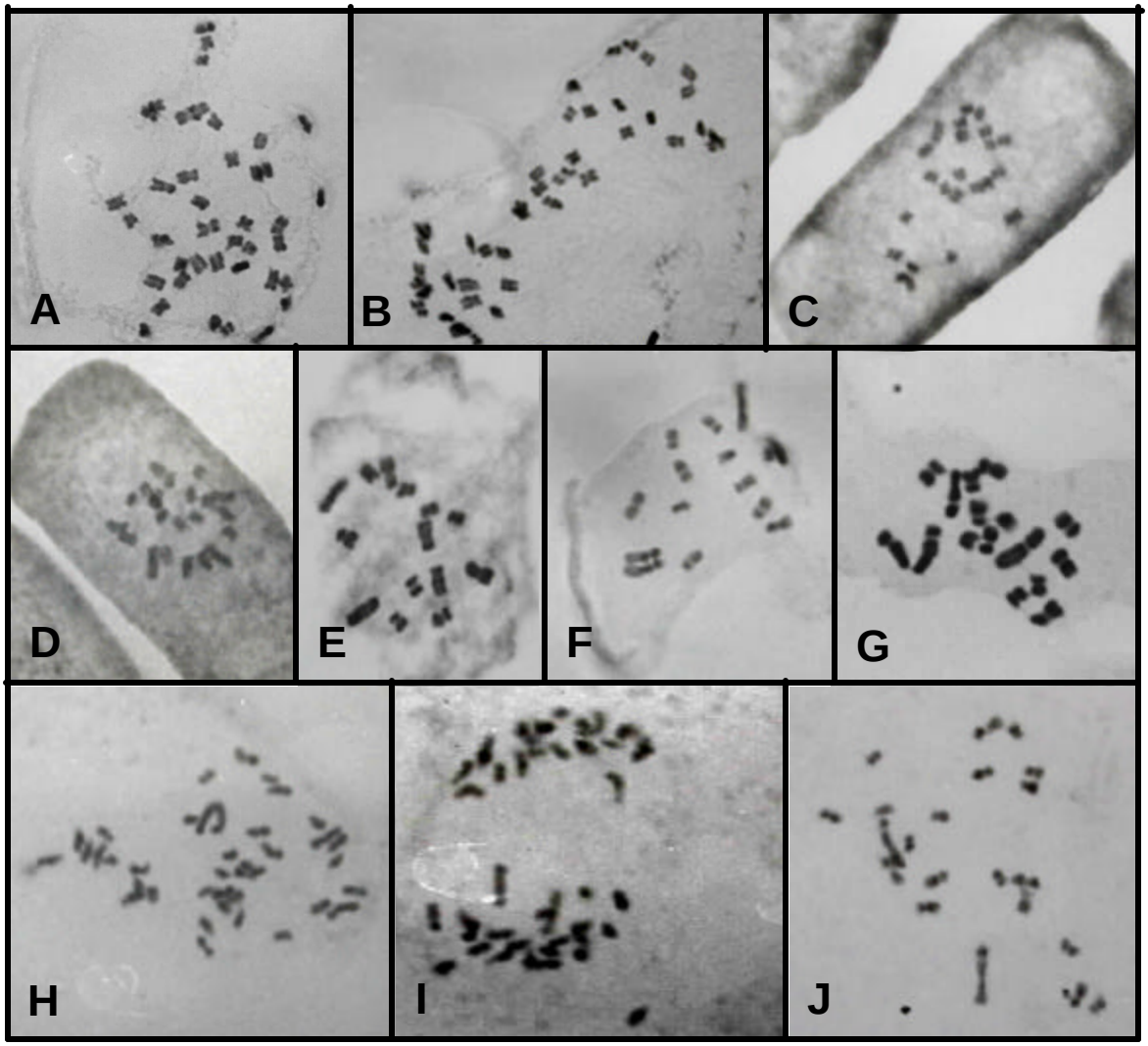


Figure 3.5: Mitotic chromosome in the genus *Lachenalia*. A & B, *L. bulbifera* (*Spies 6932*) with 2n = 6x = 42; C, *L. hirta* (*Spies 6858*) with 2n = 2x = 22; D, *L. juncifolia* (*Spies 7380*) with 2n = 2x = 22; E, *L. mathewsii* (*Spies 6938*) with 2n = 2x = 14; F & G, *L. pallida* (*Spies 7089*) with 2n = 2x = 16; H & I, *L. unifolia* (*Spies 6878*) with 2n = 4x = 44 (H) and anaphase with 2n = 22 (I); J, *L. unifo lia* (*Spies 6892*) with 2n = 2x = 22.

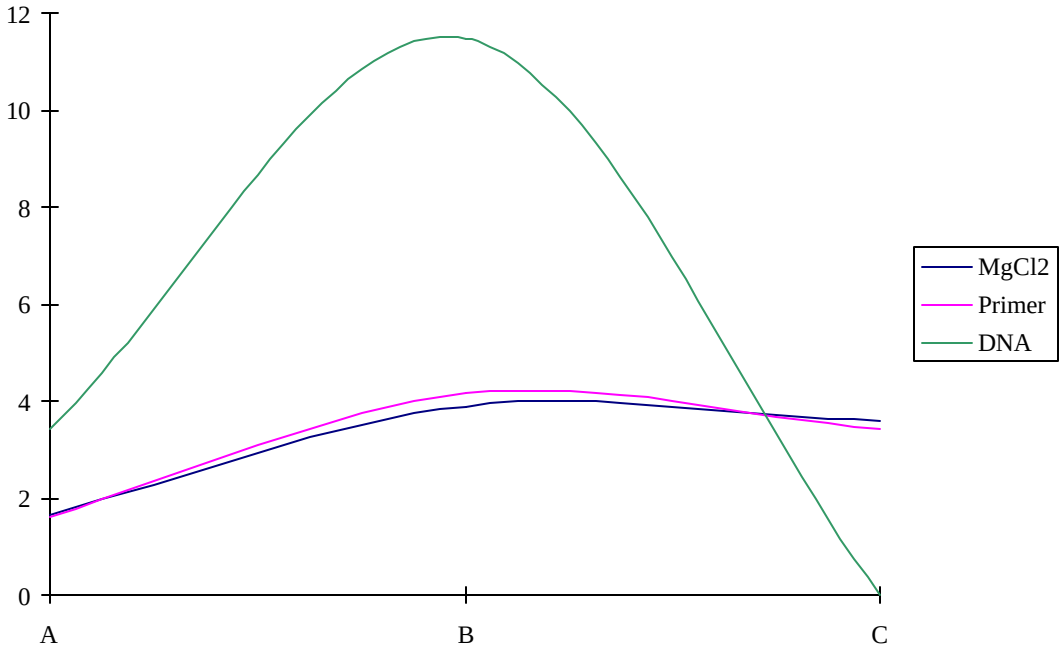


Figure 3.6: Graph obtained from the SNL values. The maximum of the curve is the optimum concentration for each reaction component. The number on the lines indicate the SNL value for each variable.

(Amaryllidaceae), 1 *Schizocarpus* (Hyacinthaceae), 1 *Trachyandra* (Asphodelaceae) and 1 *Veltheimia* (Hyacinthaceae)].

The sequences were edited using the Macintosh computer program AutoAssemblerTM version 1.4.0. The forward and reverse strands of each specimen were compared and edited to match each other. Sequences were compared to sequences obtained from Genbank and adjusted according to the length of those sequences. This region will be referred to as the *trn*L-F region, although some parts at the beginning and end of this region may be missing. The consensus sequences were saved as text (*.txt) files and transferred to a personal computer.

The computer program ClustalG (version 1.0) was initially used to align the sequences, where after the sequences were manually aligned. Two data sets were used for alignment. The one set contained all the *Lachenalia* sequences, together with *Massonia*, *Polyxena* and *Veltheimia* as outgroups. The other set comprised all the other sequences (including those from Genbank). This was done because the data matrix containing all sequences was too large for the computer to handle.

Table 3.2: Taguchi optimization: A, B and C is the representatives of the volumes used for the Taguchi reactions. The numbers in the top part of each row is the scores given to each reaction containing that specific volume. There are three numbers per column because there were three reactions containing that specific volume. The value in the bottom half of each row is the SNL values.

	A	B	C
25 mM $MgCl_2$	1, 5, 1 **1.68**	1, 3, 3 **3.9**	4, 1, 2 **3.59**
50 pmole Primer	1, 1, 4 **1.63**	5, 3, 1 **4.16**	1, 3, 2 **3.43**
DNA	1, 3, 2 **3.43**	5, 3, 4 **11.48**	1, 1, 1 **0**

The length of the *trn*L-F region in the genus *Lachenalia* ranged from 527 bp in *L. isopetala* to 586 bp in *L. purpureo-caerulea*, with an average length of 557 bp.

Lachenalia isopetala had the shortest sequence (527 bp) and *Veltheimia capensis* the longest (604 bp). The sequences of these two genera were very similar and were grouped together in a clade. Only one specimen of *L. isopetala* was sequenced and another specimen should be sequenced before the close relationship between this species and *Veltheimia* can be confirmed. Therefore both were excluded from the *Lachenalia* cladogram.

With *L. isopetala* removed from the data matrix, the second shortest sequences were that of *L. mathewsii*, *L. attenuata* and *L. unifolia* with a length of 567 bp. The sequence length for *Polyxena* varied between 527 bp (*P. calcicola*) and 580 bp (*P. longituba* and *P. odorata*). All *Massonia* species had a length of 602 bp. The consensus length of this region (after alignment) in *Lachenalia*, *Massonia* and *Polyxena* was 691 bp (Appendix B). Characters 1-7 at the beginning of the sequences and characters 669-691 at the end of the sequences were excluded from the analysis. Too many samples had uncertainties in those regions. The final number of included characters for the phylogenetic analyses was 671.

Lachenalia has two 4 bp deletions, which are not fully unique to the genus. The first deletion is shared by *Dipcadi viride* and *D. fulvum* and is absent in four *Lachenalia* species, i.e. *L. polyphilla*, *L. sargeantii*, *L. juncifolia* and *L. zeyheri*. *Lachenalia isopetala* has a deletion of 90 bp shared by none of the other *Lachenalia* species. This deletion is included in a 220 bp deletion found in *Scadoxus mambranaceus* and a 135 bp deletion found in *Whiteheadia bifolia*.

Certain genera are characterized by distinctive INDELS. *Massonia* has a 4 bp. insertion partially shared by *L. isopetala*, a 13 bp insertion shared by *Velheimia capensis* and a 3 bp insertion also shared by *V. capensis* and *L. isopetala*. *Veltheimia* has one distinctive insertion of

5 bp not shared by any of the other species. *Lachenalia isopetala* has four distinctive INDELS: a 3 bp, 4 bp and 1 bp insertion, as well as a 73 bp deletion.

The number of INDELS obtained from GAPCODER was 76 and ranged between 1 bp and 73 bp (in *L. isopetala*).

The C/G contents in *Lachenalia* are relatively constant and ranged from 33.04% (*L. isopetala*) to 33.78% (*L. magregoriorum*), with a mean content of 33.35%. The G/C content of the outgroups varied from 35.44% (*Gloriosa sp.*) to 43.75% (*Albuca sp.*), with an average of 40.9% (Table 3.3), which is slightly higher than the 33.35% G/C content in the genus *Lachenalia*. The tree length of the consensus cladogram was 130 and CI, RI and RC values of 0.5308, 0.8641 and 0.4587 respectively were obtained.

Several of the 140 plants sequenced in this study and of those obtained from Genbank, had to be excluded from the final analysis due to a large number of uncertain characters in the sequences. Only 110 specimens were therefore used in the phylogenetic study, including 29 *Lachenalia*, 4 *Massonia* and 6 *Polyxena* species.

In the other liliacious genera, the length of the *trn*L-F region ranged from 599 bp in *Scadoxus membranaceus* to 984 in *Bulbine succulenta*, with a mean of 792 bp. The aligned length of the *trn*L-F region in the other genera was 1 567 bp (Appendix C). The total number of characters was 2 071 (INDELS included), of which only 682 were included in the analysis. The number of INDELS determined by GAPCODER were 504, ranging between 1 bp and 271 bp (in *Scadoxus membranaceus*). The tree length for the consensus cladogram was 1 806. The CI, RI and RC values were 0.5133, 0.8066 and 0.4140 respectively. Of the 671 characters included, only 66 were parsimony informative and included in the analysis. A total of 702 characters were excluded from the analysis.

The strict consensus cladogram of the *Lachenalia trn*L-F region gave highly unresolved and weakly supported clades (Fig. 3.7). In contrast, the Adams consensus cladogram gave much more resolution. The phylogenetic analysis of the sequences of *Lachenalia*, *Massonia* and *Polyxena* in the Adams consensus cladogram resulted in four well-defined clades (Fig. 3.8). The strict, as well as Adams consensus cladogram (Fig. 3.9) including all genera, gave well supported clades.

Table 3.3: Results: Comparison between the cladogram results for the genus *Lachenalia* and for the other Liliacious genera.

	Lachenalia	**Other Liliacious genera**
	*trn*L-F region	*trn*L-F region without the exon
Length range (bp)	527 (*L. isopetala*) – 586 (*L. purpureo-caerulea*)	599 (*Scadoxus membranaceus*) - 984 (*Bulbine succulenta*)
Length mean (bp)	557	792
Aligned length (bp)	691	1 567
G + C content range (%)	33.04% (*L. isopetala*) 33.78% (*L. magregoriorum*)	35.44% (*Gloriosa* sp.) 43.75% (*Albuca* sp.)
G + C content mean	33.35%	40.9%
Total characters	671	2 071
Number of characters excluded	702	1 389
Number of characters included	66	682
Number of indels	76	504
Indel size range (bp)	1-73 (In *L. isopetala*)	1-271 (In *Scadoxus membranaceus*)
Tree length	130	1 806
CI value	0.5308	0.5133
RI value	0.8641	0.8066
RC value	0.4587	0.4140

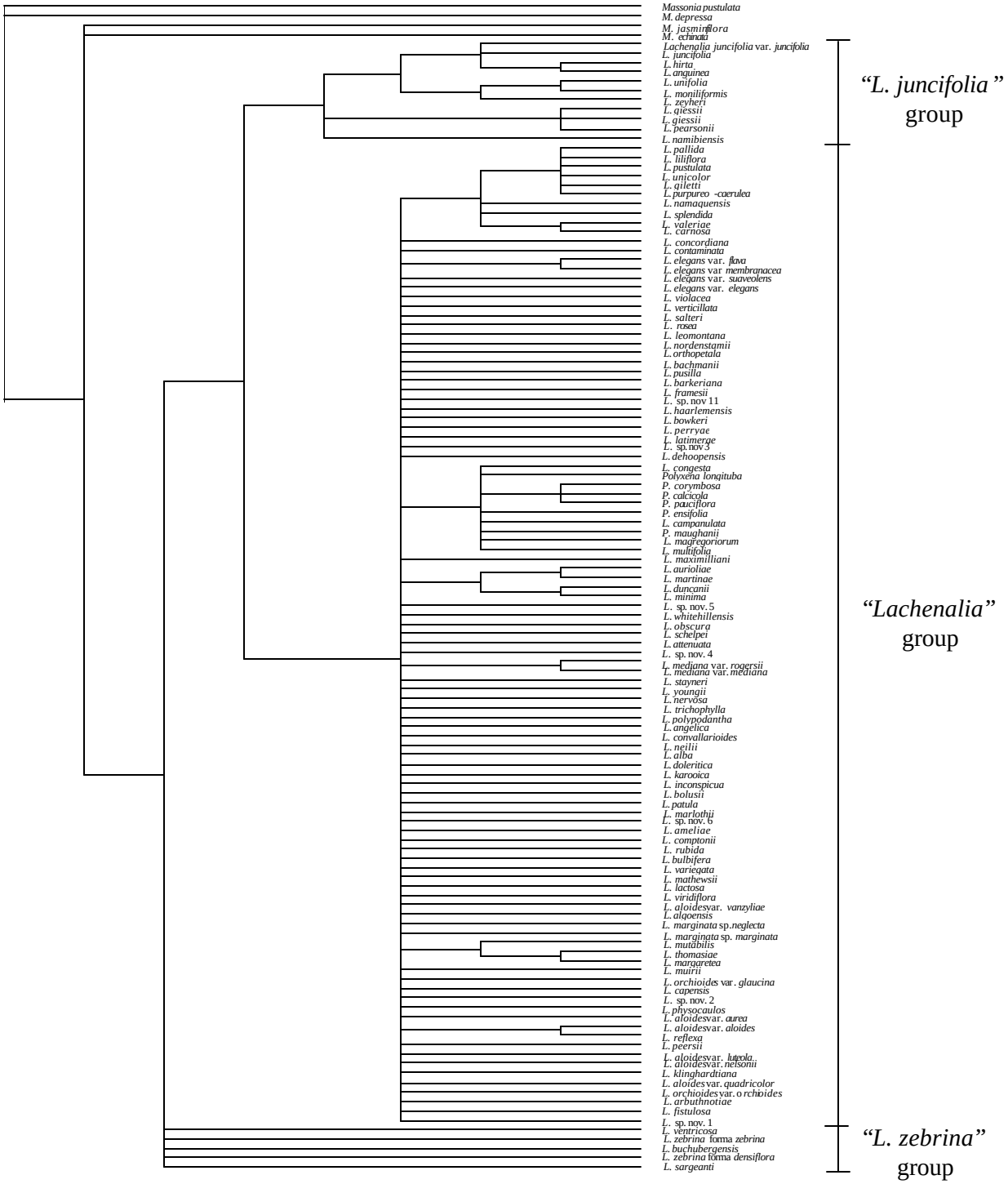


Figure 3.7: The strict consensus cladogram for the genera *Massonia*, *Polyxena* and *Lachenalia*, indicating the three main groups.

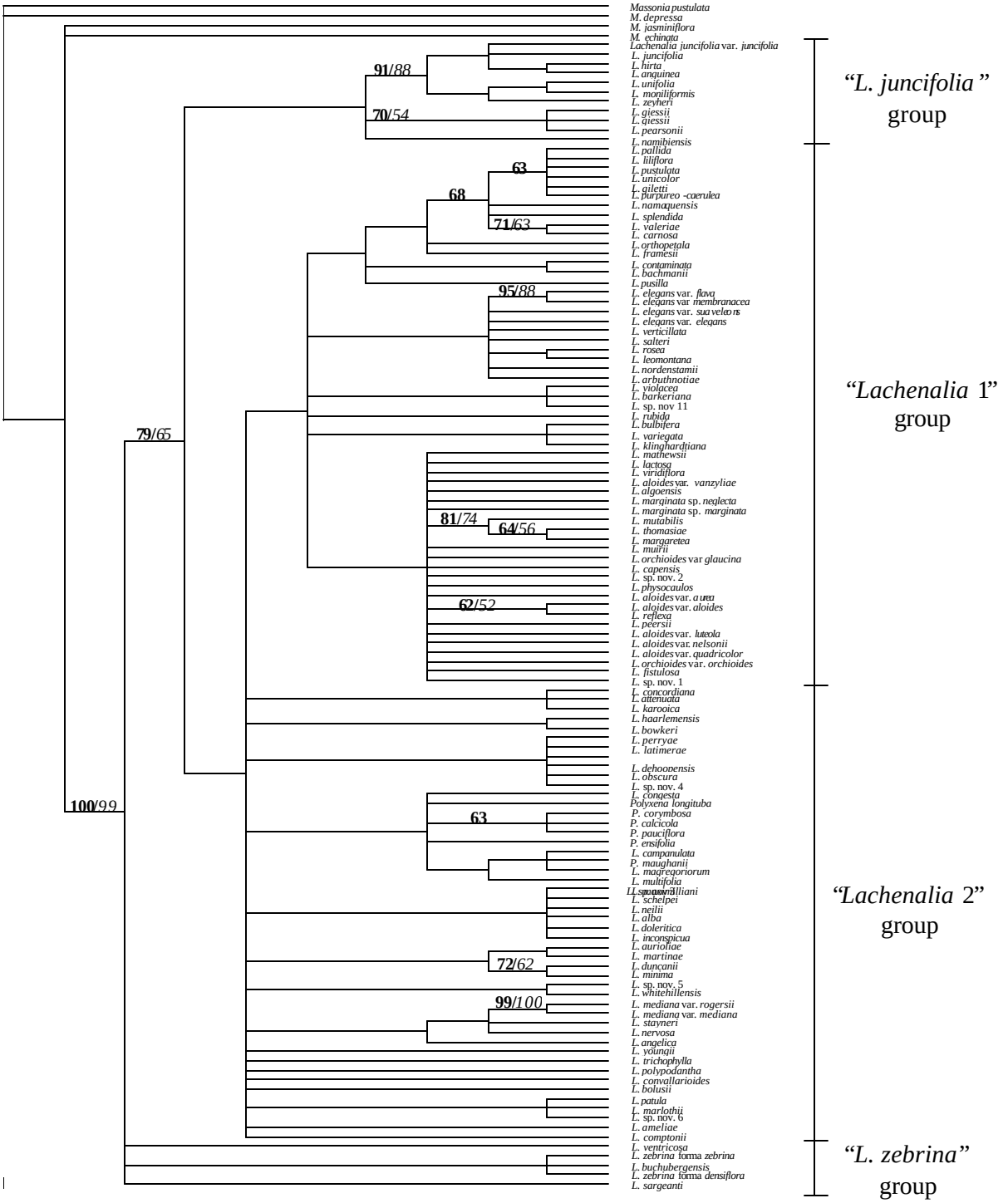


Figure 3.8: The Adams consensus cladogram for the genera *Massonia*, *Polyxena* and *Lachenalia* with the four main groups indicated. Length of shortest tree found = 130, CI (Consistency Index) = 0.5308, RI (Retention Index) = 0.8641 and RC (Rescaled Consistency Index) = 0.4587. Bootstrap (first value in bold) and Jackknife confidence values (second value in italic) greater than 50% are shown.

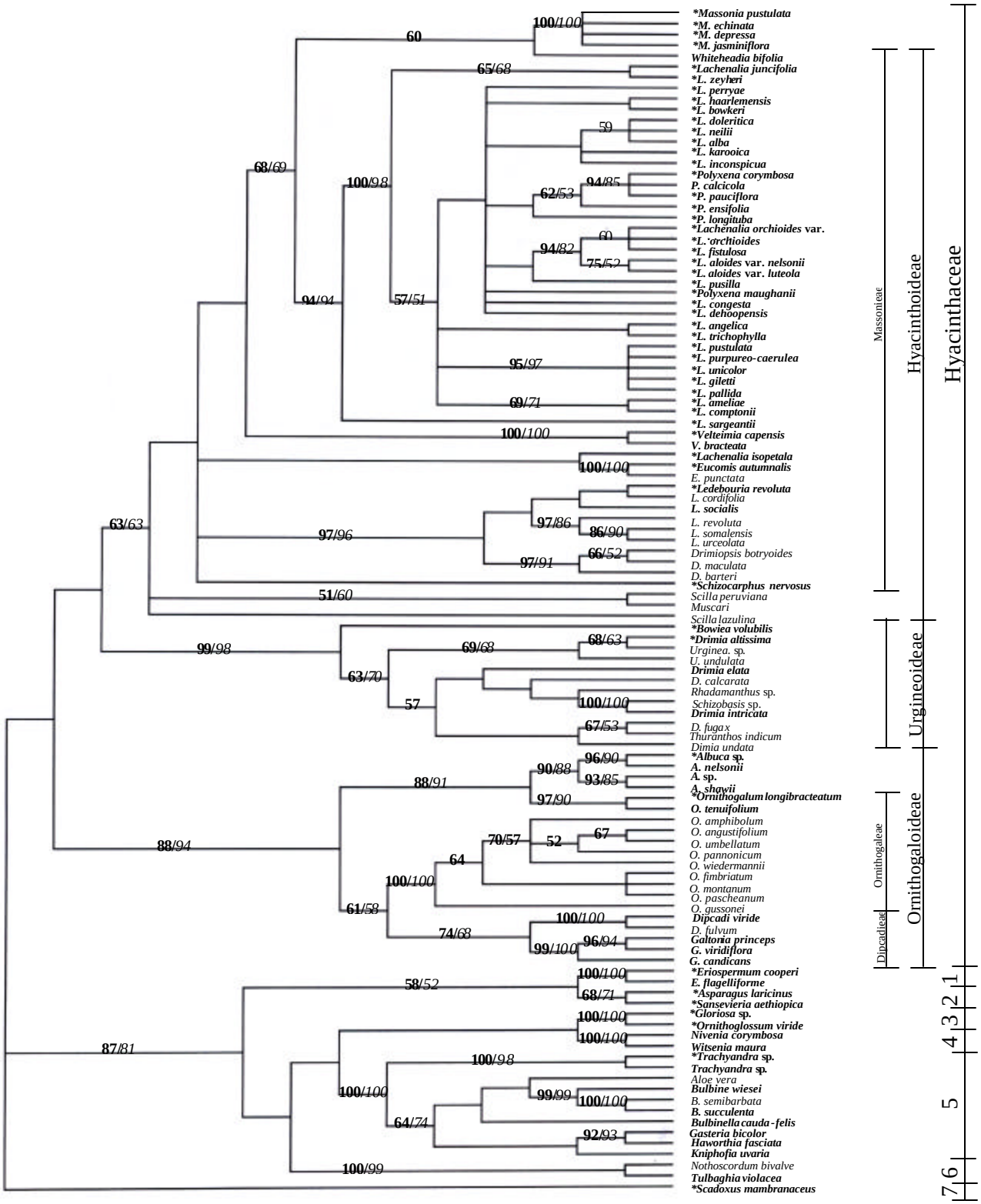


Figure 3.9: The Adams consensus cladogram, indicating the four main groups. Bootstrap (first value in bold) and Jackknife confidence values (second value in italic) greater than 50% are shown. * Indicates species contributed from this study. Species in bold indicate species endemic to S.A. The subfamilial (Hyacinthoideae, Ornithogaloideae and Urgineoideae) and tribal limits (Hyacintheae, Massonieae, Ornithogaleae and Dipcadieae) (Pfosser & Speta, 1999) and the current familial classifications are indicated [Hyacinthaceae; Eriospermaceae (1); Asparagaceae & Dracaenaceae (2); Colchicaceae (3); Iridaceae (5); Aspodelaceae (6) and Amaryllidaceae (7)]

Chapter FOUR

Discussion

4.1 INTRODUCTION

The genus *Lachenalia* is a member of the family Hyacinthaceae and endemic to southern Africa, occurring mainly in the Western Cape and Namibia, with a few species as far as the Eastern Cape Province. One species occur in the Free State. The genus consists of beautiful small bulbous geophytes, divided into approximately 120 species (Duncan, personal comm.). Chromosome numbers of 46 specimens, including new chromosome numbers for 13 additional species, were obtained during this study. This brings the total number of species for which chromosome numbers are known to 62 (57.4%) (Table 4.1). Different basic chromosome numbers and various ploidy levels (from 2x to 8x) have been reported for this genus (Moffett, 1936; Sato, 1942; Therman, 1956; De Wet, 1957; Gouws, 1965; Fernandes & Neves, 1962; Riley, 1962; Zakharyeva & Makushenko, 1969; Speta, 1972; Ornduff & Watters, 1978; Mogford, 1978; Nordenstam, 1982; Crosby, 1986; Hancke & Liebenberg, 1990; Hancke, 1991; Johnson & Brandham, 1997; Kleynhans, 1997; Hancke & Liebenberg, 1998; Kleynhans & Spies, 1999; Spies *et al.*, 2000; Du Preez *et al.*, 2002; Spies *et al.*, 2002).

Many of the species are endangered. A complete collection of all the species is maintained at Kirstenbosch Botanical Gardens.

Why implementing chromosome numbers? Knowledge of the chromosome numbers is a necessity for the breeders to use in their crosses and to determine whether hybridisation occurred. On a broader spectrum, chromosome characters can be incorporated validly into floristic descriptions and utilized in taximetric and cladistic analyses. Chromosome data, even the chromosome number have significance beyond that. Homology of chromosomes is reflected by their pairing behaviour and fertility, and hence the breeding behaviour and patterns of variation, knowledge of which is fundamental to achieving a classification that reflects evolution (Stace, 2000).

4.2 CYTOGENETICS

Chromosome numbers of n = 5, 7, 8, 9, 11, 13, 14, 21 and 28 and 2n = 10, 12, 14, 14 + 0-2B, 15, 16, 16 + 0-1B , 17, 18, 18 + 0-1B, 20, 21, 22, 24, 26, 28, 29, 30, 30 + 2B, 32, c. 39, 40, c.

41, 42, 43, 44, c. 45, c. 46, c. 47, c. 48, 49, c. 54, 56 and c. 57 was previously described in the genus *Lachenalia* and many of these numbers are supported by this study.

Table 4.1: Summary of the number of species cytogenetically studied.

	First time observed during this study	**Published by other authors and obtained during this study**	**Number of species described**
Number of species	13	49	108
Percentage calculated from # species	12.03%	45.37%	

This genus has a very complex chromosomal constitution and consist of numerous basic chromosome numbers, i.e. x = 5/10, 7, 8, 9, 11 and 13. Several species have more than one different chromosome number ascribed to it (Appendix D). The most prevalent chromosome number per species was assumed as being the correct chromosome number for that species. A species such as *L. mutabilis*, however, has several different basic chromosome numbers (x = 5, 6 and 7) (Minnaar, 2004), and all are assumed to be correct. In such instances it was accepted that there are more than one basic chromosome number.

4.2.1 Chromosome numbers in this study

A somatic chromosome number of 2n = 2x = 14 was observed in *L. aloides* var. *aurea*, *L. aloides* var. *nelsonii*, *L. aloides* var. *quadricolor*, *L. fistulosa* (=*L. convallariodora* Stapf), *L. mathewsii*, *L. rubida* and *L. viridiflora*, and confirm previous reports (Moffett, 1936; De Wet, 1957; Ornduff & Watters, 1978; Nordenstam, 1982; Crosby, 1986; Hancke & Liebenberg, 1990; Hancke, 1991; Johnson & Brandham, 1997; Kleynhans, 1997; Hamatani *et al.*, 1998; Hancke & Liebenberg, 1998; Kleynhans & Spies, 1999). This suggests a basic chromosome number of x = 7 for these species.

A somatic chromosome number of 2n = 2x = 16 was observed in *L. liliflora* and *L. purpureo-caerulea*. These results support previous findings of Moffett (1936), De Wet (1957), Fernandes and Neves (1962), Ornduff and Watters (1978), Crosby (1986), Hancke (1991) and Johnson and Brandham (1997). The basic chromosome number of these species is x = 8.

Ornduff and Watters (1978) and Johnson and Brandham (1997) reported a somatic chromosome number of 2n = 2x = 22 for *L. juncifolia* and *L. zeyheri*. This study supports these findings and suggests a basic chromosome number of x = 11 for these species.

Certain species had more than one basic chromosome number as observed in this study as well as reported elsewhere. These different numbers will be discussed below. In many of these species (*L. reflexa*, *L. pallida*, *L. unifolia*, *L. violacea* and *L. comptonii*), the basic chromosome number could still be determined from the majority of numbers reported.

Gametic numbers of n = x = 7 (Hancke & Liebenberg, 1990; Hancke, 1991) and n = 4x = 28 (Hancke, 1991) and somatic numbers of 2n = 2x = 14 (Crosby, 1986; Hancke & Liebenberg, 1990; Hancke, 1991; Johnson & Brandham, 1997; Hamatani *et al.*, 1998) and 2n = 2x = 14 + 0-2B (Hancke & Liebenberg, 1990; Hancke, 1991), were reported in *L. reflexa*. A report of De Wet (1957) suggested a somatic number of 2n = 16. The majority numbers reported as well as two accessions with 2n = 2x = 14 in this study, however, indicate a basic chromosome number of x = 7 for this species. Hancke & Liebenberg (1990) suggests that the chromosomes number should be 2n = 14 + 0-2B, instead of the reported 2n = 16 (de Wet 1957). This wrong count could be the result of B-chromosomes included in the count due to microtome sections used instead of squashes (Hancke & Liebenberg, 1990).

Lachenalia pallida had chromosome numbers of n = x = 8 (Ornduff & Watters, 1978) and 2n = 2x = 16 (Moffett, 1936; Crosby, 1986; Johnson & Brandham, 1997; Hamatani *et al.*, 1998) with a deviating number of 2n = 14 (Kleynhans, 1997) reported. This study supports the majority reports of n = 2x = 16, suggesting a basic number of x = 8 for the species *L. pallida*. The deviating number may be the result of a misidentified specimen. The morphological similarities between many species make the correct identification of a plant often very difficult.

Lachenalia unifolia had a gametic chromosome number of n = x = 11 (Ornduff & Watters, 1978) and somatic chromosome numbers of 2n = 16 (Hancke, 1991), 2n = 21 (De Wet, 1957), 2n = 22 (Moffett, 1936; De Wet, 1957; Crosby, 1986; Johnson & Brandham, 1997), 2n = 24 (De Wet, 1957), 2n = 26 (Moffett, 1936; De Wet, 1957) and 2n = 44 (Johnson & Brandham, 1997) reported. Of the 11 reports, one suggest a meiotic chromosome number of n = x = 11, supported by four authors who reported somatic chromosome numbers of 2n = 2x = 22. A tetraploid plant with a basic number of x = 11 was also reported. This study supports the somatic (12 accessions) and gametic (one accession) chromosome numbers observed in previous reports. Thus, the basic chromosome number for this species is x = 11.

Lachenalia violacea has a gametic chromosome number of n = x = 7 (Ornduff & Watters, 1978) and a somatic chromosome number of 2n = 14 (Hancke, 1991; Johnson & Brandham,

1997; Kleynhans, 1997; Hamatani *et al.*, 1998) reported. Deviating somatic numbers are 2n = 15 (Johnson & Brandham, 1997) and 2n = 16 (Crosby, 1986). This study supports the gametic number of n = x = 7 and also the basic chromosome number of x = 7.

Somatic chromosome numbers of 2n = 2x = 20 (Johnson & Brandham, 1997), and 2n = c. 20, c. 26 (Crosby, 1986) were reported in *L. comptonii*. A gametic chromosome number of n = x = 10, were observed for the first time in this study. It seems that the basic chromosome number for this species should be x = 10.

Certain species (*L. hirta* and *L. mediana*) had such a variety of chromosome numbers observed in this study and reported elsewhere (see discussion below) that no basic chromosome number could be determined. An example of such species is *L. hirta*, where chromosome numbers of n = x = 9 and n = x = 11 (Ornduff & Watters, 1978) have been reported. The different somatic chromosome numbers reported for this species were 2n = 2x = 18 (Ornduff & Watters, 1978), 2n = 2x = 22 (Ornduff & Watters, 1978; Johnson & Brandham, 1997), 2n = 2x = c. 22 (Kleynhans, 1997) and 2n = 2x = 24 (De Wet, 1957; Hancke, 1991; Johnson & Brandham, 1997). The basic chromosome number can not be derived from this information. A somatic number of 2n = 2x = 11 were observed in three different accessions of *L. hirta*, supporting the findings of Ornduff and Watters (1978), Johnson and Brandham (1997) and Kleynhans (1997), suggesting that the basic chromosome number should be x = 11.

Lachenalia mediana had a gametic chromosome number of n = x = 9. This number contradicts reports by other authors, who suggested somatic chromosome numbers of 2n = 2x = 14 (Johnson & Brandham, 1997) and 2n = 2x = 26 (Crosby, 1986) for *L. mediana* var. *mediana*. The basic chromosome number for this subspecific taxon could not be determined. *Lachenalia mediana* var. *rogersii*, however, had a gametic chromosome number of n = x = 13 observed for the first time in this study. This number corresponds to Crosby's (1986) finding of 2n = 2x = 26 in the species *L. mediana* var. *mediana*. This suggests a basic chromosome number of x = 13 for the species *L. mediana*.

The different chromosome numbers reported for the above mentioned species could be explained by the fact that the species examined were wrongly identified. Crosby (1986) suggested that *L. mediana* (2n = 26) was, on several occasions, miss-identified as *L. unifolia* (2n = 22, 44). The chromosomes in the genus are very small and could have, in some reports, contributed to miscounts and possible miss-identified B-chromosomes. Another problem could be that too much pressure on the cells could damage the chromosomes, splitting it at the centromers and contributing to a higher chromosome count if an insufficient number of cells were counted. Finally abnormalities, i.e. reciprocal translocations (*L. mutabilis*), large inert

centric fragments (*L. pallida*) (Ornduff & Watters, 1978; Hancke & Liebenberg, 1990) and B-chromosomes (*L. reflexa*) (Hancke & Liebenberg, 1990) could explain miss-counts, as well as misidentifications, abnormal cells or tissues, or unusual cultivated mutants, etc. (Stace, 2000). The long pair of chromosomes in *L. contaminata* has a secondary constriction, dividing the distal arm into almost equal halves (Gouws, 1965). B-chromosomes reported in this species could originate from this part of the chromosome breaking from the rest of the chromosome. If other species also have this secondary constriction, it is possible for it to break during the preparation process of the slides, further explaining miss-counts.

B-chromosomes have been reported in five species in the genus *Lachenalia* (table 4.2). B-chromosomes were observed for the first time in this study in the meiotic cells of *L. carnosa* (n = x = 8 + 0-2B).

Table 4.2: B-chromosomes in the genus *Lachenalia* observed in this study and elsewhere.

Species	**n**	**2n**	**Author**
L. aloides var. *quadricolor*	7 + 0-1B		Hancke & Liebenberg, 1990
	14 + 0-1B		Hancke, 1991
L. anguinea		30 + 2B	Johnson & Brandham, 1997
L. carnosa	8 + 0-2B		This study
L. contaminata		16 + 0-1B	Johnson & Brandham, 1997
L. obscura		18 + 0-1B	Johnson & Brandham, 1997
L. reflexa		14 + 0-2B	Hancke & Liebenberg, 1990; Hancke, 1991

4.2.2 Polyploidy in the genus *Lachenalia*

An estimate of 55% to 60% of monocotyledons are polyploids (Goldblatt, 1980; Grant 1981), based on the assumption that n = 13 or higher is polyploid (Grant, 1981). Polyploidy occurs in 40% of the species in the genus *Lachenalia* from which the chromosome numbers are known. This high number of polyploidy allows for the possibility of hybridisation (Tischler, 1934; Funk, 1985).

Diploids have evolved into polyploids on numerous occasions across the taxonomic spectrum (Raven, 1975). Polyploidy are evolutionary more advanced than diploidy because of the advantages it has for the plants. Chromosome doubling may alter the reproductive system, pest and pathogen tolerance and the ability to withstand nutrient stress, drought and cold (Levin, 2001). Polyploids always originate from diploid species and rarely give rise to them again (Singh, 1991). Diploids, therefore, belong to the more primitive species on the evolutionary scale.

Polyploidy (3x, 4x, 6x, 7x and 8x) ha ve been reported in 20 species in the genus *Lachenalia* (Table 4.3) and occurred in five species studied. *Lachenalia aloides* var. *vanzyliae* (2n = 4x = 28) (Crosby, 1986; Hancke, 1991; Kleynhans, 1997; Hamatani *et al.*, 1998), *L. bulbifera* (2n = 4x = 28) (Crosby, 1986; Hancke, 1991; Kleynhans, 1997; Kleynhans & Spies, 1999), *L. juncifolia* (2n = 4x = 44 observed only in this study), *L. unifolia* (2n = 4x = 44) (Johnson & Brandham, 1997) and *L. variegata* (2n = 4x = 28 observed only in this study) were tetraploids. The gametic cells of *Lachenalia bulbifera* were hexaploid (n = 6x = 21 observed only in this study) as well as somatic cells (2n = 6x = 42), thus confirming results of Moffett (1936); Crosby (1986); Johnson and Brandham (1997); Kleynhans (1997); Hamatani *et al.* (1998); Kleynhans and Spies (1999). *Lachenalia unifolia* was octaploid (2n = 8x = c. 80 observed only in this study).

Table 4.3: Ploidy levels in the genus *Lachenalia* observed in this study and elsewhere.

Species	**n**	**2n**	**Ploidy level**	**Basic #**	**Author**
L. alba		40	4x	10	Johnson & Brandham, 1997
L. algoensis		21	3x	7	Hancke, 1991
L. aloides var. *aloides*		21	3x		Moffett, 1936
	14		4x	7	Ornduff & Watters, 1978; Hancke & Liebenberg, 1990
		28	4x		Hancke & Liebenberg, 1990; Hancke, 1991
L. aloides var. *quadricolor*		28	4x	7	Hancke & Liebenberg, 1990; Hancke, 1991
L. aloides var. *vanzyliae*		28	4x	7	Crosby, 1986; Hancke, 1991; Kleynhans, 1997; Hamatani *et al.*, 1998; This study
L. bulbifera	14		4x	7	Ornduff & Watters, 1978;
		28	4x		Crosby, 1986; Hancke, 1991; Kleynhans, 1997; Kleynhans & Spies, 1999; This study

	21		6x		This study
		42	6x		Moffett, 1936; Crosby, 1986; Johnson & Brandham, 1997; Kleynhans, 1997; Hamatani *et al.*, 1998; Kleynhans & Spies, 1999; This study
		49	7x		Kleynhans & Spies, 1999
		56	8x		Crosby, 1986; Hancke, 1991; Johnson & Brandham, 1997; Kleynhans, 1997; Kleynhans & Spies, 1999
L. capensis		c. 28	4x	8	Johnson & Brandham, 1997
L. contaminata		32	4x	8	Johnson & Brandham, 1997
L. elegans var. *elegans*		28	4x		Moffett, 1936; Crosby, 1986; Johnson & Brandham, 1997; Minnaar, 2004
		42	6x		Johnson & Brandham, 1997; Minnaar, 2004
	28		8x	7	Ornduff & Watters, 1978
		56	8x		De Wet, 1957
L. elegans var. *flava*		42	6x	7	Johnson & Brandham, 1997
L. juncifolia		44	4x		This study
L. marginata ssp. *marginata*		28	4x	7	Johnson & Brandham, 1997
L. mutabilis	12		4x	6	Minnaar, 2004
		24	4x	6	Kleynhans, 1997; Spies *et al.*, 2000; Minnaar, 2004
	14		4x	7	Hancke, 1991
		56	8x	7	De Wet, 1957
L. orchioides var. *glaucina*		28	4x	7	Moffett, 1936; De Wet, 1957; Crosby, 1986; Johnson & Brandham, 1997
L. orchioides. var. *orchioides*		28	4x	7	Moffett, 1936; Therman, 1956; De Wet, 1957; Johnson & Brandham, 1997
L. pusilla		28	4x	7	Hancke 1991
L. pustulata		32	4x	8	Sato, 1942
L. reflexa	14		4x	7	Hancke, 1991
L. rubida var. *rubida*		28	4x	7	Crosby, 1986
L. stayneri		24	4x	6	Johnson & Brandham, 1997
L. unicolor		32	4x	8	Crosby, 1986
L. unifolia		44	4x	11	Johnson & Brandham, 1997; This study

		c. 80	8x		This study
L. variegata		28	4x		This study
L. viridiflora	14		4x	7	Hancke, 1991

Usually, the chromosomes studied from different genera collected in their natural habitat are seldomly triploid. The most common chromosome level in nature in the genus *Tulipa* is diploid, but an analysis of 99 cultivars revealed a range of ploidy levels of which the majority (86.4%) were diploid, 11.3% were triploid and a few were tetra- and pentaploid. Although *Hyacinthus* is usually diploid in nature, there are many diploids, triploids and tetraploids in cultivation (Ruiz Rejón *et al.*, 1999). Another phenomenon in the genus *Hyacinthus* is the existence of many aneuploids, especially aneuploid triploids (Ruiz Rejón *et al.*, 1999). This can be an explanation for the occurrence of many different basic numbers within one species, i.e. *L. mutabilis* and *L. unifolia*. It was observed that some species of the genus *Lachenalia* may become polyploids in cultivation (Kleynhans, personal comm.). If the same phenomenon of triploid formation in a species in cultivation for *Lachenalia* occurs, the existence of triploid levels in the genus (Table 4.3) are questioned because it can be the result of species kept in cultivation. The basic numbers of 3x are therefore excluded from this discussion. This is also a motivation for the hypothesis that 2n = 30 has a basic number of 2n = 2x = 15 and not 2n = 3x = 10. The number of polyploids in the genus can also be questioned as is the case with the genus *Hyacinthus*. All the specimens examined in this study were kept in a greenhouse after being collected in nature. No triploids were observed, but instead several other ploidy levels exist. Other polyploids in the genus can be questioned, but because of the uncertainty of the origin of the specimens examined elsewhere, the hypotheses will be discussed as if all specimens were analysed directly from their natural habitats. A further study is needed to compare specimens in cultivation with those in the wild to determine what the effect of cultivation practices (selection, hybridisation and vegetative reproduction with somaclonal variation) (Ruiz Rejón *et al.*, 1999) has on the chromosome behaviour in the genus. As for the genus *Muscari*, the same question can be asked for the genus *Lachenalia* and some of its species: "Does cultivation affect the wide chromosomal variability found in this species?" (Ruiz Rejón *et al.*, 1999).

4.2.3 Effect of environmental factors on the morphology and chromosomes

The environment has different effects on plants, their cytogenetics and speciation. The effect of environment needs to be taken in consideration in this study, to determine to what extent environment vs. hybridisation for instance, contribute to the morphological and chromosomal variation in the genus. If there are environmental factors contributing to differences within the genus, what will the effect of unnatural environments such as a greenhouse have on these differences? This was, however not an in depth study, but it is necessary to be aware that other factors can contribute to these variations.

The explanation for the extraordinary plant species richness of the Cape region is that taxa have differentiated in a mosaic of growth environments. Substrate gradients have a large role in the differentiation of Cape taxa (Linder, 1985; Cowling, 1987; Cowling *et al.*, 1990). Certain *Lachenalia* species prefer certain soil types (Duncan, 1988), thus the same theory may be applied to the genus. Substrate gradient may be one of the main driving forces for speciation in the genus, and therefore variation.

The ploidy levels as well as the chromosome size may be influenced by the environment. In the genus *Agrostis*, distribution of different cytotypes is mainly determined by environmental factors, with higher ploidy cytotypes in the stable competitive habitats and tetraploids in distributed and stressful habitats (Kik *et al.*, 1992).

4.2.4 Basic chromosome numbers in *Lachenalia*

The basic chromosome numbers are frequently of great evolutionary significance and taxonomic value because a wide range presumably indicates active evolution (Stace, 2000). Stebbins (1966) concluded that phylogenetic reduction in chromosome number is usually associated with the occurrence of unequal translocations between non-homologous chromosomes, followed by the loss of heterochromatic, genetically inert, or nonessential centromeric regions.

A thorough cytogenetic study needs to be conducted to determine the precise evolution of the basic chromosome numbers. In this study, the cytogenetic and the molecular data available elsewhere and generated in this study, will be used to test different hypotheses on the evolution of *Lachenalia* and its basic chromosome numbers. Assumptions regarding the different ploidy complexes resulted in many hypotheses for the chromosome evolution. These polyploid

complexes were classified into five types (young, young mature, old mature and old), which is considered to be stages of their evolution marked by a decreasing number of diploids and an increasing number of polyploids. In the first category there are few polyploids, whereas in the last category the diploids have all died out (Stebbins, 1971).

The percentage taxa per ploidy level in the genus are 2x = 67%, 3x = 3%, 4x = 21%, 6x = 3%, 7x = 1% and 8x = 4% (Table 4.2 & 3). Having mostly diploids, just over one fifth tetraploids and a small amount of the other ploidy levels (x = 3, x = 6, x = 7 and x = 8), the genus *Lachenalia* can be described as a mature polyploid complex. Previous studies indicated that an increase in ploidy level within a polyploid complex, coincide with a decrease in fertility (Fukuda, 1967; Asay & Dewey, 1976) and in some species this is accompanied by an increase in vegetative vigour (Nordenskiold, 1951; Jones & Carrol, 1962; Rowe, 1967; Dewey, 1979).

A separate analysis of the ploidy levels of the basic chromosome numbers is as follows:

- The basic number x = 5: It is not certain whether x = 5 really exists. If it is assumed that the species with 2n = 20 and 2n = 30 are tetra- and hexaploids of x = 5, then this basic number formed an old polyploid complex. There are only two species with 2n = 20, of which one has n = x = 10 observed in this study. It is possible that the other 2n = 20 species also has a basic number of x = 10 in stead of x = 5. The question remains if 2n = 30 is a hexaploid of x = 5, a triploid of x = 10, or a diploid of x = 15. Since triploids are very scarce in nature, it is more likely to be the result of a hybrid between x = 7 and x = 8. This is a more likely explanation for the formation of this number than the polyploidization of x = 5 to a hexaploid. If this theory can be accepted, there is only one species, *L. mutabilis* that has a basic chromosome number of x = 5. But *L. mutabilis* also has basic numbers of x = 6 and x = 7 (Appendix D). This means that x = 5 could be a newly evolving chromosome number from x = 7 via x = 6. According to Johnson & Brandham (1997) x = 5 (2n = 2x = 10) are derived from plants with 2n = 14 via two Robertsonian fusions. Two acrocentric chromosomes fuse at the centromere to produce a single larger chromosome, with the associated loss of the short arms, thus lowering the chromosome number by one. Robertsonian fusions (dysploidy) have been shown to be important in the chromosomal evolution of other plant families, e.g. the *Commelinaceae* (Jones, 1976).
- The basic number x = 6: At first it seemed that this number does not exist, but if it is considered that *L. mutabilis* has more than one basic number including x = 6, and that *L. stayneri* has a 2n = 4x = 24 (x = 6) instead of 2n = 3x = 24 (x = 8), this number seems to exist. It is however, like x = 5, a very uncommon basic number.
- The basic number x = 7: Based on this number mainly diploids are observed, 28.6%

tetraploids and a few hexa- and octaploids (Fig. 4.1). Therefore, this group represents a young mature polyploid complex. Most of the known species in *Lachenalia* have a basic number of x = 7. It seems that x = 7 is the oldest basic number from which many of the other numbers evolved. The numbers x = 6 could have evolved from x = 7 by descending aneuploidy. The same applies to x = 5 that evolved from x = 6.

- The basic numbers x = 8 and x = 11, both have mostly diploids with a few tetraploids, thus forming young polyploid complexes. The basic number of x = 8 has the second most taxa, and it could have evolved through gain aneuploidy from x = 7. It is uncertain at this stage how x = 11 formed. Because of the theory that both x = 5 and x = 6 are very recent basic numbers, x = 11 could not have formed from a hybrid between x = 5 and x = 6, and it could not have formed from aneuploidy from x = 12. It may have developed from loss aneuploidy or dysploidy from 2n = 2x = 14. There are very little taxa with x = 10 and it seems that this number is not very old (if it even exists), so it is questioned if x = 11 evolved from this number. The only theory is that x = 11 must have evolved from a diploid x = 14 through aneuploidy.

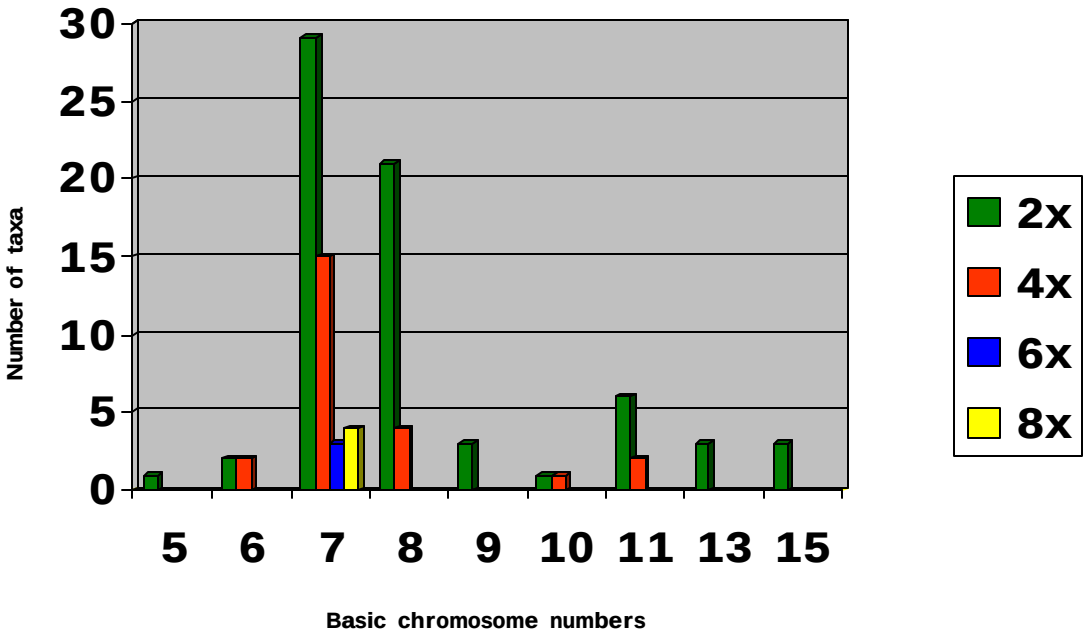


Figure 4.1: The number of taxa per ploidy level in *Lachenalia* observed for each assumed basic chromosome number.

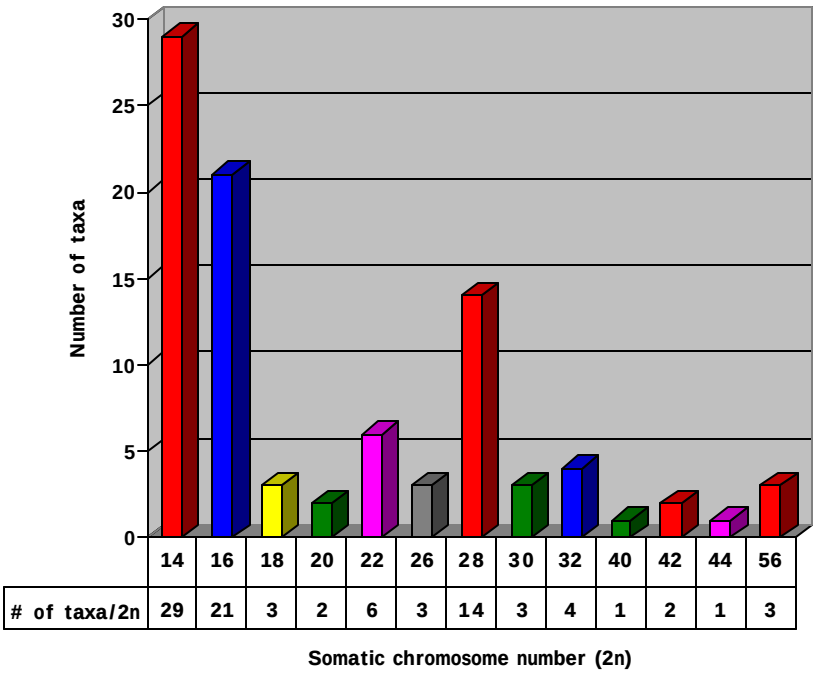


Figure 4.2: Number of *Lachenalia* taxa per somatic chromosome number based on x = 5 (green), x = 7 (red), x= 8 (blue), x = 9 (yellow), x = 11 (purple) and x = 13 (grey). Doubtful numbers and uneven ploidy levels are excluded.

- It is at this stage uncertain whether the basic chromosome number of x = 5 really exists, or if a number of x = 10 is a more reliable assumption. If the latter is the case, the basic chromosome number of x = 10 probably is a secondary basic chromosome number. This hypothesis is supported by Johnson & Brandham (1997), who analysed the karyotypes of x = 7 – 13 and 15, and discovered that all these basic numbers were structural diploids produced with twice the chromosome number. An example is the number 2n = 20 representing a diploid based on x = 10 rather than a tetraploid based on x = 5.

- The number x = 9, x = 13 and x = 15 have only diploids. The x = 9 taxa probably formed by aneuploidy from x = 8 (the more likely hypothesis), or by descending aneuploidy from x = 10. The x = 13 group could have evolved either from x = 11 or x = 14. Since x = 6 is presumably a newly developed number, it is unlikely to form from x = 12. According to Johnson and Brandham (1997), it could be possible that the diploids with 2n = 30 (x = 15) are allotetraploids derived from the doubling of chromosome number of a hybrid between taxa with x = 7 and x = 8. Stace (2000) although in another genus, suggested that a chromosome number of 2n = 30 could be the result of hybridisation between x = 7 and x = 8 (dibasic polyploidy) or aneuploid reduction from a tetraploid (n = 16) or hypotetraploid (n = 15) derived from n = 8 could have resulted in 2n = 30.

The most frequent basic chromosome numbers are x = 7, x = 8 and x = 11 (Fig. 4.2), and it can be concluded that these three forms the basis of the chromosome numbers in the genus *Lachenalia*.

Ecological conditions favour different kinds of chromosomal changes. The angiosperm flora can be reconstructed based on three early periods of a) aneuploid change, b) polyploidization and c) speciation and generic differentiation (Stebbins, 1966). This is confirmed by the data presented in Fig. 4.2, because x = 7 appears to be the oldest number, from which aneuploidy formed x = 6, 8 and 9. Polyploidisation formed the basis of many of the higher numbers.

A final hypothesis for many of the basic numbers is that new numbers were introduced through hybridisation by other genera closely related to *Lachenalia* such as *Polyxena* and *Massonia*. *Lachenalia* species could also have evolved from some of these species. Unfortunately there are very little chromosome numbers available for the genus *Polyxena* which is the closest related to *Lachenalia*. *Polyxena ensifolia* has chromosome numbers of 2n = 4x = 24 (x = 6) and 2n = 2x = 26 (x = 13). *Massonia*, also closely related to *Lachenalia*, has numbers of 2n = 2x = 18 (x = 9), 2n = 2x = 22 (x = 11) and 2n = 2x = 26 (x = 13). These numbers could have been introduced into the genus. There are several hypotheses on the evolution of the basic numbers, which will later in the chapter be compared with the molecular phylogenetic cladograms to be accepted or rejected.

4.2.5 Hybridisation and speciation in the genus *Lachenalia*

Natural hybridisation may lead to the formation of hybrid species. These hybrid derivatives may involve polyploidy, parthenogenesis, hybridogenesis or homoploid (diploid) speciation (Arnold, 1992). According to the chromosome number data and the molecular phylogenetic cladograms (which will be discussed later), it is suspected that *Lachenalia* includes many hybrid species.

The chromosome numbers of *Lachenalia* probably consist of a decreasing aneuploid series from polyploid specimens after an initial increase from 7 to 8. This is characteristic of many mainly outcrossing species (Stebbins, 1966). These species are consequently heterozygous for many loci and may occupy pioneer habitats. Such species must repeatedly colonise new areas and their success depends on their adaptability in comparison to their competitors. Colonisation success is correlated with the formation of genetically identical offspring to the pioneering parents (Stebbins, 1966). Because these species should constantly colonise new areas, the

different chromosome numbers and the various morphological differences in the genus could be explained. There is a constant exchange of genetic material because outcrossing could be prevailing in natural habitats, although seed set seems to be very poor in unnatural conditions such as a green house (Kleynhans, personal comm.). This results in many hybrids and thus, putative new species. Many of these new species produce offspring genetically similar to themselves by means of vegetative reproduction (Thompson *et al.*, 1991). Some *Lachenalia* species forms small bulbs at the base of their bulbs or leaves, thus maximizing the rate of colonization after adapting to a new environment. This hypothesis should be tested on a molecular level (Riesenberg & Soltis, 1991; Riesenberg & Ellstrand, 1993; Riesenberg & Wendell, 1993).

4.2.6 Chromosome evolution

The chromosomes of the *Lachenalia* genus are very small. In some genera, primitive species (on morphological grounds) have the largest chromosomes and the smallest chromosomes are found in specialized species (Stebbins, 1966). The small chromosomes in the genus, thus supports the theory that *Lachenalia* is a more advanced genus. Although differences in chromosome size between species of the genus *Lachenalia* can be detected with the naked eye, the facilities were not available to compare the advancements of the different species within the genus and correlate the results with the molecular data and cladograms. The more primitive chromosome numbers such as n = 10, seem to be larger than those of the more advanced chromosome numbers.

4.3 MOLECULAR SYSTEMATICS

Molecular systematics is a widespread method used in the animal, plant and microbial kingdoms to determine phylogenetic relationships. Molecular techniques are used to create a data matrix, from which a phylogenetic tree is obtained.

Systematics is important to assist in the understanding of and communication about the natural world. It advances our knowledge of evolution by establishing a historical context for understanding a wide variety of biological phenomena, such as adaptation, speciation, rates of evolution, ecological diversification and specialisation, co-evolutionary relationships of hosts

and parasites, and biogeography. The basic activities of systematics, i.e. classification and naming have been implemented since ancient times to deal with information about the natural world (Judd *et al.*, 1999).

Classification based on evolutionary relationships lead, in the past, to several discussions. It was always uncertain how the results in the form of a cladogram should be reflected in classification. Another problem that occurred was that there were no method of translating a phylogeny into a classification and the analysis of the phylogeny data was largely intuitive. The sequence data together with an explicit method of analysis overcame these problems and has created a large impact on plant systematics. The use of a combination of morphological and molecular data carries particular weight, but there are still potential limitations (Crawford, 2000).

The importance of determining the phylogeny of species is to indicate the evolutionary path of the organism, as well as the relationships between organisms (Qui *et al.*, 1999; Nishikawa *et al*., 1999) or genes by combining molecular biology and statistical techniques (Li, 1997). Phylogenies can also be used as a framework for investigating many significant questions about character evolution in flowering plants (Qui *et al.*, 1999).

Molecular data, particularly DNA sequences are, for evolutionary studies, favoured over morphological and physiological data. DNA sequences are more accurate in determining phylogenetic relationships than morphological or physiological data. Molecular data are also much more amenable to quantitative treatments than morphological data and are much more abundant (Li, 1997).

In this study, the DNA sequences of different species were obtained using the PCR technique. The sequences are aligned and phylogenetic cladograms are constructed based on this set of data.

4.3.1 Sequences and cladogram of *Lachenalia*

The *trn*L-F region proved to be usefull in solving phylogeny on various taxonomic levels (Bayer & Starr, 1998; Fennel *et al.*, 1998; Stedje, 1998; Meerow *et al.*, 1999; Molvray *et al.*, 1999; Fay *et al.*, 2000; Asmussen & Chase, 2001; Bradford, 2001; Richardson *et al.*, 2001; Hodkinson *et al.*, 2002; Van der Bank *et al.*, 2002; Mayer *et al.*, 2003).

The consistency index (CI index) (Kluge & Farris, 1969) measures the overall amount of homoplasy (independent evolution of the same character state) and are used as a standard to compare levels of homoplasy. If homoplasy is absent, the CI index is 1.0 and the CI index

decreases towards 0 as homoplasy increases. The CI index for the *Lachenalia* cladogram was relatively low (0.5308) indicating homoplasy in the genus. Sanderson & Donoghue (1989) indicated that as the number of taxa included in the analysis increases the CI index decreases. Larger data sets may report tree lengths that are longer than the usual minimal tree(s), entailing more homoplasy (Sanderson & Donoghue, 1989).

This could explain the relatively low CI index in *Lachenalia*. Another explanation is the hypervariable AT-rich and poly-T satellite regions that result in high homoplasy indices (Pfosser & Speta, 1999). This region presumably evolves from a di-nucleotide microsatellite. A similar hypervariable poly-T microsatellite was found in this study and elsewhere (Pfosser & Speta, 1999) in the intergenic spacer region (IGS). An increase in the number of taxa used in a phylogenetic study usually increases the resolution of unrelated taxa but decreases the resolution of closely related taxa (Olmstead & Palmer, 1994). This might explain the poor resolution in the strict consensus cladogram of *Lachenalia* .

Variable characters will increase the tree length but may add more resolution for faster evolving sites (Hillis, 1998). The tree length for the *Lachenalia* cladogram was 130 and the RI value was 0.8641.

4.3.2 Phylogeny within *Lachenalia* and its closest relatives

Two consensus cladograms were obtained from the molecular data, i.e. a strict consensus cladogram (Fig. 3.7) and an Adams consensus cladogram (Fig. 3.8), as well as a neighbour joining (NJ) cladogram. The two consensus cladograms were divided into distinctive groups and subgroups. Groups and subgroups in the Adams consensus cladogram (with the number of species in brackets) were redrawn to indicate the relationships and the divisions (Fig. 4.3 - 6). The different groups identified include:

1. The "*L. juncifolia*" group (11)
2. The "*Lachenalia*" group (105) with
    a. "*L. pallida*" subgroup (10)
    b. "*Polyxena*" subgroup (10)
    c. "*L. aurioliae*" subgroup (4)
    d. "*L. mutabilis*" subgroup (3)

3. The "*L. zebrina*" group (5)

The strict consensus cladogram is poorly resolved compared to the Adams consensus cladogram, suggesting the existence of hybrids in the genus *Lachenalia*. If two cladograms of equal length are compared, and one taxon position changes, the taxon that is moving may be a hybrid and the two taxa between which it is moving may be the parents (Funk, 1985). The problem with this hypothesis is that approximately 77 of the species are unresolved in the strict consensus cladogram, indicating that the genus is most probably a hybrid swarm. This in turns explains the difficulty in classifying the genera and species.

The chromosome numbers were superimposed on the strict consensus cladogram. Ten of the species with x = 8 were grouped together (the "*L. pallida*" group). Twenty-two species with x = 7 were grouped adjacent each other in the large clade formed (the "*Lachenalia*" group). Species with chromosome numbers of x = 6, 7, 8, 9, 10, 11 and 13 (including the *Polyxena* species) were scattered between the x = 7 grouping and x = 8 group within the "*Lachenalia*" clade. Many of these species are also poorly resolved in the Adams consensus cladogram (the "*Lachenalia* 2" group). These species are not hybrids between x = 7 and x = 8, but could be new species with new chromosomes evolving, probably by hybridisation with the genus *Polyxena*.

The topology of the NJ cladogram and Adams consensus cladogram corresponded. The resolution in the Adams consensus cladogram is by far better than the strict consensus cladogram, and the focus will therefore be on the Adams cladogram.

The four distinctive groups in the Adams consensus cladogram were:

1. The "*L. juncifolia*" group (11; x = 11) (Fig. 4.3).

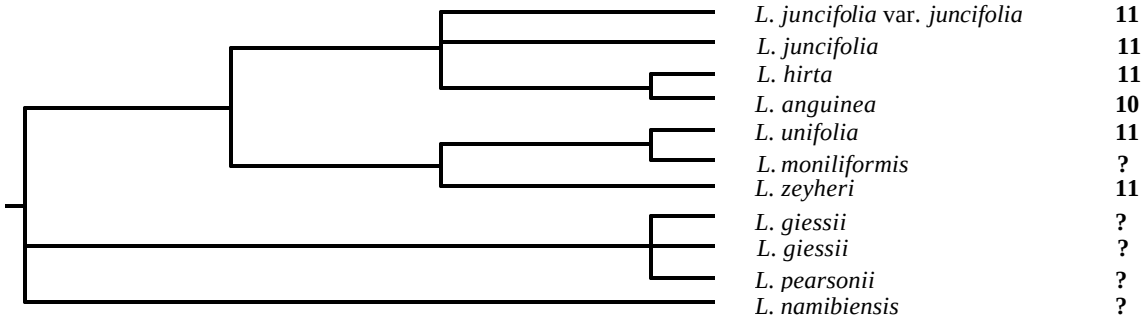


Figure 4.3: The "*L. juncifolia*" group from the Adams consensus cladograms with the known basic numbers indicated**.**

2. The "*Lachenalia* 1" group (57; x = 7 & 8) (Fig. 4.4)
    a. "*L. pallida*" subgroup (15; x = 8)
    b. "*L. elegans*" subgroup (10; x = 7)
    c. "*L. violacea*" subgroup (3; x = 7)
    d. "*L. bulbifera*" subgroup (3; x = 7)
    e. "*L. mathewsii*" subgroup (20; x = 7)
    f. "*L. mutabilis*" subgroup (3; x = 5, 6, 7)
3. The "*Lachenalia* 2" group (48; x = 6, 8, 9, 10, 13) (Fig. 4.5)
    a. "*L. concordiana*" subgroup (3; x = ?)
    b. "*L. perryae*" subgroup (6; x = 9)
    c. "*Polyxena*" subgroup (10; x = 13?)
    d. "*L. maximiliani*" subgroup (6; x = 10?)
    e. "*L. aurioliae*" subgroup (4; x = 8?, 13?)
    f. "*L. mediana*" subgroup (5; x = 6, 8 & 13)
    g. "*L. patula*" subgroup (3; x = 8)
4. The "*L. zebrina*" group (5; x = 10?) (Fig. 4.6)
    a. "*L. zebrina*" subgroup (3; x = 10?)

Ten species from the "*L. pallida*" subgroup in the Adams consensus cladogram correspond to the same group in the strict consensus cladogram, but five extra species were included into this group, therefore the 10+5 in brackets.

Three groups remained the same between the strict consensus cladogram and the Adams consensus cladogram. These groups are the "*L. juncifolia*", the "*L. aurioliae*" and the "*L. mutabilis*" subgroups. The "*L. pallida*" subgroup corresponded partially. Two other groups had the same species constitution for both cladograms, but had, in both instances, better resolution in the Adams cladogram. These groups were the "*Polyxena*" subgroup and the "*L. zebrina*" group.

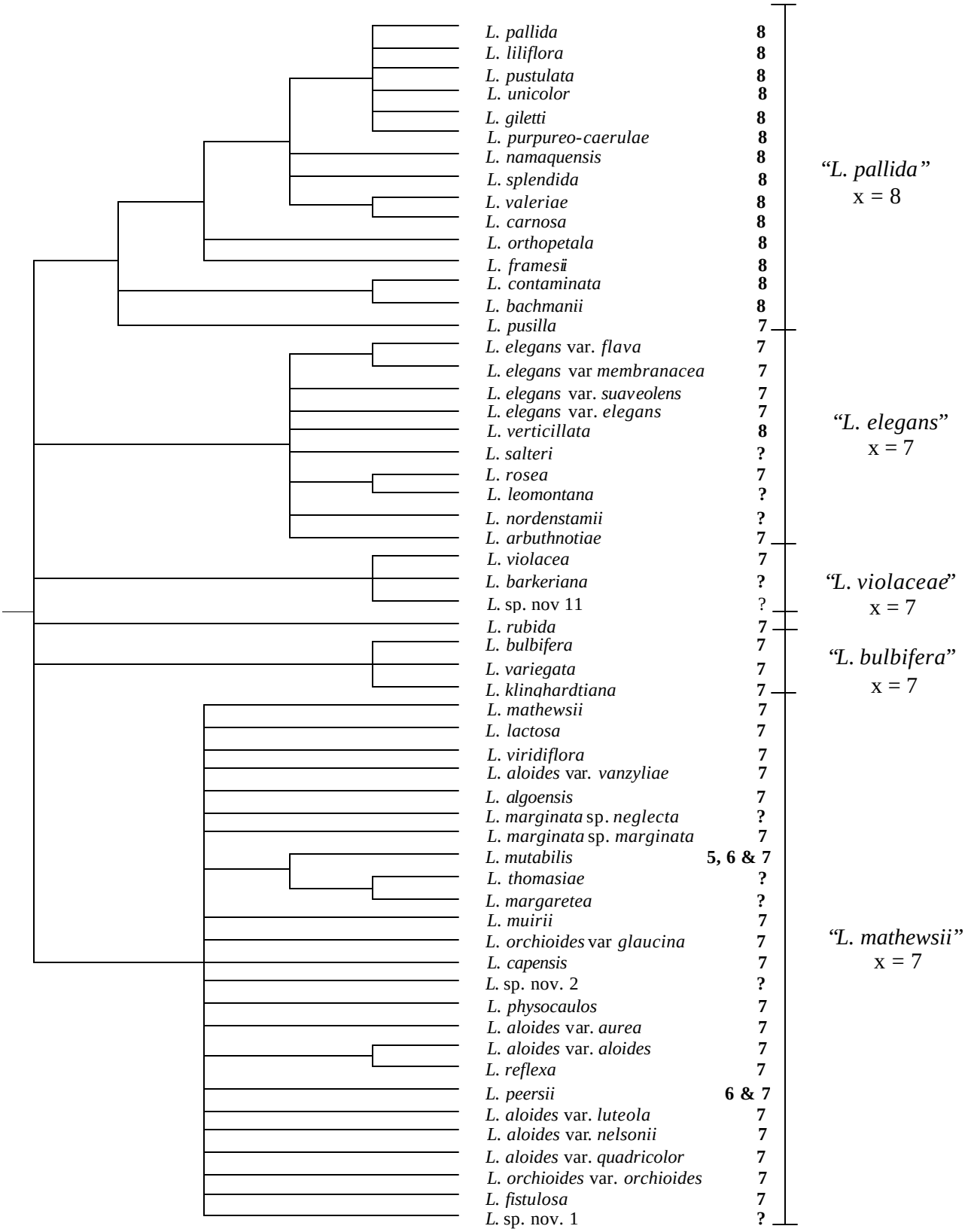


Figure 44: The "*Lachenalia* 1" group from the Adams consensus cladogram, with the 6 "subgroups" indicated, as well as their basic chromosome numbers.

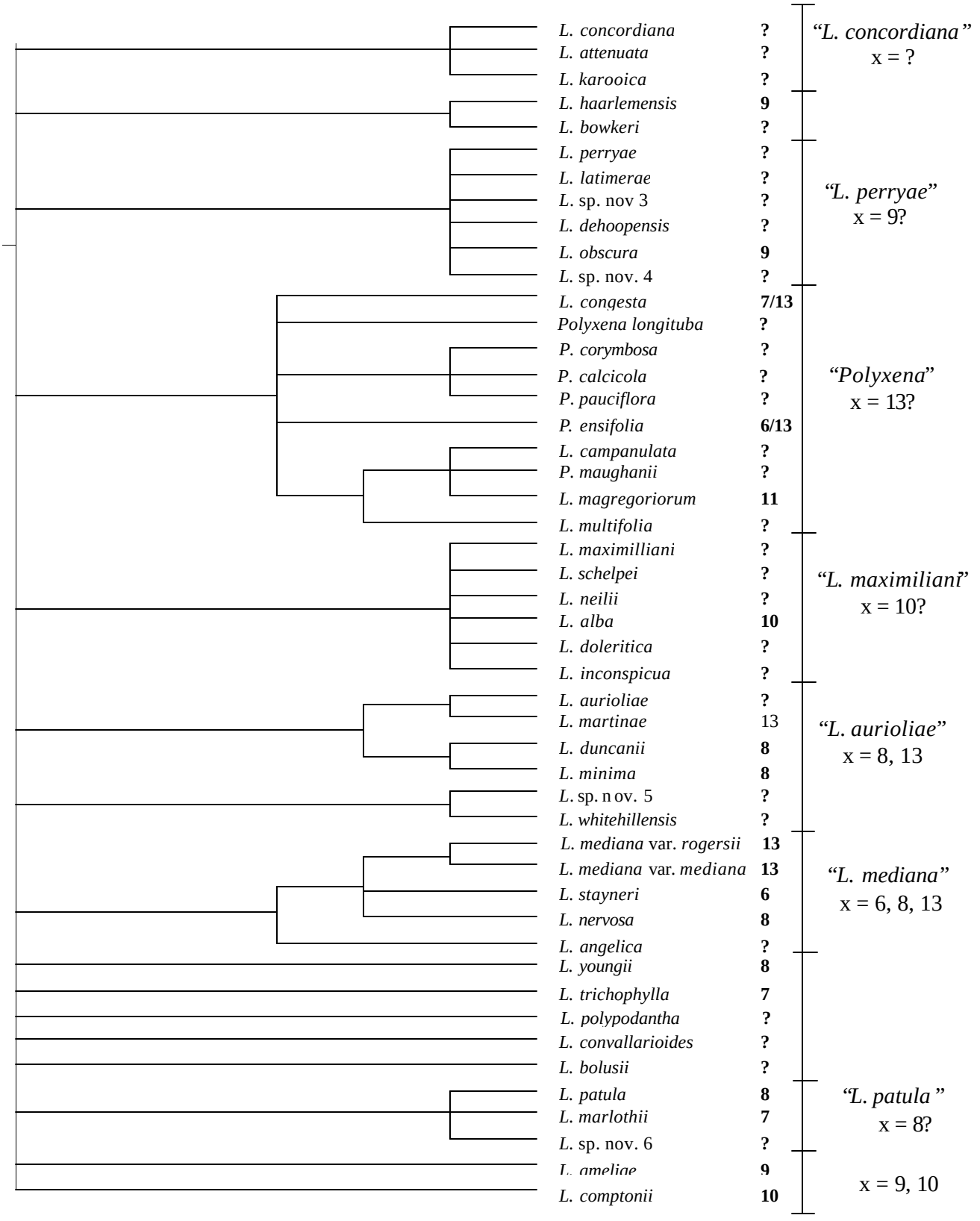


Figure 45: The "*Lachenalia* 2" group from the Adams consensus cladogram, with the 7 "subgroups" indicated, as well as their basic chromosome numbers.

The monophyletic clade formed with the *Lachenalia* and *Polyxena* species (*"L. juncifolia"*-, *"Lachenalia* 1"-, *"Lachenalia* 2" and *"L. zebrina*" groups) are supported by a very high bootstrap value of 100, separating it from the outgroup: the genus *Massonia*. The *"L. juncifolia"*-, *"Lachenalia* 1"-, *"Lachenalia* 2" groups form a monophyletic clade supported by a high bootstrap value of 79.

The basic chromosome numbers were determined from the majority of chromosome numbers published per species as well as chromosome numbers determined in this study. These numbers were superimposed on the Adams cladogram to determine any correlation between the chromosome numbers and clades.

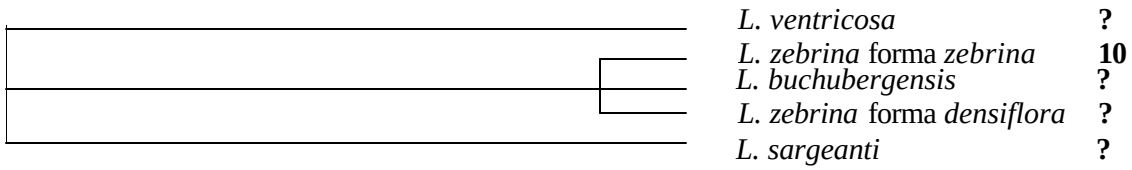


Figure 4.6: The *"L. zebrina*" group from the Adams consensus cladogram, as well as their basic chromosome numbers.

4.3.2.1 The "*L. juncifolia*" group

Four species have a basic chromosome number of x = 11, one has a basic number of x = 10 and the chromosome number of four species is unknown. Thus, the majority of species in this group have a basic number of x = 11. The monophyletic clade consisting of the species with x = 11 and the one with x = 10, are supported by a very high bootstrap value of 91 (Fig. 4.3). Two species in the group, *L. giessii* and *L. pearsonii*, are grouped together with a bootstrap value of 70. It seems that the *"L. juncifolia"* group consist of species with x = 11, but the chromosome numbers of the other species need to be determined.

4.3.2.2 The "*Lachenalia* 1" group

Three large subgroups from the "*Lachenalia* 1" group indicate a definite correlation between the clades formed and basic chromosome numbers (Fig. 4.4):

1. The "*L. pallida*" subgroup consists of 15 species all with a basic chromosome number of

x = 8 with the exception of *L. pusilla* with a basic number of x = 7.

2. The *"L. elegans"* subgroups consists of six species with a basic chromosome number of x = 7, one species with x = 8 and three species have unknown chromosome numbers. *Lachenalia verticillata* is the only species in this group with a basic chromosome number of x = 8, determined by Crosby (1986). A further investigation into this chromosome number is needed to confirm whether this is a correct number. The majority species in the *"L. elegans"* subgroup have a basic chromosome number of x = 7.

3. The "*L. mathewsii*" subgroup had 19 species with a basic chromosome number of x = 7. One species, *L. mutabilis* has basic chromosome numbers of x = 5, 6 & 7 reported. The chromosome number of four species are unknown in this group, and the chromosome number of one species, *L. peersii*, are uncertain because of a basic chromosome number of x = 6 and x = 7 reported (Johnson & Brandham, 1997; Kleynhans, 1997). The main basic chromosome number of the *"L. mathewsii"* subgroup are x = 7.

Thus, 40 species and subspecies from the *"Lachenalia* 1" group are grouped according to their chromosome numbers. One subgroup with a basic chromosome number of x = 8 are formed. The rest of the subgroups all consists of species with a basic chromosome number of x = 7.

4.3.2.3 The "*Lachenalia* 2" and "*L. zebrina*" groups

The chromosome numbers of the majority of species from the *"Lachenalia* 2" (Fig. 4.5) and "*L. zebrina*" (Fig. 4.6) groups are unknown. It could therefore not be confirmed whether there is the same correlation between chromosome numbers and subgroups formed in these groups. The "*Lachenalia* 2" group has a basic chromosome number distribution of 6, 7, 8, 9, 10, 11 and 13. The *"L. mediana"* subgroup has the majority of chromosome numbers available, i.e. the number of four species, which have basic numbers of x = 6, 8 and 13. This group contradicts the hypothesis of similar chromosome numbers representing certain clades. More information should be gathered on the chromosome numbers of all the species. The *"Lachenalia* 2" group has poor resolution, indicating that it might in large consists of hybrids. The genus *Polyxena* is included in the *"Lachenalia* 2" clade with a bootstrap support <50, indicating that these hybrids could be between species of *Lachenalia's*, or that the genus *Polyxena* could have hybridised with *Lachenalia* to form the mixture of chromosome numbers within this clade. Since the

chromosome number of only one *Polyxena* is known, and very little chromosome numbers of *Lachenalia* species are known in this clade, it is difficult to make a precise conclusion on this hypothesis. The inclusion of *Polyxena* in the clade also indicates that is should form part of the genus *Lachenalia* or that some of the *Lachenalia* species should be included in the *Polyxena* genus. An example is the species *L. pusilla*, which has a leaf morphology very similar to that of representatives of the genus *Polyxena*, but are classified as a member of the genus *Lachenalia*. The molecular phylogeny does not, according to the *trn*L-F region, group this species as part of the genus *Polyxena*. Other species (*L. congesta*, *L. campanulata*, *L. magregoriorum* and *L. multifolia*) forms a monophyletic group with *Polyxena*. These species have no significant morphological correspondence with the genus *Polyxena* (Fig. 4.7). Taxa should be monophyletic groups in the sense of Hennig (1966). This is the primary principle of phylogenetic classification (Backlund & Bremer, 1998). The genus *Polyxena* forms a monophyletic group with *Lachenalia* and should, therefore, be included in the genus *Lachenalia*. In spite of the close relationship between *Lachenalia* and *Polyxena*, it was placed in the two different subtribes Lachenaliinae and Massoniinae, respectively (Müller-Doblies & Müller-Doblies, 1997).

In an attempt to determine the correlation between "chromosome clades" and distinctive INDELS, it was determined that the "*L. juncifolia*" group has a unique and distinctive 4 bp deletion. The "*Lachenalia* 1" and "*Lachenalia* 2" groups combined have a 4 bp INDEL distinguishing it from the "*L. juncifolia*" and "*L. zebrina*" groups. None of the subgroups have INDELS distinguishing it from the rest. Only the two main groups, the "*L. juncifolia*" (x = 11) and "*Lachenalia*" group can be distinguished from each other by an INDEL.

4.3.3 The evolution of the basic chromosome numbers in *Lachenalia*

The majority of chromosome numbers available indicate that a definite correlation between the groupings from the *trn*L-F region and chromosome numbers exist, because similar chromosome numbers are grouped together. The groups with a basic number of x = 7 and x = 8 are sister groups in the Adams cladogram. This means that these two numbers could have evolved simultaneously. The chromosome data indicate that x = 7 is the oldest group because of the high number of polyploids within this group. The basic number x = 8 are the second oldest group and, therefore, evolved from x = 7 through gain aneuploidy. This is supported by the fact that ascending dysploidy is a rare phenomenon in natural populations and does not play a significant role in the evolution of any plant groups (Goldblatt & Takei, 1997). The number x =

7, therefore did not evolve from x = 8. Thus, the hypothesis is that the initial basic chromosome number in the genus *Lachenalia* were x = 7, from which x = 8 evolved shortly thereafter.

The third basic number that seems to have evolved according to the cladogram and the chromosome data, is x = 11. This group is, according the cladogram, closely related to the genus *Massonia* (x = 9, 11 and 13). It is possible for x = 11 to have evolved from a ploidy x = 8, i.e. x = 16 through ascending aneuploidy to x = 11. Another explanation is that the genus *Massonia* introduced new chromosome numbers in the genus.

4.3.4 Comparison between the different subgeneric classifications

Crosby's (1986) classification is mostly based on the chromosome numbers in the genus, whereas the classification of Baker (1897) and Duncan (1988 & 2002) are based on the morphology. The groups in the cladogram corresponds to the chromosome numbers, and according to the cladogram, the classification of Crosby is the most correct one.

Because there seems to be no correlation between the morphology in the genus *Lachenalia* and the phylogenetic tree obtained from the cpDNA sequences, it can be speculated whether introgressive hybridisation in the chloroplast genome are also responsible for the difference between the strict consensus cladogram and the Adams consensus cladogram. Can this also be the reason why the species in the one half of the cladogram have very little resolution as well as no correlation with chromosome numbers, in contrast with the other half?

There is very little correspondence between the cladogram and morphological classifications as described by Duncan (1988 & 2002). Nuclear genes need to be sequenced and analysed to see if a better correlation between morphology and molecular phylogeny could be obtained to assist the taxonomists in resolving the genus. The implementation of the *trn*L-F region is, however, a very valuable tool for the breeders as indication of which species to use for breeding.

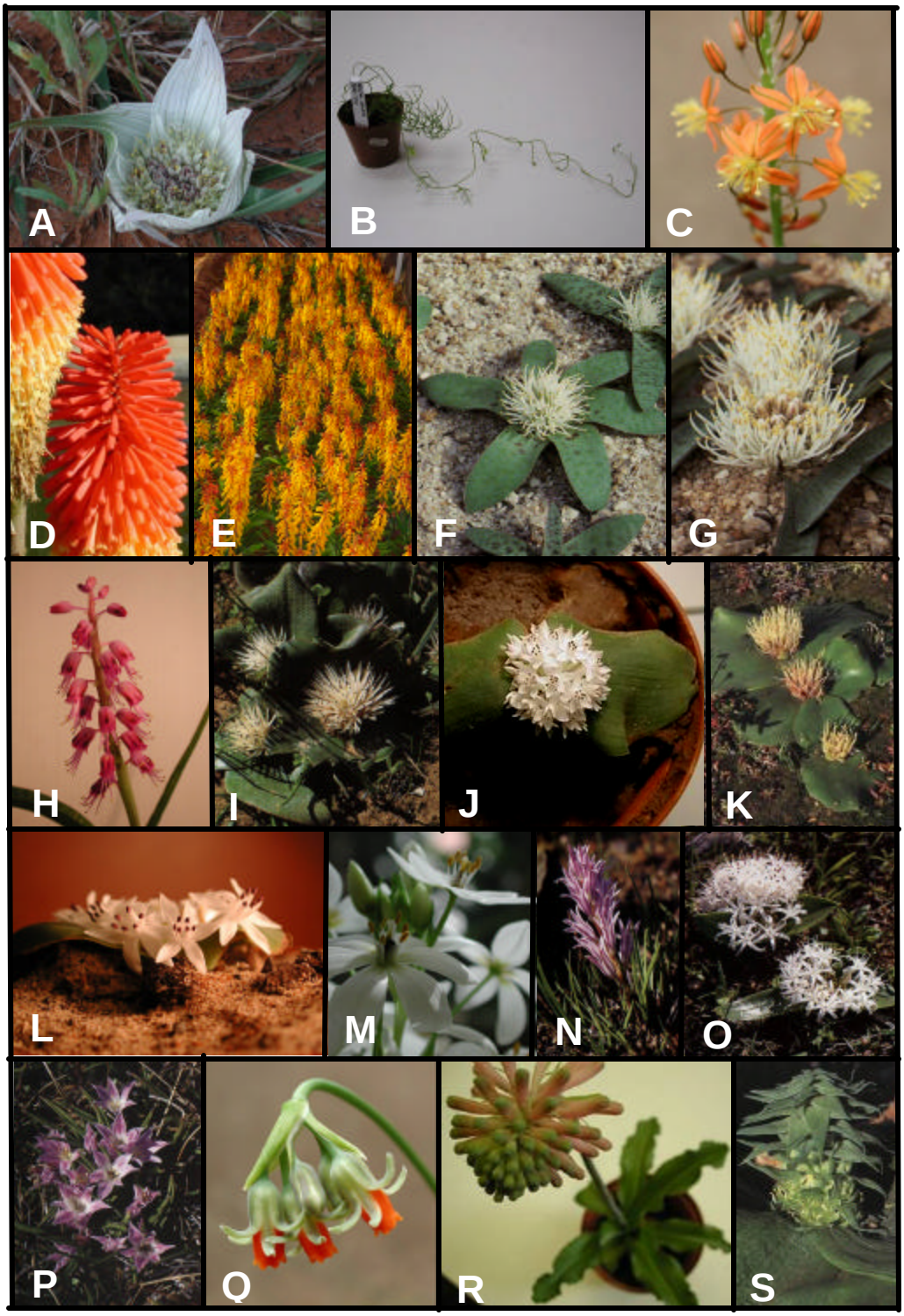


Figure 4.7: Photographs of some representatives of some genera used during this study. A, *Androcymbium*; B, *Bowiea*; C, *Bulbine*; D, *Kniphofia*; E-H, *Lachenalia*; I-L, *Massonia*; M, *Ornithogalum*; N-P, *Polyxena*; Q, *Tulbaghia*; R, *Veltheimia*; S, *Whiteheadia*. F & G from Duncan (1988); I, K, N, O, P & S from Manning *et al.* (2002).

4.3.5 The phylogenetic position of *Lachenalia* among the liliaceous plants

The tree length of this cladogram (Fig. 3.9) was 1 806 steps, the CI was 0.5133 and the RI value was 0.8066. This is comparable to the results of Pfosser and Speta (1999), whose data yielded a tree length of 1415 steps, a CI of 0.597 and RI of 0.862.

There is some speculation whether molecular data can exclusively be used for classification or inferring phylogenetic relationships. In the genera *Drimia* and *Urginea*, the only morphological character that separates these two genera, is the degree of fusing of the perianth segments. This character gives a very weak basis for generic delimitation (Stedje, 1987). Jessop (1977), Stearn (1978) and Stedje (1987) thus speculated that these genera should be joined to form one genus. Three *Drimia* species were also regarded as belonging to the genus *Thuranthos*, due to the shape of their filaments (Stedje, 2000). The speculations that the genus boundaries for *Drimia*, *Urginea* and *Thuranthos* should be reconsidered are supported by sequences of the chloroplast *trn*L-F region, where *Drimia* and *Urginea* forms a monophyletic group, together with species of the genus *Rhadamanthus*, *Schizobasis* and *Thuranthos indicum*. Another example was obtained from this study. *Polyxena* is, according to classification, related to the genera *Massonia*, *Whiteheadia* (Dout, 1994-1995) and *Lachenalia* (Duncan, 1992). This classification is confirmed in the cladogram, where these genera form a monophyletic clade. These examples indicate that the use of molecular data can guide the taxonomist in classification on genus level. Can it be used as a tool on species level? There does not seem to be a significant correlation between the morphology of the genus *Lachenalia* according to Duncan (2002) and the sequence data of the *trn*L-F region. An additional nuclear gene may provide better answers.

Can the use of molecular data be influenced by genera/species that are geographically separated? In the Massonieae clade described by Pfosser and Speta (1999), all the South African genera cluster together, in spite that they are morphological heterogeneous. Another example on species level is in the genus *Drimia*. The species *Drimia fugax* and *D. undata* are from the Mediterranean area (Stedje, 2000) and *D. elata* from South Africa. The first two species forms a separate group from the latter species. The same phenomenon was observed in the genus *Ornithogalum*. The two South African species of *Ornithogalum* grouped with the South African *Albuca* species to form a sister group with the rest of the Northern hemisphere *Ornithogalum* species. This indicates that there is a correlation between hemispherical separation and the molecular sequences. This hypothesis, however, still needs to be confirmed within the genus *Lachenalia* which is distributed within the same hemisphere. The differences in the sequences

from species from different geographical distributions could be explained by the ecological barriers caused by distance and speciation (and thus mutations) due to environmental pressure.

The cladogram (Fig. 3.9) can be divided into three distinctive groups. Group 1 consists of the family Hyacinthaceae, group 2 (consisting of the clades numbered 1-6 in the cladogram) consist of the families Eriospermaceae, Asparagaceae, Draceanaceae, Colchicaceae, Iridaceae, Asphodelaceae and Alliaceae. Group 3 (clade 7) consists of the family Amaryllidaceae. Groups 2 and 3 can be considered as the outgroups. These families were chosen as outgroup, because of their close relationship with the family Hyacinthaceae.

The topology of group 1 corresponds with the cladogram obtained by Pfosser and Speta (1999) and can accordingly be subdivided into subfamilial (Hyacinthoideae, Ornithogaloideae and Urgineoideae) and tribal limits (Hyacintheae, Massonieae, Ornithogaleae and Dipcadieae) (Fig. 3.9). The relationships discussed by Pfosser and Speta (1999) will not be repeated in detail in this study. The focus will rather be on the position of *Lachenalia* within this group. *Lachenalia* is included in the tribal limit, i.e. the Massonieae clade, together with the genera *Massonia*, *Whiteheadia*, *Polyxena*, *Veltheimia*, *Eucomis*, *Ledebouria* and *Drimiopsis*. The genera *Massonia*, *Whiteheadia*, *Polyxena* and *Lachenalia* form a monophyletic clade supported by a 68 bootstrap value. The exception is *L. isopetala*, clading with the genus *Eucomis*. One explanation, as is the case with other unanticipated and sometimes inexplicable results reported, is that it results from inadvertent amplification of a sequence from the wrong, i.e. contaminating, DNA. The result is that two related species yield disparate sequences, one of which is placed phylogenetically in a highly unexpected position (Olmstead & Palmer, 1994; Li, 1997). Only one sample of *L. isopetala* was sequenced, thus additional samples need to be sequenced to confirm this grouping. It was previously discussed that the cladogram topology from sequences of the *trn*L-F region corresponds with the basic chromosome numbers. In the case of the unexplainable clade of *L. isopetala* and *Eucomis*, it was also found that both these species have a basic chromosome number of x = 15. It is, however, uncertain why *L. isopetala* rather grouped with *Eucomis* with the same number than with other *Lachenalia* species with x = 15.

The relationship between *Massonia*, *Whiteheadia*, *Polyxena*, *Veltheimia* and *Lachenalia* are challenged *Lachenalia* and *Polyxena* were placed in two different subtribes as mentioned earlier (Müller-Doblies & Müller-Doblies, 1997), which is questionable in this study. In the same classification, *Lachenalia* and *Veltheimia* belong to the subtribe Lachenaliinae, and *Whiteheadia* belong to the subtribe Massoniinae (together with *Eucomis*, *Massonia*, *Namophila*, *Periboea*, *Polyxena*, *Androsiphon*, *Amphisiphon*, *Neobakeria* and *Daubenya*). Previous studies indicated that the division of the tribe Massonieae (Müller-Doblies & Müller-Doblies, 1997) is not

supported by molecular data (Speta, 1998; Manning & van der Merwe, 2002). Since *Whiteheadia* forms a monophyletic clade with *Massonia*, supported by a bootstrap value of 60, this classification seems to be correct. The *Massonia*-*Whiteheadia* clade, however are situated between *Veltheimia* and *Lachenalia*, and the *Lachenalia*-*Veltheimia* grouping into the same subgroup are questioned.

Lachenalia and *Polyxena* form a monophyletic group with a bootstrap support of 94, with *Massonia* and *Whiteheadia* as their closest relatives, followed by *Veltheimia*.

Group 2 are supported by a bootstrap value of 87. The families in this group that are represented by more than one species per family, all are supported by a very high bootstrap value of 100. The use of the *trn*L-F region for classification is extremely reliable and useful on family level. The two genera that are represented by more than one species, were supported by a bootstrap value of 100 (*Trachyandra*) and 99 (*Bulbine*), supporting the statement that this region is a valuable tool for classification of genus level.

The families Eriospermaceae, Asparagaceae and Draceanaceae forms a monophyletic clade supported by a bootstrap value of 58 in group 2. According to Stebbins (1966) the genera *Asparagus* and *Sansevieria*, which represents the families Asparagaceae and Draceanaceae in this study, have smaller nuclei and are more specialized genera in the order Liliales. These two families are grouped together by a bootstrap support of 68.

The family Alliaceae forms a sister group to two other groups, the one being monophyletic for the family Asphodelaceae and the other monophyletic group consists of the families Colchicaceae and Iridaceae. This study did not have an in depth investigation to determine the morphological and topological correlations on family or genus level.

These results clearly indicate that the *trn*L-F region is especially useful to study phylogenetic relationships on genus or higher taxonomic levels. Although the success at species level cannot be compared with the resolution at higher taxonomic levels, subgeneric clades seem to be supported by these results. Further studies involving more genes, preferably including at least one nuclear gene, could contribute a lot to our understanding of the evolution of *Lachenalia* and its related taxa.

The cytogenetic and molecular data support one another and provides a new way of studying chromosomal evolution. Further studies, including more comprehensive cytogenetic data and phylogenetic studies support by more genes, should be able to indicate the evolution of chromosomes in this variable genus. The combination of all the suggested data, combined with a

molecular cytogenetic study (GISH-analysis), should eventually solve the evolutionary pathway of these beautiful plants.

Chapter FIVE

Conclusions

This study clearly indicated that the genus *Lachenalia* consists of many species with many differences on cytogenetic and molecular level. The first aim of this study was to determine and/or confirm the basic chromosome numbers of *Lachenalia* .

Basic chromosome numbers of x = 5, 7, 8, 9, 10, 11 & 13 have been described. Different basic chromosome numbers even exist within a single species, i.e. *L. mutabilis* with x = 5, 6 & 7. Several factors may contribute to different basic chromosome numbers within a species. It may be the result of erroneous counts, misidentified species, the presence of B-chromosomes, abnormalities such as translocations, large inert centric fragments, etc.

Of all the *Lachenalia* species and subspecific taxa examined in the past by other authors as well as in this study, a basic number of x = 7 is the most common number detected in 50% of the species. The number second most observed were that of x = 8 in 33.9% of the species, followed by x = 11 (8% of the species). The basic numbers occurring the least in the genus *Lachenalia* is x = 5 (1.6%), x = 9 (4.8%), x = 10 (3.2%), x = 13 (1.6%) and x = 15 (4.8%).

It is uncertain which one of the basic numbers of x = 5, 10 and 15 really exists, because x = 5 could be the basis of 2n = 10, 20, 30 and 40, x = 10 could be the basis for 2n = 20, 30 and 40. It is more likely that x = 15 forms the basic number for 2n = 30, instead of 2n = 3x = 30 with a basic number of x = 10 or 2n = 6x = 30 with a basic number of x = 5. The basic number x = 15 could be a hybrid number evolving between x = 7 and x = 8. Basic number x = 5 could be a newly evolving number, whereas x = 10 is a secondary basic chromosome number

The basic number x = 6 is very uncommon occurring in only two species and could, therefore, also be a newly evolving number.

The basic number x = 7 has mainly diploids (56.8%), followed by 28.6% tetraploids and a few hexa- and octaploids and are therefore a young mature polyploid complex. As mentioned, this number occurred the most in the genus and could be the oldest number forming the basis for the evolution of all the other numbers.

The basic number x = 8 are a young polyploid complex, having the second most taxa with this number. This number evolved through aneuploidy from x = 7. There were no 6x and 8x levels reported for plants with a basic number of x=8 and x=11. These two basic numbers have similar ploidy level distributions with 84% and 75% of the species being diploid respectively.

Another young polyploid complex is the number x = 11, which could have evolved from aneuploidy from x = 14. The numbers x = 9, x = 13 and x = 15 have only diploids. The x = 9 taxa probably formed by aneuploidy from x = 8 and x = 13 could have evolved from the polyploid x = 12. More specimens per species and more species, including species of related

taxa, should be studied to complete our knowledge of the chromosomal variation in the Hyacinthaceae. More cytogenetic (meiotic) studies on artificial hybrids, especially those formed by two different basic chromosome numbers, may help to determine the degree of genomic relationships in *Lachenalia*. The final answer may be dependant on genomic *in situ* hybridisation to determine the degree of genome homology between the different basic chromosome numbers.

Polyploidy occurs in 20 species in the genus and mainly in the species with x = 7. Polyploidy occurs (as percentage of taxa per basic chromosome number) as follows: 0% (x = 5), 50% (x = 6), 43.1% (x = 7), 16% (x = 8), 0% (x = 9), 50% (x = 10), 25% (x = 11) and 0% (x = 13 & 15). The percentage taxa per ploidy level in the genus are 2x = 67%, 3x = 3%, 4x = 21%, 6x = 3%, 7x = 1% and 8x = 4%

This study clearly indicated that the *trn*L-F region can be used in determining phylogenetic relationships in *Lachenalia*. Resolution at generic level was excellent, thus indicating the position of *Lachenalia* among the liliaceous plants. At specific level poor resolution was obtained. The resolution indicated several subgeneric taxa or groups but failed to resolve the phylogeny within such a group. At least one additional gene should be sequenced to clearly indicate the relationships within *Lachenalia*.

When basic chromosome numbers are superimposed on the results of the molecular study, basic chromosome numbers corresponded with certain clades. The different groups and subgroups, according to the cladogram of the *trn*L-F region, with the number of species and basic chromosome number represented by that group in brackets, are:

5. The "*L. juncifolia*" group (11; x = 11)
6. The "*Lachenalia* 1" group (57; x = 7 & 8)
    a. "*L. pallida*" subgroup (15; x = 8)
    b. "*L. elegans*" subgroup (10; x = 7)
    c. "*L. violacea*" subgroup (3; x = 7)
    d. "*L. bulbifera*" subgroup (3; x = 7)
    e. "*L. mathewsii*" subgroup (20; x = 7)
    f. "*L. mutabilis*" subgroup (3; x = 5, 6, 7)
7. The "*Lachenalia* 2" group (48; x = 6, 8, 9, 10, 13)
    a. "*L. concordiana*" subgroup (3; x = ?)
    b. "*L. perryae*" subgroup (6; x = 9)

c. *"Polyxena"* subgroup (10; x = 13?)

d. *"L. maximiliani"* subgroup (6; x = 10?)

e. *"L. aurioliae"* subgroup (4; x = 8, 13?)

f. *"L. mediana"* subgroup (5; x = 6, 8 & 13)

g. *"L. patula"* subgroup (3; x = 8)

8. The *"L. zebrina"* group (5; x = 10?)

The basic chromosome numbers in the "*Lachenalia* 1" group, corresponds with the subgroups within this group. Species with a basic chromosome number of x = 8 forms a monophyletic group, and a sistergroup with several x = 7 subgroups. This either suggests a close relationship between members of these basic chromosome numbers or the maternally inherited chloroplast gene is not revealing the true phylogenetic relationship, but rather the degree of hybridisation between plants with different basic chromosome numbers.

The *"Lachenalia* 2" group has very poor resolution and there is no correlation between basic chromosome numbers and subgroups. Very few chromosome numbers are unfortunately known in this group, which complicates any conclusions. Future studies should concentrate on obtaining more chromosome numbers from this group.

Polyxena is included in the *Lachenalia* clade, which is supported by a bootstrap value of 100. *Polyxena* should either be included in the genus *Lachenalia*, or *Lachenalia* as a paraphyletic taxon, should split.

Massonia and *Whiteheadia* are sistergroups to *Lachenalia sensu lato* (*Lachenalia* with *Polyxena* included as part of the genus). The genus *Veltheimia* is grouped between the *Massonia* - *Whiteheadia* clade. *Lachenalia isopetala* forms a monophyletic clade with *Eucomis*, sharing the same basic number (x = 15). *Massonia* has basic numbers of x = 9, 11 & 13, and because this genus is the closely related to *Lachenalia*, these numbers could have been introduced into the genus by hybridisation.

The family Hyacinthaceae forms a monophyletic group and are divided into several monophyletic subfamilies (Hyacinthoideae, Ornithogaloideae and Urgineoideae) and tribes (Hyacintheae, Massonieae, Ornithogaleae and Dipcadieae) (Pfosser & Speta, 1999).

The chloroplast DNA region *trn*L-F provides enough informative sites to give good resolution on genus and family level of the bulbous plants. Thus, the *trn*L-F region can guide the taxonomist in classification on these levels. The *trn*L-F region may not be very useful for taxonomists on species level, but the cladogram may be a helpful guide for the breeders.

Chapter SIX

Summary

Lachenalia is a small bulbous geophyte of the family Hyacinthaceae, endemic to South Africa and first described in 1787 by Jacquin. There is a large degree of variation in the genus and some species overlap morphologically with other genera such as *Polyxena* and *Massonia*, and it is very difficult to delimit the species. There are currently approximately 120 species described, but new species are frequently described. Several authors attempted to subdivide the genus (Baker, 1897; Crosby, 1986; Duncan, 1988 & 2002). *Lachenalia* has a tremendous cultivation potential, and 25 new cultivars have been introduced since 1966.

A cytogenetic, as well as a molecular study, was conducted to try and solve problems with the classification in the genus, and to provide answers to the breeders regarding infertility problems between interspecific crosses. The chromosome numbers of a few species were determined by examining meiotic and mitotic chromosomes in order to guide the breeders in their hybridisation studies. The numbers obtained during this study were combined with results of previously studies to try and determine the original basic chromosome number(s) in the genus.

Several basic chromosome numbers have been reported in the genus, i.e. x = 5/10, 7, 8, 9, 11 and 13. The majority species have a basic chromosome number of x = 7, followed by x = 8 and then x = 11. Polyploidy is common, occurring in 40% of the species in the genus. The number x = 7 has mainly diploids, 28.6% tetraploids and a few hexa- and octaploids and, therefore, represents a young mature polyploid complex. The numbers x = 8 and x = 11 both forms young polyploid complexes. According to this information, it can be concluded that x = 7 were the original basic number, from which x = 8 and x = 11 evolved. The hypothesis on the evolution of the chromosome numbers were tested by sequencing the *trn*L-F region of the chloroplast genome.

This region was also sequenced to try and provide answers for the taxonomists on the difficult task of classifying and delimiting the genus. The phylogenetic position of the genus in relation to other liliaceous plants also needed to be determined.

The basic chromosome numbers were superimposed on the cladogram, and a definite correlation between chromosome numbers and monophyletic groups were obtained. Several monophyletic clades formed, dividing the cladogram into four distictive groups: the *"L. juncifolia"*, *"Lachenalia* 1", *"Lachenalia* 2" and *"L. zebrina"* groups, and several subgroups. The position of these groups and subgroups confirms the hypothesis that x = 8 evolved from x = 7. It also indicated that several hybrids prevail within the genus, explaining the delimitation problems and the variation in basic chromosome numbers.

The genus *Polyxena* are included within the *Lachanalia* clade, indicating that this genus should either be included in the genus, or *Lachenalia* should be split into several genera.

Polyxena could also have introduced new chromosome numbers and variation in the genus by hybridisation. The cladogram confirms that *Polyxena* is the closest relative of *Lachenalia*, followed by *Massonia* and *Whiteheadia*.

This study indicated that the cytogenetic and molecular data support one another. The *trn*L-F region is useful to study phylogenetic relationships on genus or higher taxonomic levels, but the addition of other genes will probably provide more answers for the classification and evolution of the genus.

Keywords: Aneuploidy, Chromosome numbers, DNA sequencing, Evolution, Hyacinthaceae, *Lachenalia*, Phylogenetic relationships, Polyploidy.

Chapter SEVEN

Samevatting

Lachenalia is 'n klein bolplant van die familie Hyacinthaceae. Dit is endemies tot Suid-Afrika en is reeds in 1787 deur Jacquin beskryf. Die genus bevat geweldig baie variasie en oorvleuel morfologies met die genera *Polyxena* en *Massonia*. Spesie-afbakening in die groep is baie moeilik. Tans is ongeveer 120 spesies beskryf en nuwe spesies word dikwels beskryf. Verskeie outeurs het gepoog om die genus te onderverdeel (Baker, 1897; Crosby, 1986; Duncan, 1988 & 2002). *Lachenalia* het 'n uitstekende kultiveringspotensiaal en 25 nuwe kultivars is reeds sedert 1966 vrygestel.

'n Gekombineerde sitogenetiese en molekulêre studie is onderneem om die klassifikasieprobleme van die genus te probeer oplos. 'n Verdere doel van die studie was om te probeer om die onvrugbaarheidsprobleme by basters tussen verskillende spesies te begin aanspreek vir die telers. Chromosoomgetalle van 'n paar spesies is bepaal deur mitotiese en/of meiotiese studies om sodoende telers te help met moontlike kruisings beplanning. Die chromosoomgetalle waargeneem tydens hierdie studie is saam met die beskryfde getalle in die literatuur gevoeg in 'n poging om die oorspronklike basiese chromosoomgetal van die genus te probeer bepaal.

Verskeie basiese chromosoomgetalle is reeds vir die genus gerapporteer, nl. x = 5/10, 7, 8, 9, 11 en 13. Die meeste spesies het 'n basiese getal van x = 7, gevolg deur x = 8 en x = 11. Poliploïdie is 'n algemen verskynsel onder 40% van die spesies in die genus. Spesies met 'n basiese getal van sewe is meestal diploïed met 28.6% tetraploïedes en 'n paar heksa- en oktaploïedes. Hierdie spesies verteenwoordig dus 'n jong volwasse poliploïede kompleks. Spesies met basiese getalle van 8 en 11 verteenwoordig altwee jong poliploïede komplekse. Hierdie data suggereer dat x = 7 die oorspronklike basiese getal verteenwoordig, waaruit x = 8 en x = 11 ontwikkel het. Hierdie hipotese oor die basiese chromosoomgetal is getoets deur dit te vergelyk met die filogenie verkry uit die nukleotiedvolgordes vanaf die *trn*L-F streek van die chloroplaste genoom.

Hierdie streek se volgordes is ook bepaal om die taksonomiese probleme in die genus te probeer oplos. Die filogenetiese posisie van *Lachenalia* in die lelieagtiges is ook bepaal.

Die basiese chromosoomgetalle is met die kladogramme gekombineer. Die kombinasie toon duidelik dat die basiese chromosoomgetalle met die verskillende monofeletiese takke van die boom ooreenstem. Die monofeletiese takke wat gevind is kan in vier duidelike groepe onderverdeel word, nl. die "*L. juncifolia*", "*Lachenalia* 1", "*Lachenalia* 2" en "*L. zebrina*" groepe. Verskeie subgroepe kan onderskei word. Die posisie van die groepe en subgroepe steun die hipotese dat x = 8 uit x = 7 ontwikkel het. Dit dui ook op die moontlikheid dat verskeie

basters in die genus bestaan, derhalwe die probleme met spesie-afbakening en die verskillende basiese chromosoomgetalle.

Die genus *Polyxena* is ingesluit in die *Lachanalia* tak. Dit dui daarop dat *Polyxena* in *Lachenalia* ingesluit moet word of dat laasgenoemde in verskeie genera onderverdeel moet word. *Polyxena* kon nuwe chromosoomgetalle tot *Lachenalia* gevoeg het deur verbastering. Die bome bevestig dat *Polyxena* die naaste verwant is aan *Lachenalia*, met *Massonia* en *Whiteheadia* as ander verwantes.

Die sitogenetiese en molekulêre data ondersteun mekaar. Die *trn*L-F streek is bruikbaar vir filogenetiese studies op genusvlak of hoër, maar meer gene moet bestudeer word om die klassifikasie en evolusie van die genus uit te klaar.

Keywords: Aneuploïdie, Chromosoomgetalle, DNA volgordebepaling, Evolusie, Filogenetiese verwantskappe, Hyacinthaceae, *Lachenalia*, Poliploïdie.

Chapter EIGHT

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Appendices

Appendix A: **Medicinal uses of some liliaceous plants in South Africa.**

Species and synonyms	Medicinal uses	References
Agapanthus africanus (L.) Hoffmanns.	As antenatal and postnatal medicine and given to baby immediately after birth. Eases difficult labour and ensure placenta is expelled	Van Wyk *et al*., 1997
Albuca canadensis (L.) Leighton syn. *A. major*	As an anthelmintic, thirst quencher and to treat venereal diseases	Watt & Breyer-Brandwijk, 1962; Hutchings, 1989
Albuca cooperi Bak.	As an anthelmintic, lotion for washing wounds and to treat venereal diseases	Watt & Breyer-Brandwijk, 1962; Hutchings, 1989
Albuca fastigata (L.f.) Dryand.	To treat illnesses caused by poisons	Hutchings *et al.*, 1996
Albuca setosa Jacq.	As an anthelmintic, lotion for washing wounds in animals and to treat venereal diseases	Jacot Guillamod, 1971; Hutchings, 1989
Albuca shawii Bak. syn. *A. trichophylla*	As an anthelmintic and to treat constipation and gonorrhoea	Watt & Breyer-Brandwijk, 1962; Jacot Guillamod, 1971; Hutchings, 1989
Aloe ferox Mill.	Laxative. Used for arthritis, eczema, conjunctivitis, hypertension and stress	Van Wyk *et al*., 1997
Aloe arborescens Mill.	Treat skin irritations, bruises and burns	Van Wyk *et al*., 1997
Anthericum sp. L.	Remedy against hysteria	Eliovson, 1967
Boophone disticha (L.f) Herb.	Applied to boils and septic wounds. Used for headaches, abdominal pain, weakness and eye conditions	Van Wyk *et al*., 1997
Bowiea volubilis Harv.	To treat oedema (dropsy), infertility in woman and headaches Also used as a purgative, a lotion for sore eyes and a remedy for ascites, sterility and bladder complaints	Watt & Breyer-Brandwijk, 1962; Batten & Bokelmann, 1966; Hutchings, 1989; Hutchings *et al.*, 1996; Van Wyk *et al.*, 1997
Bulbine natalensis Baker	Used for rheumatism, wounds, burns, rashes, itches, ringworm, cracked lips and herpes	Eliovson, 1967, Van Wyk *et al*., 1997
Clivia miniata (Lindl.) Regel	Treatment of fever. Help with childbirth. Snake-bite remedy and relieve pain	Van Wyk *et al*., 1997
Crinum macowanii Baker	Remedy for various complaints, mainly scrofula, micturition and rheumatic fever. Also used for blood cleansing, kidney and bladder diseases, glandular swelling, fever and skin problems	Van Wyk *et al*., 1997
Dipcadi brevifolium (Thunb.) Fourc.	To treat heart pains and breathlessness	Hutchings, 1989; Hutchings *et al.*, 1996
Dipcadi gracillimum Bak. syn. *D. polyphyllum*	To treat gonorrhoea and pimples	Watt & Breyer-Brandwijk, 1962
Dipcadi viride (L.) Moench	To treat gonorrhoea and flatulence	Watt & Breyer-Brandwijk, 1962; Batten & Bokelmann, 1966; Hutchings, 1989; Hutchings *et al.*, 1996
Drimia ciliaris Jacq.	As an emetic, expectorant and diuretic	Watt & Breyer-Brandwijk, 1962
Drimia elata Jacq.	To treat high blood pressure and stabbing pains	Hutchings *et al.*, 1996
Drimia nerinformis Bak.	To treat external tumours that have been lanced	Watt & Breyer-Brandwijk, 1962; Jacot Guillamod, 1971
Drimia robusta Bak. syn. *D. alta*	As an expectorant, emetic and enema to treat feverish colds. Is a diuretic and are used to clean the bladder and treat diseases of the uterus	Hutchings, 1989; Hutchings *et al.*, 1996; Van Wyk *et al.*, 1997
Eucomis autumnalis (Mill.) Chitt.	To treat colic, urinary diseases, stomach ache, fevers, flatulence, syphilis, low backache and hangovers. To assist in post-operative recovery and to aid in the healing of fractures. Also facilitate childbirth	Hutchings *et al.*, 1996; Van Wyk *et al.*, 1997
Eucomis bicolor Bak.	For colic and as a purgative	Watt & Breyer-Brandwijk, 1962; Batten & Bokelmann, 1966; Hutchings *et al.*, 1996
Eucomis comosa (Houtt.) var. *comosa* syn *E. punctata*	To treat rheumatism and teething infants	Watt & Breyer-Brandwijk, 1962; Batten & Bokelmann, 1966; Hutchings, 1989; Hutchings *et al.*,

		1996
Eucomis poleevansii N.E. Br.	For people suffering from mental disease	Watt & Breyer-Brandwijk, 1962
Eucomis regia (L.) L'Herit	To treat venereal disease, lumbago, diarrhoea, respiratory conditions especially cough and biliousness and to prevent premature childbirth	Watt & Breyer-Brandwijk, 1962
Ledebouria cooperi (Hook.f.) Jessop syn. *Scilla cooperi, S. inandensis, S. satura*	Used in the initiation ceremony of boys; to treat gastro-intestinal, gynaecological and psychological ailments	Watt & Breyer-Brandwijk, 1962; Batten & Bokelmann, 1966; Hutchings, 1989; Hutchings *et al.*, 1996
Ledebouria ovatifolia (Bak.) Jessop syn. *Scilla ovatifolia*	To treat gastro-intestinal and gynaecological ailments, backache and influenza	Hutchings, 1989; Hutchings *et al.*, 1996
Ledebouria revolute (L.f.) Jessop syn. *Scilla lanceaefolia*	For treating lumbago and gall sickness in animals; to bathe skin eruptions and as an ointment for wounds and sores	Watt & Breyer-Brandwijk, 1962; Jacot Guillamod, 1971
Massonia echinata L.f. syn *M. bowkeri*	For ophthalmic applications, sterility and toothache	Watt & Breyer-Brandwijk, 1962; Jacot Guillamod, 1971
Ornithogalum longibracteatum Jacq.	To treat swelling or growths	Hutchings, 1989; Hutchings *et al.*, 1996
Ornithogalum dubium Houtt. syn. *O. miniatum*	As an anthelmintic	Batten & Bokelmann, 1966
Ornithogalum tenuifolium Delaroche subsp. *tenuifolium* syn. *O. ecklonii* & *O. virens*	As a rat poison	Watt & Breyer-Brandwijk, 1962; Jacot Guillamod, 1971
Ornithogalum thyrsoides Jacq.	To treat diabetes mellitus	Watt & Breyer-Brandwijk, 1962
Oxalis L.	Remedy for snakebite and an antidote against other poisons	Eliovson, 1967
Scadoxus puniceus (L.) Friis & Nordal	Treat coughs and gastro-intestinal problems. Ensures save dilivery	Van Wyk *et al.*, 1997
Schizobasis intricata (Baker) Baker	To treat chest complaints	Hutchings *et al.*, 1996
Scilla natalensis Planch. syn. *S. kraussii* & *S. dracomontana*	As a purgative and to treat sprains, fractures, boils, veldsores and lung sickness in cattle. Used for female infertility and to enhance male potency and libido	Hutchings *et al.*, 1996; Van Wyk *et al.*, 1997
Scilla nervosa (Burch.) Jessop syn. *S. rigidifolia*	To treat fevers, gastro-intestinal ailments and insanity	Hutchings, 1989; Hutchings *et al.*, 1996
Urginea altissima (L.f.) Bak.	To treat rheumatic swellings, gastro-intestinal and respiratory ailments	Watt & Breyer-Brandwijk, 1962; Hutchings, 1989; Hutchings *et al.*, 1996
Urginea epigea R.A. Dyer	As a treatment for colds and headaches	Watt & Breyer-Brandwijk, 1962
Urginea macrocentra Bak.	As an anthelmintic	Hutchings *et al.*, 1996
Urginea physodes (Jacq.) Bak.	To treat gynaecological ailments and to facilitate delivery during birth	Hutchings, 1989; Hutchings *et al.*, 1996
Urginea rubella Bak.	For the treatment of colic	Watt & Breyer-Brandwijk, 1962; Jacot Guillamod, 1971
Urginea sanguinea Schinz. syn. *U. burkei*	As an abortifacient and to treat paralysis, circulatory diseases and rheumatism paina	Watt & Breyer-Brandwijk, 1962

Appendix B: **Aligned nucleotide sequences of the *trn*L-F region in the cpDNA of *Massonia* (*M.*), *Veltheimia* (*V.*), *Lachenalia* (*L.*) and *Polyxena* (*P.*). Hyphens = gaps; N = nucleotides of unknown identity. 0 and 1 is the binary values for the gaps determined by the computer program Gapcoder.**

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M. pustulata                CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
M. depressa                 CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
M. jasminiflora             NNNNNNNCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
M. echinata                 CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. isopetala                CTANCTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
V. capensis                 CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. juncifolia v.juncifolia  CTANCTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. juncifolia               CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. unifolia                 CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. zeyheri                  CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. moniliformis             NNNACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. hirta                    NNNNNNNCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. anguinea                 CTAACTTCCNNATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. giessii 1                CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. giessii 2                CTAACTTCCNNATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. pearsonii                CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. namibiensis              CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. pallida                  CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. liliflora                CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. pustulata                CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. unicolor                 CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. giletti                  CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. namaquensis              NNNNCTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. purpureo-caerulae        CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. splendida                CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. valeriae                 CTAACTTCCAAATTCAGAGAAACCCCGGAACTAAAAATGGGCAATCCTGA
L. carnosa                  CTAACTTCCAANTTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. concordiana              CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. contaminata              CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. elegans v. flava         CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. elegans v. membranacea   NNNACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. elegans v. sauveleons    NNNNNNNCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. elegans v. elegans       NTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. violacea                 NTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. verticillata             NNNNCTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGTAATCCTGA
L. salteri                  NNNNCTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. rosea                    CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. leomontana               CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. nordenstamii             CTAAC TTCCAAATTCAGAGAAACCCCGGAACTAAAAATGGGCAATCCTGA
L. orthopetala              CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. bachmanii                NNNNCTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. pusilla                  CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. barkeriana               CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. framesii                 CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. undulata                 CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. haarlemensis             CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. bowkeri                  CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. perryae                  CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. latimerae                CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. sp. nov. 3               CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. dehoopensis              CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. congesta                 CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. maximiliani              NNNNCTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. aurioliae                CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. sp. nov. 5               CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. whitehillensis           CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. obscura                  CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. schelpei                 NNNNCTTCCNNATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
P. longituba                CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
P. odorata                  NNNNNNNNNNNNNNNNNNNAAACCCTGGAACTAAAAATGGGCAATCCTGA
P. corymbosa                CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
P. calcicola*               CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
P. pauciflora               NNNNCTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
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P. ensifolia              CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. campanulata            CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. attenuata              NNNNCTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
P. maughanii              CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. sp. nov. 4             CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. mediana v. rogersii    NNNACTTCCAAATTCAGAGAAACCCTGGAACGAAAAATGGGCAATCCTGA
L. mediana v. mediana     NNNNCTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. stayneri               NNNNCTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. youngii                CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. nervosa                CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. trichophylla           CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. polypodantha           CTAACTTCCNNATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTG A
L. angelica               NTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. convallarioides        CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. neilii                 CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. alba                   CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. doleritica             CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. karooica               CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. dasybotrya             NNNNCTTCCAAATTCAGAGAAA CCCTGGAACTAAAAATGGGCAATCCTGA
L. inconspicua            CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. duncanii               CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. minima                 CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCC TGA
L. magregoriorum          CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. bolusii                CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. patula                 CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. marlothii              CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. sp. nov. 6             CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. martinae               CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. multifolia             CTAACTTCCNNATTCAGAGA AACCCAGGAACTAAAAATGGGCAATCCTGA
L. ameliae                CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. comptonii              CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. rubida                 NNNNNNTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. bulbifera              CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. variegata              CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. mathewsii              CTAACTTCCAAATTCAGAGAAACCCGGGAACTAAAAATGGGCAATCCTGA
L. lactosa                CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. viridiflora            CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. aloides v. vanzyliae   CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. algoensis              NTAACTTCCAAATTCAGA GAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. marginata sp. neglecta NNNNCTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. marginata sp. marginataCTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. mutabilis              CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. thomasiae              CTAACTTCCNAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. muirrii                CTAACTTCCNAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. orchioides             CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. capensis               CTAACTTCCNAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. sp. nov. 2             CTAACTTCCNAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. physocaulos            CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. aloides v. aurea       NTAACTTCCNNATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. aloides v. aloides     NTAACTTCCNNATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. peersii                CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. reflexa                CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. aloides v. luteola     CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. aloides v. nelsonii    CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. klinghardtiana         CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. aloides v. quadricolor CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. orchioides v.orchioidesCTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. arbuthnotiae           CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. fistulosa              CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. longibracteata/spnov1  CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. margaretea             CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. ventricosa             CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. zebrina forma zebrina  CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. buchubergensis         CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L.zebrina forma densiflora CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
L. sargeantii             CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA

M. pustulata              GCCAAATCTTAGTTTAGTTTAATAGA----CCC---TTTTTTT-GAAAAA
M. depressa               GCCAAATCTTAGTTTAGTTTAATAGA----CCC---TTTTTTT-GAAAAA
M. jasminiflora           GCCAAATCTTAGTTTAGTTTAATAGA----CCC---TTTTTTT-GAAAAA
M. echinata               GCCAAATCTTAGTTTAGTTTAATAGA----CCC---TTTTTTT-GAAAAA
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L. isopetala                GCCAAATCTTAGTT--GTTTAATAGA----CCC---TTTTTT--GAAAAA
V. capensis                 GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. juncifolia v.juncifolia  GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTTT-GAAAAA
L. juncifolia               GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. unifolia                 GCCAAATCTTAATT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. zeyheri                  GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. moniliformis             GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. hirta                    GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. anguinea                 GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. giessii 1                GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. giessii 2                GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. pearsonii                GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. namibiensis              GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. pallida                  GCCAAATCTTAGTT-----TAATAGATAGACCCC--TTTTTT--GAAAAA
L. liliflora                GCCAAATCTTAGTT-----TAATAGATAGACCCC--TTTTTT--GAAAAA
L. pustulata                GCCAAATCTTAGTT-----TAATAGATAGACCCC--TTTTTT--GAAAAA
L. unicolor                 GCCAAATCTTAGTT-----TAATAGATAGACCCC--TTTTTT--GAAAAA
L. giletti                  GCCAAATCTTAGTT-----TAATAGATAGACCCC--TTTTTT--GAAAAA
L. namaquensis              GCCAAATCTTAGTT-----TAATAGATAGACCCC--TTTTTT--GAAAAA
L. purpureo-caerulae        GCCAAATCTTAGTT-----TAATAGATAGACCCC--TTTTTT--GAAAAA
L. splendida                GCCAAATCTTAGTT-----TAATAGATAGACCCC--TTTTTT--GAAAAA
L. valeriae                 GCCAAATCTT----------ATAGATAGACCCC--TTTTTT--GAAAAA
L. carnosa                  GCCAAATCTT----------ATAGATAGACCCC--TTTTTT--GAAAAA
L. concordiana              GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. contaminata              GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. elegans v. flava         GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. elegans v. membranacea   GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. elegans v. sauveleons    GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. elegans v. elegans       GCCAA ATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. violacea                 GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. verticillata             GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. salteri                  GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. rosea                    GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. leomontana               GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. nordenstamii             GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. orthopetala              GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. bachmanii                GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. pusilla                  GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. barkeriana               GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTT---GAAAAA
L. framesii                 GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. undulata                 GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. haarlemensis             GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. bowkeri                  GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. perryae                  GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. latimerae                GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. sp. nov. 3               GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. dehoopensis              GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. congesta                 GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. maximiliani              GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. aurioliae                GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. sp. nov. 5               GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. whitehillensis           GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. obscura                  GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. schelpei                 GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
P. longituba                GCCAAATCTTAGTT-----TAATAGA----CCCCC-TTTTTTTTGAAAAA
P. odorata                  GCCAAATCTTAGTT-----TAATAGA----CCCCC-TTTTT---GAAAAA
P. corymbosa                GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
P. calcicola*               GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
P. pauciflora               GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
P. ensifolia                GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. campanulata              GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. attenuata                GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
P. maughanii                GCCAAATCTTAGTT-----TAATAGA----CCCCC-TTTTT---GAAAAA
L. sp. nov. 4               GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. mediana v. rogersii      GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAA A
L. mediana v. mediana       GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. stayneri                 GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. youngii                  GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. nervosa                  GCCAAATCTTAGTT-----TAATAGA----CCCCAGTTTTTT--GAAAAA
L. trichophylla             GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. polypodantha             GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
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L. angelica                GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. convallarioides         GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. neilii                  GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. alba                    GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. doleritica              GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. karooica                GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. dasybotrya              GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. inconspicua             GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. duncanii                GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. minima                  GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. magregoriorum           GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. bolusii                 GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. patula                  GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. marlothii               GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. sp. nov. 6              GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. martinae                GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. multifolia              GCCAAATCTT--TT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. ameliae                 GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. comptonii               GCCAAATCTTAGTT-----TAATAGA----CCCC--NTTTTT--GAAAAA
L. rubida                  GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. bulbifera               GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. variegata               GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. mathewsii               GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. lactosa                 GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. viridiflora             GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. aloides v. vanzyliae    GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. algoensis               GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. marginata sp. neglecta  GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. marginata sp. marginata GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. mutabilis               GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. thomasiae               GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. muirrii                 GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. orchioides              GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. capensis                GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. sp. nov. 2              GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. physocaulos             GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. aloides v. aurea        GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. aloides v. aloides      GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. peersii                 GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. reflexa                 GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. aloides v. luteola      GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. aloides v. nelsonii     GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. klinghardtiana          GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. aloides v. quadricolor  GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. orchioides v.orchioides GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. arbuthnotiae            GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. fistulosa               GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. longibracteata/spnov1   GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. margaretea              GCCAAATCTTAGTT-----TAATAGA----CCCC--TTTTTT--GAAAAA
L. ventricosa              GCCAAATCTTAGTT-----TAATAGA----CCC---TTTTTTT-GAAAAA
L. zebrina forma zebrina   GCCAAATCTTAGTT-----TAATAGA----CCC---TTTTTTN-GAAAAA
L. buchubergensis          GCCAAATCTTAGTT-----TAATAGA----CCC---TTTTTTT-GAAAAA
L.zebrina forma densiflora GCCAAATCTTAGTT-----TAATAGA----CCC---TTTTTTN-GAAAAA
L. sargeantii              GCCAAATCTTAGTT-----TAATAGA----CCC---TTTTTTT-GAAAAA

M. pustulata               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
M. depressa                CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
M. jasminiflora            CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
M. echinata                CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. isopetala               CTGATTAATCGAACGAGAATCGAGAATAAAGAGAGAGTCCCGTTCTACAT
V. capensis                CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. juncifolia v.juncifolia CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. juncifolia              CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. unifolia                CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. zeyheri                 CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. moniliformis            CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. hirta                   CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. anguinea                CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. giessii 1               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. giessii 2               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. pearsonii               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
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L. namibiensis            CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. pallida                CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. liliflora              CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. pustulata              CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. unicolor               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. giletti                CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. namaquensis            CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. purpureo-caerulae      CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. splendida              CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. valeriae               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. carnosa                CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. concordiana            CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. contaminata            CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. elegans v. flava       CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. elegans v. membranacea CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. elegans v. sauveleons  CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. elegans v. elegans     CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. violacea               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. verticillata           CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. salteri                CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. rosea                  CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. leomontana             CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. nordenstamii           CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. orthopetala            CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. bachmanii              CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. pusilla                CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. barkeriana             CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. framesii               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. undulata               CTAATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. haarlemensis           CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. bowkeri                CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. perryae                CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. latimerae              CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. sp. nov. 3             CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. dehoopensis            CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. congesta               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. maximiliani            CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. aurioliae              CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. sp. nov. 5             CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. whitehillensis         CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. obscura                CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. schelpei               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
P. longituba              CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
P. odorata                CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
P. corymbosa              CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
P. calcicola*             CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
P. pauciflora             CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
P. ensifolia              CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. campanulata            CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. attenuata              CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
P. maughanii              CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. sp. nov. 4             CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. mediana v. rogersii    CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. mediana v. mediana     CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTTTACAT
L. stayneri               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. youngii                CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. nervosa                CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. trichophylla           CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. polypodantha           CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. angelica               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. convallarioides        CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. neilii                 CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. alba                   CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. doleritica             CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. karooica               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. dasybotrya             CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. inconspicua            CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. duncanii               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. minima                 CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. magregoriorum          CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. bolusii                CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
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L. patula                  CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. marlothii               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. sp. nov. 6              CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. martinae                CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. multifolia              CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. ameliae                 CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. comptonii               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. rubida                  CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. bulbifera               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. variegata               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. mathewsii               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. lactosa                 CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. viridiflora             CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. aloides v. vanzyliae    CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. algoensis               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. marginata sp. neglecta  CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. marginata sp. marginata CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. mutabilis               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. thomasiae               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. muirrii                 CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. orchioides              CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. capensis                CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. sp. nov. 2              CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. physocaulos             CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. aloides v. aurea        CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. aloides v. aloides      CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCTGTTCTACAT
L. peersii                 CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. reflexa                 CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCTGTTCTACAT
L. aloides v. luteola      CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. aloides v. nelsonii     CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. klinghardtiana          CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. aloides v. quadricolor  CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. orchioides v.orchioides CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. arbuthnotiae            CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. fistulosa               CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. longibracteata/spnov1   CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. margaretea              CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. ventricosa              CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. zebrina forma zebrina   CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. buchubergensis          CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L.zebrina forma densiflora CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT
L. sargeantii              CTGATTAATCG---GA----CGAGAATAAAGAGAGAGTCCCGTTCTACAT

M. pustulata               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
M. depressa                GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
M. jasminiflora            GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
M. echinata                GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. isopetala               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
V. capensis                GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. juncifolia v.juncifolia GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. juncifolia              GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. unifolia                GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. zeyheri                 GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. moniliformis            GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. hirta                   GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. anguinea                GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. giessii 1               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. giessii 2               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. pearsonii               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. namibiensis             GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. pallida                 GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. liliflora               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. pustulata               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. unicolor                GTCAA TACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. giletti                 GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. namaquensis             GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. purpureo-caerulae       GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. splendida               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. valeriae                GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. carnosa                 GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. concordiana             GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
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L. contaminata            GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. elegans v. flava       GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. elegans v. membranacea GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. elegans v. sauveleons  GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. elegans v. elegans     GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. violacea               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. verticillata           GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. salteri                GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. rosea                  GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. leomontana             GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. nordenstamii           GTCAATACCGACAACAATGAAATTTATAGTAAGAGNAAAATCCGTCGACT
L. orthopetala            GTCAATACCGACAACAATGAANTTTATAGTAAGAGGAAAATCCGTCGACT
L. bachmanii              GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. pusilla                GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. barkeriana             GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. framesii               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. undulata               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. haarlemensis           GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. bowkeri                GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. perryae                GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. latimerae              GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. sp. nov. 3             GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. dehoopensis            GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. congesta               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. maximiliani            GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. aurioliae              GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. sp. nov. 5             GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. whitehillensis         GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. obscura                GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGAC T
L. schelpei               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
P. longituba              GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
P. odorata                GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
P. corymbosa              GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
P. calcicola*             GTCAATACCGACAACAATGAAATTTATAGTAAGAGGA------------
P. pauciflora             GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
P. ensifolia              GTCAATACCGACAACAATGAAA TTTATAGTAAGAGGAAAATCCGTCGACT
L. campanulata            GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. attenuata              GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
P. maughanii              GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCG ACT
L. sp. nov. 4             GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. mediana v. rogersii    GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. mediana v. mediana     GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. stayneri               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. youngii                GTCAATACCGACAACAATGAAATTTAGAGTAAGAGGAAAATCCGTCGACT
L. nervosa                GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. trichophylla           GTCAATACCGACAACAATGA AATTTATAGTAAGAGGAAAATCCGTCGACT
L. polypodantha           GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. angelica               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. convallarioides        GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. neilii                 GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. alba                   GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. doleritica             GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. karooica               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. dasybotrya             GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. inconspicua            GTCAATACCGACACCAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. duncanii               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. minima                 GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. magregoriorum          GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. bolusii                GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. patula                 GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. marlothii              GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. sp. nov. 6             GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. martinae               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. multifolia             GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. ameliae                GTCAATATCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. comptonii              GTCAATATCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. rubida                 GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. bulbifera              GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. variegata              GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. mathewsii              GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. lactosa                GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
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L. viridiflora              GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. aloides v. vanzyliae     GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. algoensis                GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. marginata sp. neglecta   GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. marginata sp. marginata  GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. mutabilis                GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. thomasiae                GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. muirrii                  GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. orchioides               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. capensis                 GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. sp. nov. 2               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. physocaulos              GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. aloides v. aurea         GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. aloides v. aloides       GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. peersii                  GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. reflexa                  GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. aloides v. luteola       GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. aloides v. nelsonii      GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. klinghardtiana           GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. aloides v. quadricolor   GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. orchioides v.orchioides  GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. arbuthnotiae             GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. fistulosa                GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. longibracteata/spnov1    GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. margaretea               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. ventricosa               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. zebrina forma zebrina    GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. buchubergensis           GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L.zebrina forma densiflora  GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
L. sargeantii               GTCAATACCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT

M. pustulata                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAATAAACTGTCCCCA
M. depressa                 TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAATAAACTGTCCCCA
M. jasminiflora             TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAATAAACTGTCCCCA
M. echinata                 TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAATAAACTGTCCCCA
L. isopetala                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
V. capensis                 TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAATAAACTGTCCCCA
L. juncifolia v.juncifolia  TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. juncifolia               TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. unifolia                 TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. zeyheri                  TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. moniliformis             TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. hirta                    TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. anguinea                 TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. giessii 1                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. giessii 2                TTAGA AATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. pearsonii                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. namibiensis              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. pallida                  TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. liliflora                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. pustulata                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. unicolor                 TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. giletti                  TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. namaquensis              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. purpureo-caerulae        TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. splendida                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. valeriae                 TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. carnosa                  TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. concordiana              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. contaminata              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. elegans v. flava         TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. elegans v. membranacea   TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. elegans v. sauveleons    TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. elegans v. elegans       TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. violacea                 TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. verticillata             TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. salteri                  TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. rosea                    TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. leomontana               TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. nordenstamii             TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. orthopetala              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
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L. bachmanii              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. pusilla                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. barkeriana             TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. framesii               TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. undulata               TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. haarlemensis           TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. bowkeri                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. perryae                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. latimerae              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. sp. nov. 3             TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. dehoopensis            TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. congesta               TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. maximiliani            TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. aurioliae              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. sp. nov. 5             TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. whitehillensis         TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. obscura                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. schelpei               TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
P. longituba              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
P. odorata                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
P. corymbosa              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
P. calcicola*             --------------------------------------------------
P. pauciflora             TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
P. ensifolia              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. campanulata            TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. attenuata              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
P. maughanii              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. sp. nov. 4             TTAGAAATCGTGAGGGTTCA AGTCCCTCTATCCCC----------A
L. mediana v. rogersii    TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. mediana v. mediana     TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. stayneri               TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. youngii                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. nervosa                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. trichophylla           TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. polypodantha           TTATAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. angelica               TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. convallarioides        TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. neilii                 TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. alba                   TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. doleritica             TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. karooica               TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. dasybotrya             TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. inconspicua            TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. duncanii               TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. minima                 TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. magregoriorum          TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. bolusii                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. patula                 TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. marlothii              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. sp. nov. 6             TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. martinae               TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. multifolia             TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. ameliae                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. comptonii              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. rubida                 TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. bulbifera              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. variegata              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. mathewsii              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. lactosa                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. viridiflora            TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. aloides v. vanzyliae   TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. algoensis              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. marginata sp. neglecta TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. marginata sp. marginataTTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. mutabilis              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. thomasiae              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. muirrii                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. orchioides             TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. capensis               TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. sp. nov. 2             TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. physocaulos            TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
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L. aloides v. aurea          TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. aloides v. aloides        TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. peersii                   TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. reflexa                   TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. aloides v. luteola        TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. aloides v. nelsonii       TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. klinghardtiana            TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. aloides v. quadricolor    TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. orchioides v.orchioides   TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. arbuthnotiae              TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. fistulosa                 TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. longibracteata/spnov1     TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. margaretea                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. ventricosa                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. zebrina forma zebrina     TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. buchubergensis            TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L.zebrina forma densiflora   TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A
L. sargeantii                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCC----------A

M. pustulata                 ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCTTCC-
M. depressa                  ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCTTCC-
M. jasminiflora              ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCTTCC-
M. echinata                  ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCTTCC-
L. isopetala                 ATAAAAA-----GCCCATTTGACTTCTTAACTAT------TTATCCTCC-
V. capensis                  ATAAAAA-----GCCCATTTGACTTCTTAACTAT------TTATCCTCN-
L. juncifolia v.juncifolia   ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. juncifolia                ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. unifolia                  ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. zeyheri                   ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. moniliformis              ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCTC
L. hirta                     ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. anguinea                  ATAAAAA-----GACCATTTGACTT-----CTAT------TTATCCTCCC
L. giessii 1                 ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. giessii 2                 ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. pearsonii                 ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. namibiensis               ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. pallida                   ATAAAAA-----GATTATTTGACTTCTTAACTAT------CTATCCTCCC
L. liliflora                 ATAAAAA-----GATNATTTGACTTCTTAACTAT------CTATCCTCCC
L. pustulata                 ATAAAAA-----GATTATTTGACTTCTTAACTAT------CTATCCTCCC
L. unicolor                  ATAAAAA-----GATTATTTGACTTCTTAACTAT------CTATCCTCCC
L. giletti                   ATAAAAA-----GATTATTTGACTTCTTAACTAT------CTATCCTCCC
L. namaquensis               ATAAAAA-----GATTATTTGACTTCTTAACTAT------CTATCCTCCC
L. purpureo-caerulae         ATAAAAA-----GATTATTTGACTTCTTAACTAT------CTATCCTCCC
L. splendida                 ATAAAAA-----GATTATTTGACTTCTTAACTAT------CTATCCTCCC
L. valeriae                  ATAAAAA-----GATTATTTGACTTCTTAACTAT------CTATCCTCCC
L. carnosa                   ATAAAAA-----GATTATTTGACTTCTTAACTAT------CTATCCTCCC
L. concordiana               ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. contaminata               ATAAAAA-----GATCATTTGACTTCTTAACTAT------CTATCCTCCC
L. elegans v. flava          ATAAAAA-----GATCATTTGACTTCTTAACTATTTATCTTTATCCTCCC
L. elegans v. membranacea    ATAAAAA-----GATCATTTGACTTCTTAACTATTTATCTTTATCCTCCC
L. elegans v. sauveleons     ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. elegans v. elegans        ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. violacea                  ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. verticillata              ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. salteri                   ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. rosea                     ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. leomontana                ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. nordenstamii              ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. orthopetala               ATAAAAA-----GATCATTTGACTTCTTAACTAT------CTATCCTCCC
L. bachmanii                 ATAAAAA-----GATCATTTGACTTCTTAACTAT------CTATCCTCCC
L. pusilla                   ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. barkeriana                ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. framesii                  ATAAAAA-----GATCATTTGACTTCTTAACTAT------CTATCCTCCC
L. undulata                  ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. haarlemensis              ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. bowkeri                   ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. perryae                   ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. latimerae                 ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. sp. nov. 3                ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. dehoopensis               ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. congesta                  ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCTC
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L. maximiliani             ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. aurioliae               ATAAAAN-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. sp. nov. 5              ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. whitehillensis          ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. obscura                 ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. schelpei                ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
P. longituba               ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCTC
P. odorata                 ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCTC
P. corymbosa               ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCTC
P. calcicola*              -TAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCTC
P. pauciflora              ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCTC
P. ensifolia               ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCTC
L. campanulata             ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCTC
L. attenuata               ATAAAAA-----GACCATTTGACTTNTTAACTAT------TTATCCTCCC
P. maughanii               ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCTC
L. sp. nov. 4              ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. mediana v. rogersii     ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. mediana v. mediana      ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. stayneri                ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. youngii                 ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. nervosa                 ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. trichophylla            ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. polypodantha            ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. angelica                ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. convallarioides         ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. neilii                  ATAAAAA-----GNCCATTTGACTTCTTAACTAT------TTATCCTCCC
L. alba                    ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. doleritica              ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. karooica                ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. dasybotrya              ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. inconspicua             ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. duncanii                ATAAAAA-----GACCATTTGACTT-----CTAT------TTATCCTCCC
L. minima                  ATAAAAA-----GACCATTTGACTT-----CTAT------TTATCCTCCC
L. magregoriorum           ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCTC
L. bolusii                 ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. patula                  ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. marlothii               ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. sp. nov. 6              ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC
L. martinae                ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCCC

L. multifolia              ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCTC
L. ameliae                 ATAAAAA-----GACTATTTGACTTCTTAACTAT------TTATCCTCCC
L. comptonii               ATAAAAA-----GACTATTTGACTTCTTAACTAT------TTATCCTCCC
L. rubida                  ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. bulbifera               ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. variegata               ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. mathewsii               ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. lactosa                 ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. viridiflora             ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. aloides v. vanzyliae    ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. algoensis               ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. marginata sp. neglecta  ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. marginata sp. marginata ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. mutabilis               ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. thomasiae               ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. muirrii                 ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. orchioides              ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. capensis                ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. sp. nov. 2              ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. physocaulos             ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTCTCCTCCC
L. aloides v. aurea        ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. aloides v. aloides      ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. peersii                 ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. reflexa                 ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. aloides v. luteola      ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. aloides v. nelsonii     ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. klinghardtiana          ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. aloides v. quadricolor  ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. orchioides v.orchioides ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. arbuthnotiae            ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. fistulosa               ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
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L. longibracteata/spnov1  ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. margaretea             ATAAAAA-----GATCATTTGACTTCTTAACTAT------TTATCCTCCC
L. ventricosa             ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCC-
L. zebrina forma zebrina  ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCC-
L. buchubergensis         ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCC-
L.zebrina forma densiflora ATAAAAA-----GACCATTTGACTTCTTAACTAT------TTATCCTCC-
L. sargeantii             ATAAAAAAAAAAGACCATTTGACTTCTTAACTAT------TTATCCTCC-

M. pustulata              ---TTTTTTTT---CGTAAGTGGTTCAAATAAATTC-----AATATCTTT
M. depressa               ---TTTTTTTT---CGTAAGTGGTTCAAATAAATTC-----AATATCTTT
M. jasminiflora           ---TTTTTTTT---CGTAAGTGGTTCAAATAAATTC-----AATATCTTT
M. echinata               ---TTTTTTTT---CGTAAGTGGTTCAAATAAATTC-----AATATCTTT
L. isopetala              ---TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATAT----
V. capensis               ---TTTTTTTTTTTCGTAAGCGGTTTAAATAAATTC-----AATATCTTT
L. juncifolia v.juncifolia C--TTTTTTTTTT-CGTAAGCGGTTCAG-----TTC----AAATATCTTT
L. juncifolia             C--TTTTTTTTTT-CGTAAGCGGTTCAG-----TTC----AAATATCTTT
L. unifolia               CCCTTTTTTTTT--CGTAAGCGGTTCAG-----TTC----AAATATCTTT
L. zeyheri                CC-TTTTTTT----CGTAAGCGGTTCAG-----TTC----AAATATCTTT
L. moniliformis           CCCTTTTTTTT---CGTAAGCGGTTCAG-----TTC----AAATATCTTT
L. hirta                  C--TTTTTTTT---CGTAAGCGGTTCAG-----TTCAAATAAATATCTTT
L. anguinea               C--TTTTTTTTT-CGTAAGCGGTTCAG-----TTCAAATAAATATCTTT
L. giessii 1              ---TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. giessii 2              ---TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. pearsonii              ---TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. namibiensis            ---TTTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. pallida                C--TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. liliflora              C--TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. pustulata              C--TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. unicolor               C--TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. giletti                C--TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. namaquensis            C--TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. purpureo-caerulae      C--TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. splendida              C--TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. valeriae               CC-TTTTTTT----CGTAAGCGGTT CAAATAAATTC-----AATATCTTT
L. carnosa                C--TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. concordiana            C--TTTTTTTTTT-CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. contaminata            ---TTTTTTTTTTCGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. elegans v. flava       ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. elegans v. membranacea ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. elegans v. sauveleons  ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. elegans v. elegans     ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. violacea               ---TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. verticillata           ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. salteri                N--TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. rosea                  ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. leomontana             ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. nordenstamii           C--TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. orthopetala            ---TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. bachmanii              ---TTTTTTTTTT-CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. pusilla                ---TTTTTTTTT-CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. barkeriana             ---TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. framesii               ---TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. undulata               ---TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. haarlemensis           C--TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. bowkeri                C--TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. perryae                ---TTTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. latimerae              ---TTTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. sp. nov. 3             ---TTTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. dehoopensis            ---TTTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. congesta               ---TTTTTTTT---CGTAAGCGGTTCAAA----TTC-----AATATCTTT
L. maximiliani            ---TTTTTTTTT-CGTAAGCGGTTCAAA----TTC-----AATATCTTT
L. aurioliae              CC-TTTTTT-----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. sp. nov. 5             ---TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. whitehillensis         ---TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. obscura                ---TTTTTTTTT--AGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. schelpei               ---TTTTTTTTT-CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
P. longituba              ---TTTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
P. odorata                ---TTTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
P. corymbosa              ---TTTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
P. calcicola*             ---TTTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
P. pauciflora             ---TTTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
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P. ensifolia              ---TTTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. campanulata            ---TTTTTTTTTTTCGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. attenuata              N--TTTTTTTTTT-CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
P. maughanii              ---TTTTTTTTTTTCGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. sp. nov. 4             ---TTTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. mediana v. rogersii    C--TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AACCGCTTT
L. mediana v. mediana     C--TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AACCGCTTT
L. stayneri               C--TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. youngii                C--TTTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. nervosa                C--TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. trichophylla           ---TTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. polypodantha           ---TTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. angelica               C--TTTTTTTTT-CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. convallarioides        ---TTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. neilii                 ---TTTTTTTTT-CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. alba                   ---TTTTTTTTT-CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. doleritica             ---TTTTTTTTTTCGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. karooica               C--TTTTTTTTT-CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. dasybotrya             ---TTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. inconspicua            ---TTTTTTTTT-CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. duncanii               C--TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. minima                 C--TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. magregoriorum          ---TTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. bolusii                C--TTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. patula                 ---TTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. marlothii              ---TTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. sp. nov. 6             ---TTTTTTTTT-CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. martinae               CC-TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. multifolia             ---TTTTTTTTT-CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. ameliae                ---TTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. comptonii              C--TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. rubida                 ---TTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. bulbifera              ---TTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. variegata              ---TTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. mathewsii              ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. lactosa                ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. viridiflora            ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. aloides v. vanzyliae   ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. algoensis              ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. marginata sp. neglecta ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. marginata sp. marginata---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. mutabilis              ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. thomasiae              ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. muirrii                ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. orchioides             ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. capensis               ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. sp. nov. 2             ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. physocaulos            ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. aloides v. aurea       ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. aloides v. aloides     ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. peersii                ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. reflexa                ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. aloides v. luteola     ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. aloides v. nelsonii    ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. klinghardtiana         ---TTTTTTTT---CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. aloides v. quadricolor ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. orchioides v.orchioides---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. arbuthnotiae           ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. fistulosa              ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. longibracteata/spnov1  ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. margaretea             ---TTTTTTT----CGTAAGCGGTTCAAA----TTC-----AATATCTTT
L. ventricosa             ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. zebrina forma zebrina  ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. buchubergensis         ---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L.zebrina forma densiflora---TTTTTTT----CGTAAGCGGTTCAAATAAATTC-----AATATCTTT
L. sargeantii             ---TTTTTTTTT--CGTAAGCGGTTCAAATAAATTC-----AATATCTTT

M. pustulata              CTCATTCATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
M. depressa               CTCATTCATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
M. jasminiflora           CTCATTCATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
M. echinata               CTCATTCATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
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L. isopetala                --------------------------------------------------
V. capensis                 CTCATTCATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. juncifolia v.juncifolia  CTCATTCATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTG---
L. juncifolia               CTCATTCATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTG---
L. unifolia                 CTCATTCATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTG---
L. zeyheri                  CTCATTCATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCCTTG---
L. moniliformis             CTCATTCATTATACTCTTTC----ATAGATCCGGGCAGAAATCTTTG---
L. hirta                    CTCATTCATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTG---
L. anguinea                 CTCATTCATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTG---
L. giessii 1                CTCATTCATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTG---
L. giessii 2                CTCATTCATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTG---
L. pearsonii                CTCATTCATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTG---
L. namibiensis              CTCATTCATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTG---
L. pallida                  CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. liliflora                CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. pustulata                CT----CATTATACTCTTTCGCAAA TAGATCCGGGCAGAAATCTTTGGAT
L. unicolor                 CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. giletti                  CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. namaquensis              CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. purpureo-caerulae        CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. splendida                CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. valeriae                 CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. carnosa                  CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. concordiana              CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. contaminata              CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. elegans v. flava         CT----CACTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. elegans v. membranacea   CT----CACTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. elegans v. sauveleons    CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. elegans v. elegans       CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. violacea                 CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. verticillata             CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. salteri                  CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. rosea                    CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. leomontana               CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. nordenstamii             CT----CATTATACTCTTTCGCCAATAGATCCGGGCAGAAATCTTTGGAT
L. orthopetala              CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. bachmanii                CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. pusilla                  CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. barkeriana               CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. framesii                 CT----CATTATACTCTTTCGCAAATAGATCCGGGCATAAATCTTTGGAT
L. undulata                 CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. haarlemensis             CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. bowkeri                  CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. perryae                  CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. latimerae                CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. sp. nov. 3               CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. dehoopensis              CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. congesta                 CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. maximiliani              CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. aurioliae                CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. sp. nov. 5               CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. whitehillensis           CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. obscura                  CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. schelpei                 CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
P. longituba                CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
P. odorata                  CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
P. corymbosa                CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
P. calcicola*               CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
P. pauciflora               CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
P. ensifolia                CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. campanulata              CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. attenuata                CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
P. maughanii                CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. sp. nov. 4               CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. mediana v. rogersii      CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. mediana v. mediana       CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. stayneri                 CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. youngii                  CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. nervosa                  CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. trichophylla             CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. polypodantha             CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
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L. angelica                CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. convallarioides         CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. neilii                  CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. alba                    CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. doleritica              CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. karooica                CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. dasybotrya              CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. inconspicua             CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. duncanii                CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. minima                  CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. magregoriorum           CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. bolusii                 CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. patula                  CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. marlothii               CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. sp. nov. 6              CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. martinae                CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. multifolia              CT----CATTATACTCTTTCACAAATAGATCCGGGCAGAAATCCTTGGAT
L. ameliae                 CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. comptonii               CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. rubida                  CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. bulbifera               CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. variegata               CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. mathewsii               CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. lactosa                 CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. viridiflora             CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. aloides v. vanzyliae    CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. algoensis               CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. marginata sp. neglecta  CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. marginata sp. marginata CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. mutabilis               CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. thomasiae               CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. muirrii                 CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. orchioides              CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. capensis                CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. sp. nov. 2              CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. physocaulos             CT--------ATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. aloides v. aurea        CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. aloides v. aloides      CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. peersii                 CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. reflexa                 CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. aloides v. luteola      CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. aloides v. nelsonii     CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. klinghardtiana          CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. aloides v. quadricolor  CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. orchioides v.orchioides CT---CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. arbuthnotiae            CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. fistulosa               CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. longibracteata/spnov1   CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. margaretea              CT----CATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. ventricosa              CTCATTCATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. zebrina forma zebrina   CTCATTCATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. buchubergensis          CTCATTCATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L.zebrina forma densiflora CTCATTCATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT
L. sargeantii              CTCATTCATTATACTCTTTCGCAAATAGATCCGGGCAGAAATCTTTGGAT

M. pustulata               CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
M. depressa                CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
M. jasminiflora            CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
M. echinata                CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. isopetala               ----------------------TAGGTTTGA---ATAGATAC-----CTGTA
V. capensis                CTTATCC-----CTATTAATTAGGTTTGA---ATAGATACGATACCTGTA
L. juncifolia v.juncifolia -TTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. juncifolia              -TTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. unifolia                -TTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. zeyheri                 -TTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. moniliformis            -TTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. hirta                   -TTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. anguinea                -TTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. giessii 1               -TTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. giessii 2               -TTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
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L. pearsonii              -TTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. namibiensis            -TTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. pallida                CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. liliflora              CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. pustulata              CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. unicolor               CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. giletti                CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. namaquensis            CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. purpureo-caerulae      CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. splendida              CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. valeriae               CTTATCC-----CTAT--------TTTGA---ATAGATAC-----CTGTA
L. carnosa                CTTATCC-----CTAT--------TTTGA---ATAGATAC-----CTGTA
L. concordiana            CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. contaminata            CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. elegans v. flava       CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. elegans v. membranacea CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. elegans v. sauveleons  CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. elegans v. elegans     CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. violacea               CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. verticillata           CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. salteri                CTTATCC-ATCCCTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. rosea                  CTTATCC-ATCCCTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. leomontana             CTTATCC-ATCCCTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. nordenstamii           CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. orthopetala            CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. bachmanii              CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. pusilla                CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. barkeriana             CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. framesii               CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. undulata               CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. haarlemensis           CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. bowkeri                CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. perryae                CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. latimerae              CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. sp. nov. 3             CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. dehoopensis            CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. congesta               CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. maximiliani            CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. aurioliae              CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. sp. nov. 5             CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. whitehillensis         CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. obscura                CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. schelpei               CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
P. longituba              CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
P. odorata                CTTATCC-----CTAT----TAGGTTTGATGAATAGATAC-----CTGTA
P. corymbosa              CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
P. calcicola*             CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
P. pauciflora             CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
P. ensifolia              CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. campanulata            CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. attenuata              CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
P. maughanii              CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. sp. nov. 4             CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. mediana v. rogersii    CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. mediana v. mediana     CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. stayneri               CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. youngii                CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. nervosa                CTTATCC-----CTA-------GGTTTGA---ATAGATAC-----CTGTA
L. trichophylla           CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. polypodantha           CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. angelica               CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. convallarioides        CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC------TGTA
L. neilii                 CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. alba                   CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. doleritica             CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. karooica               CTTATCC-ATCCCTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. dasybotrya             CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. inconspicua            CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. duncanii               CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. minima                 CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. magregoriorum          CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
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L. bolusii                CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. patula                 CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. marlothii              CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. sp. nov. 6             CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. martinae               CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. multifolia             CTTATCT-ATCCCTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. ameliae                CTTATCC-----CTATTTATTAGGTTTGA---ATAGATAC-----CTGTA
L. comptonii              CTTATCC-----CTAT----TAGGTTTGA---ATAAATAC-----CTGTA
L. rubida                 CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. bulbifera              CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. variegata              CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. mathewsii              CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. lactosa                CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. viridiflora            CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. aloides v. vanzyliae   CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. algoensis              CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. marginata sp. neglecta CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. marginata sp. marginataCTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. mutabilis              CTTATCCTATCCCTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. thomasiae              CTTATCCTATCCCTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. muirrii                CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. orchioides             CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. capensis               CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. sp. nov. 2             CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. physocaulos            CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. aloides v. aurea       CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. aloides v. aloides     CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. peersii                CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. reflexa                CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. aloides v. luteola     CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. aloides v. nelsonii    CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. klinghardtiana         CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. aloides v. quadricolor CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. orchioides v.orchioidesCTTATTC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. arbuthnotiae           CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. fistulosa              CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. longibracteata/spnov1  CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. margaretea             CTTATCCTATCCCTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. ventricosa             CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. zebrina forma zebrina  CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. buchubergensis         CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L.zebrina forma densiflora CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA
L. sargeantii             CTTATCC-----CTAT----TAGGTTTGA---ATAGATAC-----CTGTA

M. pustulata              CAAATG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
M. depressa               CAAATG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
M. jasminiflora           CAAATG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
M. echinata               CAAATG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. isopetala              CAAATG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
V. capensis               CAAATG-----AACAGGT----ATGGTCAAGGAATTCCCATTATTGAATT
L. juncifolia v.juncifoliaCAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. juncifolia             CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. unifolia               CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. zeyheri                CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. moniliformis           CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. hirta                  CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. anguinea               CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. giessii 1              CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. giessii 2              CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. pearsonii              CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. namibiensis            CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. pallida                CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. liliflora              CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. pustulata              CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. unicolor               CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. giletti                CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. namaquensis            CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. purpureo-caerulae      CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. splendida              CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. valeriae               CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. carnosa                CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
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L. concordiana             CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. contaminata             CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. elegans v. flava        CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. elegans v. membranacea  CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. elegans v. sauveleons   CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. elegans v. elegans      CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. violacea                CAAACG-----AACATAT----ATGGCCAAGGAATTCCCATTATTGAATT
L. verticillata            CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. salteri                 CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. rosea                   CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. leomontana              CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. nordenstamii            CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. orthopetala             CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. bachmanii               CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. pusilla                 CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. barkeriana              CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. framesii                CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. undulata                CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. haarlemensis            CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. bowkeri                 CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. perryae                 CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. latimerae               CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. sp. nov. 3              CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. dehoopensis             CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. congesta                CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. maximiliani             CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. aurioliae               CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. sp. nov. 5              CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. whitehillensis          CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. obscura                 CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. schelpei                CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
P. longituba               CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
P. odorata                 CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
P. corymbosa               CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
P. calcicola*              CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
P. pauciflora              CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
P. ensifolia               CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. campanulata             CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. attenuata               CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
P. maughanii               CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. sp. nov. 4              CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. mediana v. rogersii     CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAA--
L. mediana v. mediana      CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. stayneri                CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. youngii                 CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. nervosa                 CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. trichophylla            CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. polypodantha            CAAACG-----AACATATATATATGGTCAAGGAATTCCCATTATTGAATT
L. angelica                CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. convallarioides         CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. neilii                  CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. alba                    CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. doleritica              CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. karooica                CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. dasybotrya              CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. inconspicua             CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. duncanii                CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. minima                  CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. magregoriorum           CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. bolusii                 CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. patula                  CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. marlothii               CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. sp. nov. 6              CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. martinae                CAAACA-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. multifolia              CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. ameliae                 CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. comptonii               CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. rubida                  CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. bulbifera               CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. variegata               CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. mathewsii               CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
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L. lactosa                  CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. viridiflora              CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. aloides v. vanzyliae     CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. algoensis                CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. marginata sp. neglecta   CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. marginata sp. marginata  CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. mutabilis                CAAACG-----AACATAT---TATGGTCAAGGAATTCCCATTATTGAATT
L. thomasiae                CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. muirrii                  CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. orchioides               CAAAC G-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. capensis                 CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. sp. nov. 2               CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. physocaulos              CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. aloides v. aurea         CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. aloides v. aloides       CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. peersii                  CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. reflexa                  CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. aloides v. luteola       CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. aloides v. nelsonii      CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. klinghardtiana           CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. aloides v. quadricolor   CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. orchioides v.orchioides  CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. arbuthnotiae             CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. fistulosa                CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. longibracteata/spnov1    CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. margaretea               CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. ventricosa               CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. zebrina forma zebrina    CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. buchubergensis           CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L.zebrina forma densiflora  CAAACG-----AACATAT----ATGGTCAAGGAATTCCCATTATTGAATT
L. sargeantii               CAAACGAACATAACATAT----ATGGTCAAGGAATTCCCATTATTGAATT

M. pustulata                ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
M. depressa                 ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
M. jasminiflora             ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
M. echinata                 ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. isopetala                ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAA-GTCT
V. capensis                 ATTCACAGCCCATA-CCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. juncifolia v.juncifolia  ATTCACAACCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. juncifolia               ATTCACAACCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. unifolia                 ATTCAC----CATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. zeyheri                  ATTCACAACCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. moniliformis             ATTCACAACCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. hirta                    ATTCACAACCCGTA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. anguinea                 ATTCACAACCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. giessii 1                ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. giessii 2                ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. pearsonii                ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. namibiensis              ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. pallida                  ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. liliflora                ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. pustulata                ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. unicolor                 ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. giletti                  ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. namaquensis              ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. purpureo-caerulae        ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. splendida                ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. valeriae                 ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. carnosa                  ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. concordiana              ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAA-GTCT
L. contaminata              ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. elegans v. flava         ATTCACAGCCCATAATCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. elegans v. membranacea   ATTCACAGCCCATAATCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. elegans v. sauveleons    ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. elegans v. elegans       ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. violacea                 ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. verticillata             ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. salteri                  ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. rosea                    ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. leomontana               ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
L. nordenstamii             ATTCACAGCCCATA-TCATTA-----TCCTTACATTCACAAAAAAAGTCT
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L. orthopetala              ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. bachmanii                ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. pusilla                  ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. barkeriana               ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. framesii                 ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. undulata                 ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. haarlemensis             ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
L. bowkeri                  ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
L. perryae                  ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
L. latimerae                ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
L. sp. nov. 3               ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
L. dehoopensis              ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
L. congesta                 ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. maximiliani              ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
L. aurioliae                ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
L. sp. nov. 5               ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
L. whitehillensis           ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
L. obscura                  ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
L. schelpei                 ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
P. longituba                ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
P. odorata                  ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
P. corymbosa                ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
P. calcicola*               ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
P. pauciflora               ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
P. ensifolia                ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. campanulata              ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
L. attenuata                ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
P. maughanii                ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. sp. nov. 4               ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
L. mediana v. rogersii      -TTTACAGTCCATA-TCATTACATTATCCTTACATTCACAAAAAAAGTCT
L. mediana v. mediana       ATTTACAGTCCATA-TCATTACATTATCCTTACATTCACAAAAAAAGTCT
L. stayneri                 ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. youngii                  ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. nervosa                  ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. trichophylla             ATTCACAGCCCATA-TCATTA----TCCTTACATTCGCAAAAAAAGTCT
L. polypodantha             ATTCACAGCCCATA-TCATTA----TCCTTACATTCGCAAAAAAAGTCT
L. angelica                 ATTCACAGCCCATA-TCATTA----TCCTTACATTCGCAAAAAAAGTCT
L. convallarioides          ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. neilii                   ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
L. alba                     ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
L. doleritica               ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
L. karooica                 ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
L. dasybotrya               ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
L. inconspicua              ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
L. duncanii                 ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
L. minima                   ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAA-GTCT
L. magregoriorum            ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. bolusii                  ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. patula                   ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. marlothii                ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. sp. nov. 6               ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. martinae                 ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. multifolia               ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. ameliae                  ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. comptonii                ATTCACAGCCCATA-TCAT--CATTATCCTTACATTCACAAAAAAAGTCT
L. rubida                   ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. bulbifera                ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. variegata                ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. mathewsii                ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAA----
L. lactosa                  ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. viridiflora              ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. aloides v. vanzyliae     ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. algoensis                ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. marginata sp. neglecta   ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. marginata sp. marginata  ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. mutabilis                ATTCATAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. thomasiae                ATTCATAGCCCATA-TTATTA----TCCTTACATTCACAAAAAAAGTCT
L. muirrii                  ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. orchioides               ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. capensis                 ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. sp. nov. 2               ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
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L. physocaulos              ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. aloides v. aurea         ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. aloides v. aloides       ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. peersii                  ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. reflexa                  ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. aloides v. luteola       ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. aloides v. nelsonii      ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. klinghardtiana           ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. aloides v. quadricolor   ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. orchioides v.orchioides  ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. arbuthnotiae             ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. fistulosa                ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. longibracteata/spnov1    ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. margaretea               ATTCATAGCCCATA-TTATTA----TCCTTACATTCACAAAAAAAGTCT
L. ventricosa               ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. zebrina forma zebrina    ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. buchubergensis           ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L.zebrina forma densiflora  ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT
L. sargeantii               ATTCACAGCCCATA-TCATTA----TCCTTACATTCACAAAAAAAGTCT

M. pustulata                TCT-----TTTTGAAGATCTAAGAAATTCAGGGACTAGGTCAAAATTTTT
M. depressa                 TCT-----TTTTGAAGATCTAAGAAATTCAGGGACTAGGTCAAAATTTTT
M. jasminiflora             TCT-----TTTTGAAGATCTAAGAAATTCAGGGACTAGGTCAAAATTTTT
M. echinata                 TCT-----TTTTGAAGATCTAAGAAATTCAGGGACTAGGTCAAAATTTTT
L. isopetala                TCT-----TTTTGAAGATCTAAGAAATTTGGGGACTAGGTCAAAATTTTG
V. capensis                 TCT-----TTTTGAAGATCTAA-----TCGGGGACTGGGTCAAAATTTTT
L. juncifolia v.juncifolia  TCT-----TTTTGAAGATCTAAAAAATTCGGGGACTAGGTCAAAATTTTT
L. juncifolia               TCT-----TTTTGAAGATCTAAAAAATTCGGGGACTAGGTCAAAATTTTT
L. unifolia                 TCT-----TTTTGAAGATCTAAAAAATTCGGGGACTAGGTCAAAATTTTT
L. zeyheri                  TCT-----TTTTGAAGATCTAAAAAATTCGGGGACTAGGTCAAAATTTTT
L. moniliformis             TCT-----TTTTGAAGATCTAAAAAATTCGGGGACTAGGTCAAAATTTTT
L. hirta                    TCT-----TTTTGAAGATCTAAAAAATTCGGGGACTAGGTCAAAATTTTT
L. anguinea                 TCT-----TTTTGAAGATCTAAAAAATTCGGGGACTAGGTCAAAATTTTT
L. giessii 1                TCT-----TTTTGAAGATCTAAG----TCGGGGACTAGGTCAAAATTTTT
L. giessii 2                TCT-----TTTTGAAGATCTAAG----TCGGGGACTAGGTCAAAATTTTT
L. pearsonii                TCT-----TTTTGAAGATCTAAG----TCGGGGACTAGGTCAAAATTTTT
L. namibiensis              TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. pallida                  TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. liliflora                TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. pustulata                TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. unicolor                 TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. giletti                  TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. namaquensis              TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. purpureo-caerulae        TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. splendida                TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. valeriae                 TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. carnosa                  TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. concordiana              TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. contaminata              TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. elegans v. flava         TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. elegans v. membranacea   TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. elegans v. sauveleons    TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. elegans v. elegans       TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. violacea                 TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. verticillata             TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. salteri                  TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. rosea                    TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. leomontana               TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. nordenstamii             TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. orthopetala              TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. bachmanii                TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. pusilla                  TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. barkeriana               TCT-----TTTTGAAGATCTAAG----TCGGGGACTAGGTCAAAATTTTT
L. framesii                 TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. undulata                 TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. haarlemensis             TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. bowkeri                  TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. perryae                  TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. latimerae                TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. sp. nov. 3               TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. dehoopensis              TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
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L. congesta               TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. maximiliani            TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. aurioliae              TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. sp. nov. 5             TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. whitehillensis         TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. obscura                TCT-----TTTTAAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. schelpei               TCT-----TTTTAAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
P. longituba              TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
P. odorata                TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
P. corymbosa              TCC-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
P. calcicola*             TCC-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
P. pauciflora             TCC-----TTTTGAAGATCTAATAAATTCGGGGACTAGGTCAAAATTTTT
P. ensifolia              TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. campanulata            TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. attenuata              TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
P. maughanii              TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. sp. nov. 4             TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. mediana v. rogersii    TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. mediana v. mediana     TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. stayneri               TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. youngii                TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. nervosa                TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTG
L. trichophylla           TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. polypodantha           TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. angelica               TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. convallarioides        TCT-----TTTTGAAGATCTAAGAAATTCGGAGACTAGGTCAAAATTTTT
L. neilii                 TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. alba                   TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. doleritica             TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. karooica               TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. dasybotrya             TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. inconspicua            TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. duncanii               TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. minima                 TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. magregoriorum          TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. bolusii                TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. patula                 TCT-----TTTTGAAGATCTAAGA----CGGGGACTAGGTCAAAATTTTT
L. marlothii              TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. sp. nov. 6             TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. martinae               TCT-----TTTTGAAGATCTGAGAAATTCGGGGACTAGGTAAAAATTTTT
L. multifolia             TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. ameliae                TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. comptonii              TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. rubida                 TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. bulbifera              TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. variegata              TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. mathewsii              TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. lactosa                TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. viridiflora            TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. aloides v. vanzyliae   TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. algoensis              TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. marginata sp. neglecta TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. marginata sp. marginataTCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. mutabilis              TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. thomasiae              TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. muirrii                TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. orchioides             TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. capensis               TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. sp. nov. 2             TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. physocaulos            TCTTTTTTTTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. aloides v. aurea       TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. aloides v. aloides     TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. peersii                TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. reflexa                TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. aloides v. luteola     TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. aloides v. nelsonii    TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. klinghardtiana         TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. aloides v. quadricolor TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. orchioides v.orchioidesTCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. arbuthnotiae           TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. fistulosa              TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
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L. longibracteata/spnov1  TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. margaretea             TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTGGGTCAAAATTTTT
L. ventricosa             TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. zebrina forma zebrina  TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. buchubergensis         TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L.zebrina forma densiflora TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT
L. sargeantii             TCT-----TTTTGAAGATCTAAGAAATTCGGGGACTAGGTCAAAATTTTT

M. pustulata              A----NNNNNNNNN----NNNNNNNNNNNNNNNNNNNNNNN-NNNNNNNN
M. depressa               A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
M. jasminiflora           A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
M. echinata               A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. isopetala              A----ATAGTTTTT----AGTCTATTTAATTTACATACATAATTACATAG
V. capensis               A----ATAGTTTTT----AGTCTATTTAATTTACATACATA-TTACATAG
L. juncifolia v.juncifolia A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. juncifolia             A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. unifolia               A----ATAGTTTTT----GGTCTATTT-----ACATACATA-TTACATAG
L. zeyheri                A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. moniliformis           A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. hirta                  A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. anguinea               A----ATAGTTTTT----GGTCTAGTTAATTTACATACATA-TTACATAG
L. giessii 1              A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. giessii 2              A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. pearsonii              A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. namibiensis            A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. pallida                A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. liliflora              A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. pustulata              A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. unicolor               A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. giletti                A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. namaquensis            A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. purpureo-caerulae      A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. splendida              A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. valeriae               A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. carnosa                A----ATAGTTTTT----GGTCTATTTAATNTACATACATA-TTACATAG
L. concordiana            A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. contaminata            A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. elegans v. flava       A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. elegans v. membranacea A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. elegans v. sauveleons  A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. elegans v. elegans     A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. violacea               A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. verticillata           A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. salteri                A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. rosea                  A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. leomontana             A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. nordenstamii           A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. orthopetala            A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. bachmanii              A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. pusilla                A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. barkeriana             A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. framesii               A----ATAGTTTTTTTTTGGTCTATTTAATTTACATACATA-TTACATAG
L. undulata               A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. haarlemensis           A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. bowkeri                A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. perryae                A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. latimerae              A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. sp. nov. 3             A----ATAGTTTTT----GGTCTATTTAAT----ATACATA-TTACATAG
L. dehoopensis            A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. congesta               A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. maximiliani            A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. aurioliae              A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. sp. nov. 5             A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. whitehillensis         A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. obscura                A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. schelpei               A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
P. longituba              A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
P. odorata                C----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
P. corymbosa              A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
P. calcicola*             A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
P. pauciflora             A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
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P. ensifolia              A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. campanulata            A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. attenuata              A----ATAGTTTTT----GGTCTATTTAATTTACATA-----------G
P. maughanii              A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. sp. nov. 4             A----ATAGTTTTT----GGTCTATTTAATTTACATNCATA-TTACATAG
L. mediana v. rogersii    A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. mediana v. mediana     A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. stayneri               A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. youngii                A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. nervosa                A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. trichophylla           A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. polypodantha           A----ATAGTTTTT----GGTCTATT-----TACATACATA-TTACATAG
L. angelica               A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. convallarioides        A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. neilii                 A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. alba                   A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. doleritica             A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. karooica               A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. dasybotrya             A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. inconspicua            A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. duncanii               ATTTAATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. minima                 A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. magregoriorum          A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. bolusii                A----ATAGTTTTT----GGTCTATTTCATTTACATACATA-TTACATAG
L. patula                 A----ATAGTTTTT----GGTCTATTTCATTTACATACATA-TTACATAG
L. marlothii              A----ATAGTTTTT----GGTCTATTTCATTTACATACATA-TTACATAG
L. sp. nov. 6             A----ATAGTTTTT----GGTCTATTTCATTTACATACATA-TTACATAG
L. martinae               A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. multifolia             A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. ameliae                A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. comptonii              A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. rubida                 A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. bulbifera              A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. variegata              A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. mathewsii              A----ATAGTTTTT----GGTCTATTTAATTTACATA-----TTACATAG
L. lactosa                A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. viridiflora            A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. aloides v. vanzyliae   A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. algoensis              A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. marginata sp. neglecta A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. marginata sp. marginataA----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. mutabilis              A----ATAGTTTTT----TGTCTATTTAATTTACATACATA-TTACATAG
L. thomasiae              A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. muirrii                A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. orchioides             A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. capensis               A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. sp. nov. 2             A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. physocaulos            A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. aloides v. aurea       A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. aloides v. aloides     A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. peersii                A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. reflexa                A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. aloides v. luteola     A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. aloides v. nelsonii    A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. klinghardtiana         A----ATAGTTTTT----GGTCTATTTA-----CATACATA-TTACATAG
L. aloides v. quadricolor A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. orchioides v.orchioidesA----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. arbuthnotiae           A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. fistulosa              A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. longibracteata/spnov1  A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. margaretea             A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. ventricosa             A----ATAGTTTTT----GGTCTATTTAATTTACATACAT-----CATAG
L. zebrina forma zebrina  A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATA G
L. buchubergensis         A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L.zebrina forma densiflora A----ATAGTTTTT----GGTCTATTTAATTTACATACATA-TTACATAG
L. sargeantii             A----ATAGTTTTT----GCTCGATTT-----ACATACATA-TTACATAG

M. pustulata              NNNNNNNNNN-----NNNNNNNNNNNNNNNNNNNNNNNNNN---------
M. depressa               ATATAAGTAC-----TCTACTAGGATGATGCACGGGAAATG---------
M. jasminiflora           ATATAAGTAC-----TCTACTAGGATGATGCACGNNNNNNN---------
M. echinata               ATATAAGTAC-----TCTACTAGGATGATGCACGGGAAATG---------
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L. isopetala              ATACAAGTAC-----TTTACTAGTATGATGCGCGGGAAATG---------
V. capensis               ATACAAGTAC-----TCTACTAGGATGATGCACGGGAAATG---------
L. juncifolia v.juncifolia ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. juncifolia             ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. unifolia               ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. zeyheri                ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. moniliformis           ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. hirta                  ATATCA---------TCTACTAGGATGATGCNNNNNNNNNN---------
L. anguinea               ATATCA---------TCTACTAGGATGATGCACGGNNNNNN---------
L. giessii 1              ATATCA---------TCTACTAGGATGATGCACGAGAAATG---------
L. giessii 2              ATATCA---------TCTACTAGGATGATGCACGNNNNNNN---------
L. pearsonii              ATATCA---------TCTACTAGGATGATGCACGAGAAATG---------
L. namibiensis            ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. pallida                ATATCA---------TCTATTAGGATGATGCACGGGAAATG---------
L. liliflora              ATATCA---------TCTATTAGGATGATGCACGGGAAATG---------
L. pustulata              ATATCA---------TCTATTAGGATGATGCACGGGAAATG---------
L. unicolor               ATATCA---------TCTATTAGGATGATGCACGGGAAATG---------
L. giletti                ATATCA---------TCTATTAGGATGATGCACGGGAAATG---------
L. namaquensis            ATATCA---------TCTACTAGGATGATGCACGGGAAANN---------
L. purpureo-caerulae      ATATCA----TCTATTCTATTAGGATGATGCACGGGAAATG---------
L. splendida              ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. valeriae               ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. carnosa                ATATCA---------TCTACTAGGATGATNNNNNNNNNNNN---------
L. concordiana            ATATCA---------TCTNCTCGGGTGATGCACNNNNNNNN---------
L. contaminata            ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. elegans v. flava       ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. elegans v. membranacea ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. elegans v. sauveleons  ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. elegans v. elegans     ATATCA---------TCTACTAGGATGATGCACGGNNNNNN---------
L. violacea               ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. verticillata           ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. salteri                ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. rosea                  ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. leomontana             ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. nordenstamii           ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. orthopetala            ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. bachmanii              ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. pusilla                ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. barkeriana             ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. framesii               ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. undulata               ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. haarlemensis           ATATCA---------TCTACTAGGATGATGCACGGGAAATN---------
L. bowkeri                ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. perryae                ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. latimerae              ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. sp. nov. 3             ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. dehoopensis            ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. congesta               ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. maximiliani            ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. aurioliae              ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. sp. nov. 5             ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. whitehillensis         ATATCA---------TCTACTAGGATGATGCACGGGAAATN---------
L. obscura                ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. schelpei               ATATCA---------TCTACTAGGATGATGCACGGANNNNN---------
P. longituba              ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
P. odorata                ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
P. corymbosa              ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
P. calcicola*             ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
P. pauciflora             ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
P. ensifolia              ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. campanulata            ATATCA---------TCTACTAGGATGATGCACGGGGAATG---------
L. attenuata              ATATCA---------TCTACTAGGATGATGCACGGGAAATN---------
P. maughanii              ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. sp. nov. 4             ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. mediana v. rogersii    ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. mediana v. mediana     ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. stayneri               ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. youngii                ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. nervosa                ATATCA---------TCTACTAGGATGATGCACGGNNNNNN---------
L. trichophylla           ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. polypodantha           ATATCA---------TCTACTAGGATGATGCNNNNNNNNNN---------
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L. angelica                ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. convallarioides         ATATCA---------TCTACTAGGATGATGCANNNNNNNNN---------
L. neilii                  ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. alba                    ATATCA---------TCTACTAGGATGATGCACGGGAAATN---------
L. doleritica              ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. karooica                ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. dasybotrya              ATATCA---------TNNNNNNNNNNNNNNNNNNNNNNNN---------
L. inconspicua             ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. duncanii                ATATC A---------TCTACTAGGATGATGCACGGGAAATG---------
L. minima                  ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. magregoriorum           ATATCA---------TCTACTAGGATGATGCGCGGGGAATG---------
L. bolusii                 ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. patula                  ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. marlothii               ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. sp. nov. 6              ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. martinae                ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. multifolia              ATATCA---------TCTACTAGGATGATGCACGNNNNNNN---------
L. ameliae                 ATATCA---------TCTACTAGGATGATGCACGGGAANNN---------
L. comptonii               ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. rubida                  ATATCA---------TCTACTAGGATGATNNNNNNNNNNNN---------
L. bulbifera               ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. variegata               ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. mathewsii               ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. lactosa                 ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. viridiflora             ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. aloides v. vanzyliae    ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. algoensis               ATATCA---------TCTACTAGGATGATGNNNNNNNNNNNN---------
L. marginata sp. neglecta  ATATCA---------TCTACTAGGATGATNNNNNNNNNNNN---------
L. marginata sp. marginata ATATCA---------TCTACTAGGATGATGCACGGNNNNNN---------
L. mutabilis               ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. thomasiae               ATATCA---------TCTACTAGGATGATGCACGGNNNNNN---------
L. muirrii                 ATATCA---------TCTACTAGGATGATGCNNNNNNNNNN---------
L. orchioides              ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. capensis                ATATCA---------TCTACTAGGATGATGCACGGNNNNNN---------
L. sp. nov. 2              ATATCA---------TCTACTAGGATGATGCNNNNNNNNNN---------
L. physocaulos             ATATCA---------TCTACTAGGATGATGCACGGNNNNNN---------
L. aloides v. aurea        ATATCA---------TCTACTAGGATGATGCACGGNNNNNN---------
L. aloides v. aloides      ATATCA---------TCTACTAGGATGATGCACGGNNNNNN---------
L. peersii                 ATATCA---------TCTACTAGGATGATGCACGGNAAATG---------
L. reflexa                 ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. aloides v. luteola      ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. aloides v. nelsonii     ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. klinghardtiana          ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. aloides v. quadricolor  ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. orchioides v.orchioides ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. arbuthnotiae            ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. fistulosa               ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. longibracteata/spnov1   ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. margaretea              ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. ventricosa              ATATCA---------TCTACTAGGATGATGCACGGGAAATG---------
L. zebrina forma zebrina   ATATAA---------TCTACTAGGATGATGCACGGGAAATG---------
L. buchubergensis          ATATAA---------TCTACTAGGATGATGCACGGGAAATG---------
L.zebrina forma densiflora ATATAA---------TCTACTAGGATGATGCACGGGAAATG---------
L. sargeantii              ATATAA---------TCTACTAGGATGATGCACGGGAAATG---------

M. pustulata               000011--001110010011---001--001-000001-01011011-
M. depressa                000011--001110010011---001--001-000001-01011011-
M. jasminiflora            000011--001110010011---001--001-000001-01011011-
M. echinata                000011--001110010011---001--001-000001-01011011-
L. isopetala               001011--01-000110011---001--001-1------0-011011-
V. capensis                00-1101-01-110010011---00000001-000001-00010011-
L. juncifolia v.juncifolia 00-1101-00111011001001-000011-01000011-01011011-
L. juncifolia              00-1101-01-11011001001-000011-01000011-01011011-
L. unifolia                00-1101-01-1101100100000001-1-01000011-01011011-
L. zeyheri                 00-1101-01-11011001000101---1-01000011-01011011-
L. moniliformis            00-1101-01-1101100100000001--1-01000111-01011011-
L. hirta                   00-1101-01-11011001001-001--1-00000011-01011011-
L. anguinea                00-1101-01-11011011001-000011-00000011-01011011-
L. giessii 1               00-1101-01-1101100101--001--001-000011-01011011-
L. giessii 2               00-1101-01-1101100101--001--001-000011-01011011-
L. pearsonii               00-1101-01-1101100101--001--001-000011-01011011-
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L. namibiensis	00-1101-01-1101100101--0001-001-000011-01011011-
L. pallida	00-1001-01-11011001001-001--001-010001-01011011-
L. liliflora	00-1001-01-11011001001-001--001-010001-01011011-
L. pustulata	00-1001-01-11011001001-001--001-010001-01011011-
L. unicolor	00-1001-01-11011001001-001--001-010001-01011011-
L. giletti	00-1001-01-11011001001-001--001-010001-01011011-
L. namaquensis	00-1001-01-11011001001-001--001-010001-01011011-
L. purpureo-caerulae	00-1001-01-11011001001-001--001-010001-01011011-
L. splendida	00-1001-01-11011001001-001--001-010001-01011011-
L. valeriae	1---001-01-11011001000101---001-010001-0-111011-
L. carnosa	1---001-01-11011001001-001--001-010001-0-111011-
L. concordiana	00-1101-01-11011001001-00001001-010001-01011011-
L. contaminata	00-1101-01-1101100101--00000001-010001-01011011-
L. elegans v. flava	00-1101-01-1101100001--01---001-010001-01011011-
L. elegans v. membranacea	00-1101-01-1101100001--01---001-010001-01011011-
L. elegans v. sauveleons	00-1101-01-1101100101--01---001-010001-01011011-
L. elegans v. elegans	00-1101-01-1101100101--01---001-010001-01011011-
L. violacea	00-1101-01-1101100101--001--001-010001-01011011-
L. verticillata	00-1101-01-1101100101--01---001-010001-01011011-
L. salteri	00-1101-01-11011001001-01---001-010000101011011-
L. rosea	00-1101-01-1101100101--01---001-010000101011011-
L. leomontana	00-1101-01-1101100101--01---001-010000101011011-
L. nordenstamii	00-1101-01-11011001001-01---001-010001-01011011-
L. orthopetala	00-1101-01-1101100101--001--001-010001-01011011-
L. bachmanii	00-1101-01-1101100101--00001001-010001-01011011-
L. pusilla	00-1101-01-1101100101--00001001-010001-01011011-
L. barkeriana	00-1101-1---1101100101--001--001-010001-01011011-
L. framesii	00-1101-01-1101100101--001--001-010001-01011011-
L. undulata	00-1101-01-1101100101--001--001-010001-01011011-
L. haarlemensis	00-1101-01-11011001001-001--001-010001-01011011-
L. bowkeri	00-1101-01-11011001001-001--001-010001-01011011-
L. perryae	00-1101-01-1101100101--0001-001-010001-01011011-
L. latimerae	00-1101-01-1101100101--0001-001-010001-01011011-
L. sp. nov. 3	00-1101-01-1101100101--0001-001-010001-01011011-
L. dehoopensis	00-1101-01-1101100101--0001-001-010001-01011011-
L. congesta	00-1101-01-1101100101--001--011-010001-01011011-
L. maximiliani	00-1101-01-1101100101--00001011-010001-01011011-
L. aurioliae	00-1101-01-11011001000011----001-010001-01011011-
L. sp. nov. 5	00-1101-01-1101100101--001--001-010001-01011011-
L. whitehillensis	00-1101-01-1101100101--001--001-010001-01011011-
L. obscura	00-1101-01-1101100101--0001-001-010001-01011011-
L. schelpei	00-1101-01-1101100101--00001001-010001-01011011-
P. longituba	00-1100100011011001010--0001-001-010001-01011011-
P. odorata	00-110011--1101100101--0001-001-010001-01001011-
P. corymbosa	00-1101-01-1101100101--0001-001-010001-01011011-
*P. calcicola**	00-1101-01-111-100101--0001-001-010001-01011011-
P. pauciflora	00-1101-01-1101100101--0001-001-010001-01011011-
P. ensifolia	00-1101-01-1101100101--0001-001-010001-01011011-
L. campanulata	00-1101-01-1101100101--00000001-010001-01011011-
L. attenuata	00-1101-01-11011001001-00001001-010001-01011011-
P. maughanii	00-110011--1101100101--00000001-010001-01011011-
L. sp. nov. 4	00-1101-01-1101100101--0001-001-010001-01011011-
L. mediana v. rogersii	00-1101-01-11011001001-001--001-010001-01011011-
L. mediana v. mediana	00-1101-01-11011001001-001--001-010001-01011011-
L. stayneri	00-1101-01-11011001001-001--001-010001-01011011-
L. youngii	00-1101-01-11011001001-0001-001-010001-01011011-
L. nervosa	00-1100001-11011001001-001--001-010001-1-011011-
L. trichophylla	00-1101-01-1101100101--0001-001-010001-01011011-
L. polypodantha	00-1101-01-1101100101--0001-001-010001-010110100
L. angelica	00-1101-01-11011001001-00001001-010001-01011011-
L. convallarioides	00-1101-01-1101100101--0001-001-010001-0101-111-
L. neilii	00-1101-01-1101100101--00001001-010001-01011011-
L. alba	00-1101-01-1101100101--00001001-010001-01011011-
L. doleritica	00-1101-01-1101100101--00000001-010001-01011011-
L. karooica	00-1101-01-11011001001-00001001-010000101011011-
L. dasybotrya	00-1101-01-1101100101--0001-001-010001-01011011-
L. inconspicua	00-1101-01-1101100101--00001001-010001-01011011-
L. duncanii	00-1101-01-11011011001-01---001-010001-01011011-
L. minima	00-1101-01-11011011001-01---001-010001-01011011-
L. magregoriorum	00-1101-01-1101100101--001--001-010001-01011011-
L. bolusii	00-1101-01-11011001001-0001-001-010001-01011011-

L. patula	00-1101-01-1101100101--001--001-010001-01011011-
L. marlothii	00-1101-01-1101100101--0001-001-010001-01011011-
L. sp. nov. 6	00-1101-01-1101100101--00001001-010001-01011011-
L. martinae	00-1101-01-11011001000101---001-010001-01011011-
L. multifolia	01-0101-01-1101100101--00001001-010000101011011-
L. ameliae	00-1101-01-1101100101--0001-001-010001-00011011-
L. comptonii	00-1101-01-11011001001-01---001-010001-01011011-
L. rubida	00-1101-01-1101100101--0001-001-010001-01011011-
L. bulbifera	00-1101-01-1101100101--001--001-010001-01011011-
L. variegata	00-1101-01-1101100101--001--001-010001-01011011-
L. mathewsii	00-1101-01-1101100101--01---001-010001-01011011-
L. lactosa	00-1101-01-1101100101--01---001-010001-01011011-
L. viridiflora	00-1101-01-1101100101--01---001-010001-01011011-
L. aloides v. vanzyliae	00-1101-01-1101100101--01---001-010001-01011011-
L. algoensis	00-1101-01-1101100101--01---001-010001-01011011-
L. marginata sp. neglecta	00-1101-01-1101100101--01---001-010001-01011011-
L. marginata sp. marginata	00-1101-01-1101100101--01---001-010001-01011011-
L. mutabilis	00-1101-01-1101100101--01---001-0100000010110101
L. thomasiae	00-1101-01-1101100101--01---001-010000001011011-
L. muirrii	00-1101-01-1101100101--01---001-010001-01011011-
L. orchioides	00-1101-01-1101100101--01---001-010001-01011011-
L. capensis	00-1101-01-1101100101--01---001-010001-01011011-
L. sp. nov. 2	00-1101-01-1101100101--01---001-010001-01011011-
L. physocaulos	00-1101-01-1101100101--01---001-0-1001-01011011-
L. aloides v. aurea	00-1101-01-1101100101--01---001-010001-01011011-
L. aloides v. aloides	00-1101-01-1101100101--01---001-010001-01011011-
L. peersii	00-1101-01-1101100101--01---001-010001-01011011-
L. reflexa	00-1101-01-1101100101--01---001-010001-01011011-
L. aloides v. luteola	00-1101-01-1101100101--01---001-010001-01011011-
L. aloides v. nelsonii	00-1101-01-1101100101--01---001-010001-01011011-
L. klinghardtiana	00-1101-01-1101100101--001--001-010001-01011011-
L. aloides v. quadricolor	00-1101-01-1101100101--01---001-010001-01011011-
L. orchioides v.orchioides	00-1101-01-1101100101--01---001-010001-01011011-
L. arbuthnotiae	00-1101-01-1101100101--01---001-010001-01011011-
L. fistulosa	00-1101-01-1101100101--01---001-010001-01011011-
L. longibracteata/spnov1	00-1101-01-1101100101--01---001-010001-01011011-
L. margaretea	00-1101-01-1101100101--01---011-0100000010110l1-
L. ventricosa	00-111--001110110011---01---001-000001-01011011-
L. zebrina forma zebrina	00-111--001110110011---01---001-000001-01011011-
L. buchubergensis	00-111--001110110011---01---001-000001-01011011-
L.zebrina forma densiflora	00-111--001110110011---01---001-000001-01011011-
L. sargeantii	00-111--001110100011---0001-001-000001-01011001-

M. pustulata	00101001000001100000000100010
M. depressa	00101001000001100000000100010
M. jasminiflora	00101001000001100000000100010
M. echinata	00101001000001100000000100010
L. isopetala	00101101000001100000000000010
V. capensis	0010100101-001100000000100010
L. juncifolia v.juncifolia	00101001000001100000000101--0
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L. unifolia	01101001000001101000000101--0
L. zeyheri	00101001000001100000000101--0
L. moniliformis	00101001000001100000000101--0
L. hirta	00101001000001100000000101--0
L. anguinea	00101001000001100000000101--0
L. giessii 1	00101001001001100000000101--0
L. giessii 2	00101001001001100000000101--0
L. pearsonii	00101001001001100000000101--0
L. namibiensis	00101001000001100000000101--0
L. pallida	00101001000001100000000101--0
L. liliflora	00101001000001100000000101--0
L. pustulata	00101001000001100000000101--0
L. unicolor	00101001000001100000000101--0
L. giletti	00101001000001100000000101--0
L. namaquensis	00101001000001100000000101--0
L. purpureo-caerulae	00101001000001100000000100100
L. splendida	00101001000001100000000101--0
L. valeriae	00101001000001100000000101--0
L. carnosa	00101001000001100000000101--0
L. concordiana	00101101000001100000000101--0

L. contaminata	00101001000001100000000101--0
L. elegans v. flava	00001001000001100000000101--0
L. elegans v. membranacea	00001001000001100000000101--0
L. elegans v. sauveleons	00101001000001100000000101--0
L. elegans v. elegans	00101001000001100000000101--0
L. violacea	00101001000001100000000101--0
L. verticillata	00101001000001100000000101--0
L. salteri	00101001000001100000000101--0
L. rosea	00101001000001100000000101--0
L. leomontana	00101001000001100000000101--0
L. nordenstamii	00101001000001100000000101--0
L. orthopetala	00101001000001100000000101--0
L. bachmanii	00101001000001100000000101--0
L. pusilla	00101001000001100000000101--0
L. barkeriana	00101001001001100000000101--0
L. framesii	00101001000001000000000101--0
L. undulata	00101001000001100000000101--0
L. haarlemensis	00101101000001100000000101--0
L. bowkeri	00101101000001100000000101--0
L. perryae	00101101000001100000000101--0
L. latimerae	00101101000001100000000101--0
L. sp. nov. 3	00101101000001100001000101--0
L. dehoopensis	00101101000001100000000101--0
L. congesta	00101001000001100000000101--0
L. maximiliani	00101101000001100000000101--0
L. aurioliae	00101101000001100000000101--0
L. sp. nov. 5	00101101000001100000000101--0
L. whitehillensis	00101101000001100000000101--0
L. obscura	00101101000001100000000101--0
L. schelpei	00101101000001100000000101--0
P. longituba	00101001000001100000000101--0
P. odorata	00101001000001100000000101--0
P. corymbosa	00101001000001100000000101--0
*P. calcicola**	00101001000001100000000101--0
P. pauciflora	00101001000001100000000101--0
P. ensifolia	00101001000001100000000101--0
L. campanulata	00101101000001100000000101--0
L. attenuata	00101101000001100000001---01--0
P. maughanii	00101001000001100000000101--0
L. sp. nov. 4	00101101000001100000000101--0
L. mediana v. rogersii	10100001000001100000000101--0
L. mediana v. mediana	00100001000001100000000101--0
L. stayneri	00101001000001100000000101--0
L. youngii	00101001000001100000000101--0
L. nervosa	00101001000001100000000101--0
L. trichophylla	00101001000001100000000101--0
L. polypodantha	00101001000001110000000101--0
L. angelica	00101001000001100000000101--0
L. convallarioides	00101001000001100000000101--0
L. neilii	00101101000001100000000101--0
L. alba	00101101000001100000000101--0
L. doleritica	00101101000001100000000101--0
L. karooica	00101101000001100000000101--0
L. dasybotrya	00101101000001100000000101--0
L. inconspicua	00101101000001100000000101--0
L. duncanii	00101101000000100000000101--0
L. minima	00101101000001100000000101--0
L. magregoriorum	00101001000001100000000101--0
L. bolusii	00101001000001100000000101--0
L. patula	00101001000011100000000101--0
L. marlothii	00101001000001100000000101--0
L. sp. nov. 6	00101001000001100000000101--0
L. martinae	00101001000001100000000101--0
L. multifolia	00101001000001100000000101--0
L. ameliae	00101001000001100000000101--0
L. comptonii	00110001000001100000000101--0
L. rubida	00101001000001100000000101--0
L. bulbifera	00101001000001100000000101--0
L. variegata	00101001000001100000000101--0
L. mathewsii	00101011000001100000010-01--0
L. lactosa	00101001000001100000000101--0

L. viridiflora	00101001000001100000000101--0
L. aloides v. vanzyliae	00101001000001100000000101--0
L. algoensis	00101001000001100000000101--0
L. marginata sp. neglecta	00101001000001100000000101--0
L. marginata sp. marginata	00101001000001100000000101--0
L. mutabilis	00101001000001100000000101--0
L. thomasiae	00101001000001100000000101--0
L. muirrii	00101001000001100000000101--0
L. orchioides	00101001000001100000000101--0
L. capensis	00101001000001100000000101--0
L. sp. nov. 2	00101001000001100000000101--0
L. physocaulos	00101000000001100000000101--0
L. aloides v. aurea	00101001000001100000000101--0
L. aloides v. aloides	00101001000001100000000101--0
L. peersii	00101001000001100000000101--0
L. reflexa	00101001000001100000000101--0
L. aloides v. luteola	00101001000001100000000101--0
L. aloides v. nelsonii	00101001000001100000000101--0
L. klinghardtiana	00101001000001100010000101--0
L. aloides v. quadricolor	00101001000001100000000101--0
L. orchioides v.orchioides	00101001000001100000000101--0
L. arbuthnotiae	00101001000001100000000101--0
L. fistulosa	00101001000001100000000101--0
L. longibracteata/spnov1	00101001000001100000000101--0
L. margaretea	00101001000001100000000101--0
L. ventricosa	00101001000001100000000101-01--0
L. zebrina forma zebrina	00101001000001100000000101--0
L. buchubergensis	00101001000001100000000101--0
L.zebrina forma densiflora	00101001000001100000000101--0
L. sargeantii	00101001000001101000000101--0

Appendix C: **Aligned nucleotide sequences of the *trn*L-F region in the cpDNA of the other liliacious taxa used in the molecular study. Hyphens = gaps; N = nucleotides of unknown identity. * Indicates sequences from this study. 0 and 1 is the binary values for the gaps determined by the computer program Gapcoder.**

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Albuca sp.*                NNNNCTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Albuca nelsonii            GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Albuca sp.                 GTAACTTCCAAATTCAGAGAACCCCTGGAACTAAAAATGGGCAATCCTGA
Albuca shawii              GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Bowiea volubilis*          NNNNNNNNNNNNNNCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Bowiea volubilis           GTAACTTCCCAATTCAGAGAAACCCTGGAACTCAAAATGGGCAATCTTGA
Eriospermum cooperi*       GTAACTTCCAAATTCAGAGAAACCCTGGAACGAAAAATGGGCAATCCTGA
Eriospermum flagelliforme  GTAACTTCCAAATTCAGAGAAACCCTGGAACGAAAAATGGGCAATCCTGA
Eucomis autumnalis*        CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Eucomis punctata           CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Gloriosa sp.               NNNNNNNNNAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Ledebouria revoluta*       NNNACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Ledebouria revoluta        CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Ledebouria socialis        CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Ledebouria somalensis      CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Ledebouria cordifolia      CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Ledebouria urceolata       CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Ornithogalum amphibolum    GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Ornithogalum angustif.     GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Ornithogalum fimbriatum    GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Ornithogalum gussonei      GTAACTTCCAAATTCAGAGAAACNCTGGAACTAAAAATGGGCAATCCTGA
Ornithogalum longibr       GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Ornithogalum montanum      NNNNNNNCCAAATTCAGAGAAAGCCTTGAACTAAAAATGGGCAATCCTGA
Ornithogalum pannonic.     GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Ornithogalum paschean.     GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Ornithogalum tenuifol.     GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Ornithogalum umbellat.     GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Ornithogalum wiedeman.     GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Ornithoglossum viride      NTAACTTCCAAATTCAGAGAAACCCTGGAATTAAAAATGGGCAATCCTGA
Asparagus laricin.         ATAACTTCCAAATTCAGGGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Sansevieria aethiopic.     NNAACTTCCAAATTCAGAGAAACCCTGGAACGAAAAATGGGCAATCCTGA
Scadoxus membranaceus      GTAACTTCCAAATTCAGAGAAACCCTGGGACTAAAAATGGGCAATCCTGA
Schizocarphus nervosus*    CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Schizocarphus nervosus     CTAACTTTCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Scilla peruviana           GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Scilla lazulina            GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Trachyandra sp.*           NTAACTTCCAAATTCAGAGAAACCCTGGAATTAAAAATGGGCAATCCTGA
Trachyandra sp.            GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Drimia altissima*          GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Urginea undulata           GGTNCTTCCAAATTCAGAGAANCCCTGGAACTAAAAATGGGCAATCCTGA
Urginea sp.                GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Veltheimia capensis*       CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Veltheimia bracteata       CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Aloe vera                  GTAACTTCCAAATTCAGAGAATCCCTGGAACTAAAAATGGGCAATCCTGA
Aloe bakeri                GTAACTTCCAAATTCAGAGAATCCCTGGAACTAAAAATGGGCAATCCTGA
Bulbine wiesei             GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Bulbine semibarbata        GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Bulbine succulenta         GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Bulbinella cauda-felis     GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Dipcadi viride             GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Dipcadi fulvum             GTAACTTCCAAATTCAGAGAACCCCTGGAACTAAAAATGGGCAATCCTGA
Drimia elata               GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Drimia fugax               GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Drimia calcarata           GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Drimia undata              GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Drimiopsis botryoides      CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Drimiopsis maculata        CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
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Drimiopsis barteri          CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Galtonia princeps           GGGACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Galtonia viridiflora        GGGACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Galtonia candicans          GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Gasteria bicolorvar. lili.GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Haworthia fasciata          GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Kniphofia uvaria            GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Muscari comosum             ATAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Nivenia corymbosa           GTAACTTCCAAATTCAGAGAAACCCTGGAAAAAAAGGGGGGCAATCCTGA
Nothoscordum bivalve        GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Rhadamanthus sp.            GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Schizobasis sp.             GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Drimia intricata            GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Thuranthos indicum          GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Tulbaghia violacea          GTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Whiteheadia bifolia         CTAACTTCCAAATTCAGAGAAACCCTGGAACTAAAAATGGGCAATCCTGA
Witsenia maura              GTAACTTCCAAATTCAGAGAA-CCCTGGAA-AAAAGGGGGGCAATCCTGA

Albuca sp.*                 GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Albuca nelsonii             GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Albuca sp.                  GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Albuca shawii               GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Bowiea volubilis*           GCCAAATCTTTTTTTTT----------AGAAAAA--------------CA
Bowiea volubilis            GCCAAATCTTTTTTTTT----------AGAAAAA--------------CA
Eriospermum cooperi*        GCCAAATCCTTATTTTT----------AGAAAAA--------------CA
Eriospermum flagelliforme GCCAAATCCTTATTTTT----------AGAAAAA--------------CG
Eucomis autumnalis*         GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Eucomis punctata            GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Gloriosa sp.                GCCAAATCTTTATGTT---------------------------------
Ledebouria revoluta*        GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Ledebouria revoluta         GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Ledebouria socialis         GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Ledebouria somalensis       GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Ledebouria cordifolia       GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Ledebouria urceolata        GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Ornithogalum amphibolum     GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Ornithogalum angustif.      GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Ornithogalum fimbriatum     GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Ornithogalum gussonei       GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Ornithogalum longibr        GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Ornithogalum montanum       GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Ornithogalum pannonic.      GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Ornithogalum paschean.      GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Ornithogalum tenuifol.      GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Ornithogalum umbellat.      GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Ornithogalum wiedeman.      GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Ornithoglossum viride       GCCAAATCTTTATGTTA----------AGAAAA---------------CA
Asparagus laricin.          GCCAAATCTTTATGTTT----------AGAAAAA--------------CA
Sansevieria aethiopic.      GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Scadoxus membranaceus       GCCAAATCTTTATTTTT----------AGAAAAA----------CCAACA
Schizocarphus nervosus*     GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Schizocarphus nervosus      GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Scilla peruviana            GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Scilla lazulina             GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Trachyandra sp.*            GCCAAATCTTTTTTTTTTTTT-------AGAAAAA-ATGATTAATCGGACA
Trachyandra sp.             GCCAAATCTTTTTTTTTTTTTTT------GAAAAA-ATGATTAATCGGACA
Drimia altissima*           GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Urginea undulata            GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Urginea sp.                 GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Veltheimia capensis*        GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Veltheimia bracteata        GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Aloe vera                   GCCAAATCTTTTTTTTTT----------GAAAAA-CTGATGAATCGGACA
Aloe bakeri                 GCCAAATCTTTTTTTTTT----------GAAAAA-CTGATGAATCGGACA
Bulbine wiesei              GCCAAATCTTTTTTTTT----------AGAAAAAA-TAATTAAT--GAGA
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Bulbine semibarbata         GCCAAATCTTTTTTTTTT---------AGAAAAAA-TGATTAATGGGACA
Bulbine succulenta          GCCAAATCTTTTTTTTTTTT-------AGAAAAAA-TGATTAATGGGACA
Bulbinella cauda-felis      GCCAAATCTTTTTTTT-----------AGAAAAAA-TGATTAATCGGACA
Dipcadi viride              GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Dipcadi fulvum              GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Drimia elata                GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Drimia fugax                GCCAAATCTTTTTTTTT----------AGAAAAA--------------CA
Drimia calcarata            GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Drimia undata               GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Drimiopsis botryoides       GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Drimiopsis maculata         GCCAAATCTTTATTTTT----------ATAAAAA--------------CA
Drimiopsis barteri          GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Galtonia princeps           GCCAAATCTTTTTTTTTT----------GAAAAA--------------CA
Galtonia viridiflora        GCCAAATCTTTTTTTTTTT---------GAAAAA--------------CA
Galtonia candicans          GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Gasteria bicolorvar. lili.GCCAAATCTTTTTTTTTTT---------GAAAAA-CTGATTATTCGGACA
Haworthia fasciata          GCCAAATCTTTTTTTATTTTT-------GAAAAA-CTGATTAATCGGACA
Kniphofia uvaria            GCCAAATCTTTTTTTTTTTTT-------GAAAAAA-TGATTAATCGGACA
Muscari comosum             GCCAAATCTTTTTTTTTTTTAGATTTTTAGAAAAA--------------CA
Nivenia corymbosa           GCCAAATCTTTATTTT----------GAGAAAA--------------CA
Nothoscordum bivalve        GCCAAATCTTTCTTTTTT----------GAAAAA--------------CA
Rhadamanthus sp.            GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Schizobasis sp.             GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Drimia intricata            GCCAAATCTTTATCTTT----------AGAAAAA--------------CA
Thuranthos indicum          GCCAAATCTTTTTTTTT----------AGAAAAA--------------CA
Tulbaghia violacea          GCCAAATCTTTAGTTTTT----------GAAAAA--------------CA
Whiteheadia bifolia         GCCAAATCTTTATTTTT----------AGAAAAA--------------CA
Witsenia maura              GCCAAATCTTTATTTT----------GAGAAAA--------------CA

Albuca sp.*                 AGGGTTT-----------AAAAACTAGA--------CAAAAAAA-----
Albuca nelsonii             AGGGTTT-----------AAAAACTAGA--------CAAAAAAA-----
Albuca sp.                  AGGGTTT-----------AAAAACTAGA--------CAAAAAAA-----
Albuca shawii               AGGGTTT-----------AAAAACTAGA--------CAAAAAAA-----
Bowiea volubilis*           AGGATTTT----------AAAAACTAGA-CTA----GAATAAAAA----
Bowiea volubilis            AGGATTTT----------AAAAACTAGA-CTA----GAATAAAAA----
Eriospermum cooperi*        AGGGTTTTCATTTAATTTGAAAAACTAGA----------ATAAAA-----
Eriospermum flagelliforme   AGGGTTTT-----AATTTGAAAAACTAGA----------ATAAAA-----
Eucomis autumnalis*         AGGGTTT----------AAAATACTAGA---ATAAAAAATAAAAA----
Eucomis punctata            AGGGTTT----------AAAATACTAGA---ATAAAAAATAAAAA----
Gloriosa sp.                ----------------------------------AAGAAAACAAA----
Ledebouria revoluta*        AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Ledebouria revoluta         AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Ledebouria socialis         AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Ledebouria somalensis       AGGGCTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Ledebouria cordifolia       AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Ledebouria urceolata        AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Ornithogalum amphibolum     AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Ornithogalum angustif.      AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Ornithogalum fimbriatum     AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Ornithogalum gussonei       AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Ornithogalum longibr        AGGGTTT-----------AAAAACTAGA--------CAAAAAA------
Ornithogalum montanum       AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Ornithogalum pannonic.      AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Ornithogalum paschean.      AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Ornithogalum tenuifol.      AGGGTTT-----------AAAAACTAGA--------CAAAAAA------
Ornithogalum umbellat.      AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Ornithogalum wiedeman.      AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Ornithoglossum viride       AA-----------------------------------------------
Asparagus laricin.          AGGGTTT------TAATTTAAAAACTAGA-------AGAAAAA-------
Sansevieria aethiopic.      AGGGTTTTCCTTTTATTTT-AAAACTAGA-------AGAAAAA-------
Scadoxus membranaceus       AGGGTTT-----------AAAAACTAGA----------ATAAAAA----
Schizocarphus nervosus*     AGGGTTT----------AAAATACTAGA---ATAAAAAATAAAAA----
Schizocarphus nervosus      AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Scilla peruviana            AGGGTTT----------CAAAAACTAGA-CTA----GAATAAAAAAAA-
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Scilla lazulina           AGGGTTT-----------AAAAACTAGA-C-------AAAAAAN-----
Trachyandra sp.*          A-----------------------------------GAATAAAAAA---
Trachyandra sp.           A-----------------------------------GAATAAAAAA---
Drimia altissima*         AGAATTT-----------AAAAACTAGA-CTA----GAATAAAA-----
Urginea undulata          AGAATTT-----------AAAAGCTAGA-CTA----GAATAAAA-----
Urginea sp.               AGAATTT-----------AAAAACTAGA-CTA----GAATAAAA-----
Veltheimia capensis*      AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Veltheimia bracteata      AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Aloe vera                 A-----------------------------------GAATAAAAAAA--
Aloe bakeri               A-----------------------------------GAATAAAAAAA--
Bulbine wiesei            A--------------------------------------TAAAAAA---
Bulbine semibarbata       A-----------------------------------TAATAAAAAA---
Bulbine succulenta        A-----------------------------------GAATAAAAAA---
Bulbinella cauda-felis    A-----------------------------------GAATAAAAAA---
Dipcadi viride            AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Dipcadi fulvum            AGGGTTT-----------AAAAACTAGA-CTA----GAAAAAAAA----
Drimia elata              AGAATTT-----------AAAAACTAGA-CTA----GAATAAAA-----
Drimia fugax              AGGATTT----------TAAAAACTAGA-CTA----GAATAAAAA----
Drimia calcarata          AGAATTT-----------AAAAACTAGA-CTA----GAATAAAA-----
Drimia undata             AGAATTT-----------AAAAGCTAGA-CTA----GAATAAAA-----
Drimiopsis botryoides     AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Drimiopsis maculata       AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Drimiopsis barteri        AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Galtonia princeps         AGGGTTT-----------AAAAACTAGATCTA----GAATAAAAA----
Galtonia viridiflora      AGGGTTT-----------AAAAACTAGATCTA----GAATAAAAA----
Galtonia candicans        AGGGTTT-----------AAAAACTAGA--------CAAAAAAA-----
Gasteria bicolorvar. lili.A-----------------------------------GAATAAAAAAA--
Haworthia fasciata        A-----------------------------------GAATAAAAAAA--
Kniphofia uvaria          A-----------------------------------GAATAAAAAA---
Muscari comosum           AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Nivenia corymbosa         AAGGTTTT----------AAAAACTAGA----------ATAAAAAAAA-
Nothoscordum bivalve      GGGGTTTT----------AAAAACTAGA----------ATAAAAA----
Rhadamanthus sp.          AGGATTT-----------AAAAACTAGA-CTA----GAATAAAA-----
Schizobasis sp.           AGAATTT-----------AAAAACTAGA-CTA----GAATAAAA-----
Drimia intricata          AGAATTT-----------AAAAACTAGA-CTA----GAATAAAA-----
Thuranthos indicum        AGGATTT-----------AAAAACTAGA-CTA----GAATAAAA-----
Tulbaghia violacea        AGGGTTTT----------AAAAACTAGA----------ATAAAAAA---
Whiteheadia bifolia       AGGGTTT-----------AAAAACTAGA-CTA----GAATAAAAA----
Witsenia maura            AAGGTTTT----------AAAAACTAGA----------ATAAAAAA---

Albuca sp.*                ----GGGATA------GGTGCAGAGACTCAACGGAAGCTGTTCTAAC---
Albuca nelsonii            ----GGGATA------GGTGCAGAGACTCAACGGAAGCTGTTCTAAC---
Albuca sp.                 ----GGGATA------GGTGCAGAGACTCAACGGAAGCTGTTCTAAC---
Albuca shawii              ----GGGATA------GGTGCAGAGACTCAACGGAAGCTGTTCTAAC---
Bowiea volubilis*          ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Bowiea volubilis           ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Eriospermum cooperi*       ---GGGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Eriospermum flagelliforme  ---GGGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Eucomis autumnalis*        ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Eucomis punctata           ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Gloriosa sp.               -----GGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAACAAA
Ledebouria revoluta*       ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Ledebouria revoluta        ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Ledebouria socialis        ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Ledebouria somalensis      ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Ledebouria cordifolia      ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Ledebouria urceolata       ----GGGATA------GGTGCAGAGACTCAATGGAAGATGTTCTAAC---
Ornithogalum amphibolum    ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Ornithogalum angustif.     ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Ornithogalum fimbriatum    ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Ornithogalum gussonei      ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Ornithogalum longibr       ---GGGGATA------GGTGCAGAGACTCAACGGAAGCTGTTCTAAC---
Ornithogalum montanum      ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Ornithogalum pannonic.     ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
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Ornithogalum paschean.     ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Ornithogalum tenuifol.     ---GGGGATA------GGTGCAGAGACTCAACGGAAGCTGTTCTAAC---
Ornithogalum umbellat.     ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Ornithogalum wiedeman.     ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Ornithoglossum viride      -----GGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAACAAA
Asparagus laricin.         ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Sansevieria aethiopic.     ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Scadoxus membranaceus      ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Schizocarphus nervosus*    ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Schizocarphus nervosus     ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Scilla peruviana           ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Scilla lazulina            ----GGGATA------GGTGCAGAGACTCAACGGAAGCTGTTCTAAC---
Trachyandra sp.*           -----GGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Trachyandra sp.            -----GGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Drimia altissima*          ---GGGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Urginea undulata           ---GGGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Urginea sp.                ---GGGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Veltheimia capensis*       ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Veltheimia bracteata       ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Aloe vera                  ------GATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Aloe bakeri                ------GATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Bulbine wiesei             -----GGATA------GGTGCAGAGACTCAACGGAAGCTGTTCTAAC---
Bulbine semibarbata        -----GGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Bulbine succulenta         -----GGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Bulbinella cauda-felis     -----GGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Dipcadi viride             ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Dipcadi fulvum             ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Drimia elata               ---GGGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Drimia fugax               ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Drimia calcarata           ---GGGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Drimia undata              ---GGGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAG---
Drimiopsis botryoides      ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Drimiopsis maculata        ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Drimiopsis barteri         ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Galtonia princeps          ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Galtonia viridiflora       ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Galtonia candicans         ----GGGATA------GGTGCAGAGACTCAACGGAAGCTGTTCTAAC---
Gasteria bicolorvar. lili.------GATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Haworthia fasciata         ------GATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Kniphofia uvaria           -----GGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Muscari comosum            ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Nivenia corymbosa          -----GGATA------GGTGCAGAGACTCAACGGAAGCTATTCTAAC---
Nothoscordum bivalve       ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Rhadamanthus sp.           ---GGGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Schizobasis sp.            ---GGGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Drimia intricata           ---GGGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Thuranthos indicum         ---GGGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Tulbaghia violacea         -----GGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Whiteheadia bifolia        ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---
Witsenia maura             ----GGGATA------GGTGCAGAGACTCAATGGAAGCTGTTCTAAC---

Albuca sp.*                --GAAT-GGAGTTGACTACGTTG------CATTG------ATAACA----
Albuca nelsonii            --GAAT-GGAGTTGACTACGTTG------CATTG------ATAACA----
Albuca sp.                 --GAAT-GGAGTTGACTACGTTG------CATTG------ATAACA----
Albuca shawii              --GAAT-GGAGTTGACTACGTTG------CATTG------ATAACA----
Bowiea volubilis*          --GAAT-GGAGTTGACTACGTTG------CATTG------ATAACA----
Bowiea volubilis           --GAAT-GGAGTTGACTACGTTG------CATTG------ATAACA----
Eriospermum cooperi*       --GAAT-GGAGTTGACTACGTTG------CGTTG------GTAACT----
Eriospermum flagelliforme  --GAAT-GGAGTTGACTACGTTG------CGTTG------GTAACT----
Eucomis autumnalis*        --GAAT-GGAGTTGACTACGTTG------CGTTG------ATAACA----
Eucomis punctata           --GAAT-GGAGTTGACTACGTTG------CGTTG------ATAACA----
Gloriosa sp.               TGGAATTGACGTTGACTACGTTG------CGTTG------GTAGCT----
Ledebouria revoluta*       --GAAT-GGAGTTGACTACATTG------CGTTG------ATAACA----
Ledebouria revoluta        --GAAT-GGAGTTGACTACATTG------CGTTG------ATAACA----
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Ledebouria socialis        --GAAT-GGAGTTGACTACATTG------CGTTG------ATAACA----
Ledebouria somalensis      --GAAT-GGAGTTGACTACATTG------CGTTG------ATAACA----
Ledebouria cordifolia      --GAAT-GGAGTTGACTACATTG------CGTTG------ATAACA----
Ledebouria urceolata       --GAAT-AGAGTTGACTACATTA------CGTTG------ATAACA----
Ornithogalum amphibolum    --GAAT-GGAGTTGACTACGTTG------CATTG------ATAATA----
Ornithogalum angustif.     --GAAT-GGAGTTGACTACGTTG------CATTG------ATAATA----
Ornithogalum fimbriatum    --GAAT-GGAGTTGACTACGTTG------CATTG------ATAATA----
Ornithogalum gussonei      --GAAT-GGAGTTGACTACGTTG------CATTG------ATAATA----
Ornithogalum longibr       --GAAT-GGAGTTGACTACGTTG------CATTG------ATAACA----
Ornithogalum montanum      --GAAT-GGAGTTGACTACGTTG------CATTG------ATAATA----
Ornithogalum pannonic.     --GAAT-GGAGTTGACTACGTTG------CATTG------ATAATA----
Ornithogalum paschean.     --GAAT-GGAGTTGACTACGTTG------CATTG------ATAATA----
Ornithogalum tenuifol.     --GAAT-GGGGTTGACTACGTTG------CATTG------ATAACA----
Ornithogalum umbellat.     --GAAT-GGAGTTGACTACGTTG------CATTG------ATAATA----
Ornithogalum wiedeman.     --GAAT-GGAGTTGACTACGTTG------CATTG------ATAATA----
Ornithoglossum viride     CGGAATTGACGTTGACTACGTTG------CGTTG------GTAGTT----
Asparagus laricin.         --GAAT-GGAGTTGACTATATTG------CGTTG------GTAACC----
Sansevieria aethiopic.     --GAAT-GGAGTTGACTACGTTG------CGTTG------GTAACT----
Scadoxus membranaceus      --GAAT-GGAGTTGACTACGTTG--------------------------
Schizocarphus nervosus*    --GAAT-GGAGTTGACTACGTTG------CGTTG------ATAACA----
Schizocarphus nervosus     --GAAT-GGAGTTGACTACGTTG------CGTTA------ATAACA----
Scilla peruviana           --GAAT-GGAGTTGATTACGTTG------CGTTG------ATAACA----
Scilla lazulina            --GAAT-GGGGTTGACTACGTTG------CATTG------ATAACA----
Trachyandra sp.*           --GAAT-GAAGTTGATTACGTTG------TGTTG------GTAGCT----
Trachyandra sp.            --GAAT-GAAGTTGATTACCTTG------TGTTG------GTGGCT----
Drimia altissima*          --GAAT-AGAGTTGACTACGTTG------CATTG------ATAACA----
Urginea undulata           --GAAT-AGAGTTGACTACGTTG------CATTG------ATAACA----
Urginea sp.                --GAAT-AGAGTTGACTACGTTG------CATTG------ATAACA----
Veltheimia capensis*       --GAAT-AGAGTTGACTACGTTG------CGTTA------ATAACA----
Veltheimia bracteata       --GAAT-AGAGTTGACTACGTTG------CGTTA------ATAACA----
Aloe vera                  --GAAT-GGAGTTGATTACGTTG------CGTTG------GTAGCA----
Aloe bakeri                --GAAT-GGAGTTGATTACGTTG------CGTTG------GTAGCA----
Bulbine wiesei             --GAAT-GGAGTTGATTACGTTG------CGTTG------GTAGCA--GG
Bulbine semibarbata        --GAAT-GGAGTTGATTACGTTG------CGTTG------GTAGCA--GG
Bulbine succulenta         --GAAT-GGAGTTGATTACGTTG------CGTTG------GTAGCA--GA
Bulbinella cauda-felis     --GAAT-GGAGTTGATTACGTTG------CGTTG------GTAGCT----
Dipcadi viride             --GAAT-GGAGTTGACTACGTTG------CATTG------ATAACA----
Dipcadi fulvum             --GAAT-GGAGTTGACTACGTTG------CATTG------ATAACA----
Drimia elata               --GAAT-AGAGTTGACTACGTTG------CATTG------ATAACA----
Drimia fugax               --GAAT-GGAGTTGACTACGTTG------CATTG------ATAACA----
Drimia calcarata           --GAAT-AGAGTTGACTACGTTG------CATTG------ATAACA----
Drimia undata              --CAAT-AGAGTTGACTACGTTG------CATTG------ATAACA----
Drimiopsis botryoides      --GAAT-GGAGTTGACTACATTG------CGTTG------ATAACA----
Drimiopsis maculata        --GAAT-GGAGTTGACTACATTG------CGTTG------ATAACA----
Drimiopsis barteri         --GAAT-GGAGTTGACTACATTG------CGTTG------ATAACA----
Galtonia princeps          --GAAT-GGAGTTGACTACGTTG------CATTG------ATAACA----
Galtonia viridiflora       --GAAT-GGAGTTGACTACGTTG------CATTG------ATAACA----
Galtonia candicans         --GAAT-GGAGTTGACTACGTTG------CATTG------ATAACA----
Gasteria bicolorvar. lili.--GAAT-GGAGTTGATTACGTTG------CGTTG------GTAGCA----
Haworthia fasciata         --GAAT-GGAGTTGATTACGTTG------CGTTG------GTAGCA----
Kniphofia uvaria           --GAAT-GGAGTTGATTACGTTG------CGTTG------GTAGCT----
Muscari comosum            --GAAT-GGAGTTGACTACGTTG------CGTTG------ATAACA----
Nivenia corymbosa          --GAAT-GTAGTTGACTACGTTG------TGTTG------GTAGCC----
Nothoscordum bivalve       --GAAT-GGAGTTGACTACGTTG------CGTTG------GTAACT----
Rhadamanthus sp.           --GAAT-AGAGTTGACTACGTTG------CATTG------ATAACA----
Schizobasis sp.            --GAAT-AGAGTTGACTACGTTG------CATTA------ATAACA----
Drimia intricata           --GAAT-AGAGTTGACTACGTTG------CATTA------ATAACA----
Thuranthos indicum         --GAAT-AGAGTTGACTACGTTG------CATTG------ATAACA----
Tulbaghia violacea         --GAAT-GGAGTTGACTACGTTG------CGTTG------GTAACT----
Whiteheadia bifolia        --GAAT-GGAGTTGACTACGTTG------CGTTA------ATAACA----
Witsenia maura             --GAAT-GTAGTTGACTACGTTG------TGTTG------GTAGCC----

Albuca sp.*               GGAA------------TCCTTCTAT---CGAAATT--------------
Albuca nelsonii           GGAA------------TCCTTCTAT---CGAAATT--------------
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Albuca sp.                GGAA-----------TCCTTCTAT---CGAAATT---------------
Albuca shawii             GGAA-----------TCCTTCTAT---CGAAATT---------------
Bowiea volubilis*         GGAA-----------TCCCTCTAT---TAAAATT---------------
Bowiea volubilis          GGAA-----------TCCCTCTAT---TAAAATT---------------
Eriospermum cooperi*      AGAA-----------TCCTTCT-------AAATT---------------
Eriospermum flagelliforme AGAA-----------TCCTTCT-------AAATT---------------
Eucomis autumnalis*       GGAA-----------TCCTTCTAT---CGAAATT---------------
Eucomis punctata          GGAA-----------TCCTTCTAT---CGAAATT---------------
Gloriosa sp.              GGAA-----------TCCCTCTAT---CGAAATT---------------
Ledebouria revoluta*      GGAA-----------TCCTTCTAT---CGAAATT---------------
Ledebouria revoluta       GGAA-----------TCCTTCTAT---CGAAATT---------------
Ledebouria socialis       GGAA-----------TCCTTCTAT---CGAAATT---------------
Ledebouria somalensis     GGAA-----------TCCTTCTAT---CGAAATT---------------
Ledebouria cordifolia     GGAA-----------TCCTTCTAT---CGAAATT---------------
Ledebouria urceolata      GGAA-----------TCCTTCTAT---CGAAATT---------------
Ornithogalum amphibolum   GGAA-----------TCCTTCTATTATCGAAATT---------------
Ornithogalum angustif.    GGAA-----------TCCTTCTATTATCGAAATT---------------
Ornithogalum fimbriatum   GGAA-----------TCCTTCTATTATCGAAATT---------------
Ornithogalum gussonei     GGAA-----------TCCTTCTATTATCGAAATT---------------
Ornithogalum longibr      GGAA-----------TCCTTCTAT---CGAAATT---------------
Ornithogalum montanum     GGAA-----------TCCTTCTATTATCGAAATT---------------
Ornithogalum pannonic.    GGAA-----------TCCTTCTATTATCGAAATT---------------
Ornithogalum paschean.    GGAA-----------TCCTTCTATAATCGAAATG---------------
Ornithogalum tenuifol.    GGAA-----------TCCTTCTAT---CGAAATT---------------
Ornithogalum umbellat.    GGAA-----------TCCTTCTATTATCGAAATT---------------
Ornithogalum wiedeman.    GGAA-----------TCCTTCTATTATCGAAATT---------------
Ornithoglossum viride     GGAA-----------TCCCTCTAT---CTAAATT---------------
Asparagus laricin.        GGAA-----------TCCTTCT-------AAATT---------------
Sansevieria aethiopic.    AGAA-----------TCCTTCT-------AAATT---------------
Scadoxus membranaceus     ----------------------------------------------
Schizocarphus nervosus*   GGAA-----------TCCTTCTATC---GAAATT---------------
Schizocarphus nervosus    GGAA-----------TCCTTCTATT---GAAATT---------------
Scilla peruviana          GGAA-----------TCCTTCTATC-----------------------
Scilla lazulina           GGAA-----------TCCTTCTAT---CGAAATT---------------
Trachyandra sp.*          GGAA-----------TCCTTCTTTT---GAAATT---------------
Trachyandra sp.           GGAA-----------TCCTTCTTTC---GAAATT---------------
Drimia altissima*         GGAA-----------TCCTTCTATT---GAAATT---------------
Urginea undulata          GGAA-----------TCCTTCTATT---GAAATT---------------
Urginea sp.               GGAA-----------TCCTTCTATT---GAAATT---------------
Veltheimia capensis*      GGAACAGGAA------TCCTTCTAT---CGAAATT---------------
Veltheimia bracteata      GGAACAGGAA------TCCTTCTAT---CGAAATT---------------
Aloe vera                 GGAA-----------TCCTTCTTT---CGAAATT---------------
Aloe bakeri               GGAA-----------TCCTTCTTC---CGAAATT---------------
Bulbine wiesei            GGAA-----------TCCTTCTTT---CGAAA-----------------
Bulbine semibarbata       GGAA-----------TCTTTCTTT---CGAAA-----------------
Bulbine succulenta        GGAA-----------TTCTTCTTT---CGAAA-----------------
Bulbinella cauda-felis    GGAA-----------TCCTTCTTT---CGAAATT---------------
Dipcadi viride            GGAA-----------TCCTTCTAT---CGAAATG---------------
Dipcadi fulvum            GGAA-----------TCCTTCTAT---CGAAATT---------------
Drimia elata              GGAA-----------TCCTTCTAT---TGAAATT---------------
Drimia fugax              GGAA-----------TCCCTCTAT---TAAAATT---------------
Drimia calcarata          AGAA-----------TCCT-CTATT---TAAATT---------------
Drimia undata             GGAA-----------TCCTTCTAT---TGAAATT---------------
Drimiopsis botryoides     GGAA-----------TCCTTCTAT---CGAAATT---------------
Drimiopsis maculata       GGAA-----------TCCTTCTAT---CGAAATT---------------
Drimiopsis barteri        GGAA-----------TCCTTCTAT---CGAAATT---------------
Galtonia princeps         GGAA-----------TCCTTCTAT---CGAAATT---------------
Galtonia viridiflora      GGAA-----------TCCTTCTAT---CGAAATT---------------
Galtonia candicans        GGAA-----------TCCTTCTAT---CGAAATT---------------
Gasteria bicolorvar. lili.GGAA-----------TCCTTCTTT---CGAAATT---------------
Haworthia fasciata        GGAA-----------TCCTTCTTT---CGAAATT---------------
Kniphofia uvaria          GGAA-----------TCCTTCTTT---CGAAATT---------------
Muscari comosum           AGAA-----------TCCCTCTAT---CGAAATT---------------
Nivenia corymbosa         GGAA-----------TCCTTCTAT---CGAAATTAAAAAAAAACTATCG
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Nothoscordum bivalve      GGAA-----------TCTTTCTAT---CGAAATT--------------
Rhadamanthus sp.          GGAA-----------TCCTTCTATT---GAAATT--------------
Schizobasis sp.           GGAA-----------TCCTTCTATT---GAAATT--------------
Drimia intricata          GGAA-----------TCCTTCTATT---GAAATT--------------
Thuranthos indicum        GGAA-----------TCCTTCTATT---GAAATT--------------
Tulbaghia violacea        GGAA-----------TCCTTCTAT---CGAAATT--------------
Whiteheadia bifolia       GGAA-----------TCCTTCTAT---CGAAATT--------------
Witsenia maura            GGAA-----------TCCTTCTAT---CGAAATG--------------

Albuca sp.*               -----CAAA-----------AAAGGG-TGACC-------TATATATCGAA
Albuca nelsonii           -----CAAA-----------AAAGGG-TGACC-------TATATATCGAA
Albuca sp.                -----CAAA-----------AAAGGGGTGACC-------TATATATCGAA
Albuca shawii             -----CAAA-----------AAAGGG-TGACC-------TATATATCGAA
Bowiea volubilis*         -----AAAG-----------AAAGGG-TGACC-------TATATATCTAA
Bowiea volubilis          -----AAAG-----------AAAGGG-TGACC-------TATATATCTAA
Eriospermum cooperi*      -----AAAG-----------AAAGGA-TGACC---------TATATCTAA
Eriospermum flagelliforme -----AAAG-----------AAAGGA-TGACC---------TATATATAA
Eucomis autumnalis*       -----AAAG-----------AAAGGG-TGACC-------TATATATCTAA
Eucomis punctata          -----AAAG-----------AAAGGG-TGACC-------TATATATCTAA
Gloriosa sp.              -----ACAG-------AAAGAAAGGA-TGACCC------TATATG-----
Ledebouria revoluta*      -----AAAG-----------AAAGGG-TGACC-------CATATATCTAA
Ledebouria revoluta       -----AAAG-----------AAAGGG-GGACC-------CGTATATCTAA
Ledebouria socialis       -----AAAG-----------AAAGGG-TGACC-------CATATATCTAA
Ledebouria somalensis     -----AAAG-------AAAGAAAGGG-TGATC-------CATATATCTAA
Ledebouria cordifolia     -----AAAG-----------AAAGGG-TGACCCA-----TATATATCTAA
Ledebouria urceolata      -----AAAG-------AAAGAAAGGG-TGACC-------CATACATATAA
Ornithogalum amphibolum   -----WAA------------AAAGGG-TGACC-------CATATATCTAA
Ornithogalum angustif.    -----AAA------------AAAGGG-TGACC-------CATATATCTAA
Ornithogalum fimbriatum   -----AAA------------AAAGGG-TGACC-------CATATATCTAA
Ornithogalum gussonei     -----AAA------------AAAGGG-TGANC-------CATATATCTAA
Ornithogalum longibr      -----CAAA-----------AAAGGG-TGACC-------TATATATCGAA
Ornithogalum montanum     -----AAA------------AAAGGG-TGACC-------CATATATCTAA
Ornithogalum pannonic.    -----AAA------------AAAGGG-TGACC-------CATATATCTAA
Ornithogalum paschean.    -----AAA------------AAAGGG-TGACC-------CATATATCTAA
Ornithogalum tenuifol.    -----CAAA-----------AAAGGG-TGACC-------TATATATCGAA
Ornithogalum umbellat.    -----AAA------------AAAGGG-TGACC-------CATATATCTAA
Ornithogalum wiedeman.    -----AAA------------AAAGGG-TGACC-------CATATATCTAA
Ornithoglossum viride     -----ACAG-----------AAAGGA-TGACCC--------TATATG---
Asparagus laricin.        -----AAAG-----------AAAGGA-TGACC-------TATATATCTAA
Sansevieria aethiopic.    -----AAAGATAAATTAAGAAAAGGA-TGACC-------TATTTATCTAA
Scadoxus membranaceus     ------------------------------------------------
Schizocarphus nervosus*   -----AAAG-----------AAAGGG-TGACC-------TATATATCTAA
Schizocarphus nervosus    -----AAAG-----------AAAGGG-TGACC-------CATATATCTAA
Scilla peruviana          ----------TAAAT-AAAGAAAGGG-TGACC-------TATATATCTAA
Scilla lazulina           -----AAAG-----------AAAGGG-TGACC-------TATATATCTAA
Trachyandra sp.*          -----AAAG------------AAGGA-TGACC-------TGTATATCTAA
Trachyandra sp.           -----AAAG-----------AAAGGA-TGACC-------TGTATATCTAA
Drimia altissima*         -----AAAG-----------AAAGGG-TGACC-------TATATATCTAA
Urginea undulata          -----AAAG-----------AAAGGG-TGACC-------TATATATCTAA
Urginea sp.               -----AAAG-----------AAAGGG-TGACC-------TATATATCTAA
Veltheimia capensis*      -----AAAG-----AAAAAGAAAGGG-TGACC-------TATATATCTAA
Veltheimia bracteata      -----AAAG-----------AAAGGG-TGACC--TATATTATATATCTAA
Aloe vera                 -----AAAG-----------AAAGGA-TGACC-------TGTATATCTAA
Aloe bakeri               -----AAAG-----------AAAGGA-TGACC-------TGTATATCTAA
Bulbine wiesei            -----AAAG---------------GA-TAACC-------TCTATATCTAA
Bulbine semibarbata       --------------------AAGGGA-TAACC-------TCTATATCTAA
Bulbine succulenta        --------------------AAGGGA-TAACC-------TCTATATCTAA
Bulbinella cauda-felis    -----AAAG-----------AAAGGA-TGACC-------TGTATATCTAA
Dipcadi viride            -----AAA------------AAAGGG-CGACC-------TATATATCTAA
Dipcadi fulvum            -----AAA------------AAAGGG-CAGCC-------TATATATCTAA
Drimia elata              -----AAAG-----------AAAGGG-TGACC-------TATATATCTAA
Drimia fugax              -----AAAG-----------AAAGGG-TGACC-------TATATATCTAA
Drimia calcarata          -----AAAG---AATTAAAGAAAGGG-TGACC-------TATATATCTAA
Drimia undata             -----AAAG-----------AAAGGG-TGACC-------TATATATCTAA
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Drimiopsis botryoides      -----AAAG----------AAAGGG-TGACC-------CATATATCTAA
Drimiopsis maculata        -----AAAG----------AAAGGG-TGACC-------YATATATCTAA
Drimiopsis barteri         -----AAAG----------AAAGGG-TGACC-------CATATATCTAA
Galtonia princeps          -----GAA-----------AAAGGG-TGACC-------TATATATCTAA
Galtonia viridiflora       -----GAA-----------AAAGGG-TGACC-------TATATATCTAA
Galtonia candicans         -----CAAA----------AAAGGG-TGACC-------TATATATCGAA
Gasteria bicolorvar. lili.-----AAAG----------AAAGGA-TGACT-------CGTATATCTAA
Haworthia fasciata         -----AAAG----------AAAGGA-TGACT-------CGTATATCTAA
Kniphofia uvaria           -----AAAG----------AAAGGA-TGACC-------CATATATCTAA
Muscari comosum            -----TAAG----------AAAAGG-TGGCC-------TATCTATCTAA
Nivenia corymbosa          AAATGAAAG----------AAAGGA-TAACTC------TATATACCTAA
Nothoscordum bivalve       -----AAAG----------AAAGGA-TGACT-------TATATATCTAA
Rhadamanthus sp.           -----AAAG----------AAAGGG-TGACC-------TATATATCTAA
Schizobasis sp.            -----AAGG----------AAAGGG-TGACC-------TATATATCTAA
Drimia intricata           -----AAAG----------AAAGGG-TGACC-------TATATATCTAA
Thuranthos indicum         -----AAAG----------AAAGGG-TGACC-------TATATATCTAA
Tulbaghia violacea         -----AAAG----------AAAGGA-TGACT-------TATATTTCTAA
Whiteheadia bifolia        -----AAAG----------AAAGGG-TGACC-------TATATATCTAA
Witsenia maura             -----AAAG----------AAAGGA-TAACTC------TATATACCTAA

Albuca sp.*                TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Albuca nelsonii            TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Albuca sp.                 TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Albuca shawii              TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Bowiea volubilis*          TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Bowiea volubilis           TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Eriospermum cooperi*       TACGTACGTATA----CATACTTA-TTGGCATATCAAACGATTAATCAC-
Eriospermum flagelliforme  TACGTNCGTATA----CATACTTAATTGGCATATCAAACGATTAATCAC-
Eucomis autumnalis*        TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAT-
Eucomis punctata           TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAT-
Gloriosa sp.               ------CGTATATATACATACT-----GACATATCAAACGATTAATCACA
Ledebouria revoluta*       TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAT-
Ledebouria revoluta        TACGTACGTATA----CATACT-----GACATGTCAAACGATTAATCAT-
Ledebouria socialis        TACGTACGTATA----CATACT-----GGCATATCAAACGATTAATCAT-
Ledebouria somalensis      TACGTACGTATA----CATACT----GAACATATCAAATGATTAATCAT-
Ledebouria cordifolia      TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAT-
Ledebouria urceolata       TACGTACGTATA----CATACT-----GACATATCAAATGATTAATCATA
Ornithogalum amphibolum    TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Ornithogalum angustif.     TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Ornithogalum fimbriatum    TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Ornithogalum gussonei      TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Ornithogalum longibr       TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Ornithogalum montanum      TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAT-
Ornithogalum pannonic.     TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Ornithogalum paschean.     TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Ornithogalum tenuifol.     TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Ornithogalum umbellat.     TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Ornithogalum wiedeman.     TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Ornithoglossum viride      ------CGTATATATACATACT-----GACATATCAAACGATTAATCACA
Asparagus laricin.         TACGTACGTATA----CATACT-----GGCATATCAAACGATTAATCAC-
Sansevieria aethiopic.     TACGTACGTATA----TATACT-----AGCA--------GATTAATCAC-
Scadoxus membranaceus      --CGTTGGTA---------ACT-----GGC-TATCGAA--ATTAA-----
Schizocarphus nervosus*    TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAT-
Schizocarphus nervosus     TACGTACGTATA----CNTACT-----GACATATCAAACGATTAATCAT-
Scilla peruviana           TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Scilla lazulina            TACGTACGTATA----CATACT-----GACATATCNAACGATTAATCAT-
Trachyandra sp.*           TACATACGTATA----CATACT-----GACATAGCAAACGATTAATCAC-
Trachyandra sp.            TACATACGTATA----CATACT-----GACATAGCAAACGATTAATCAC-
Drimia altissima*          TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Urginea undulata           TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Urginea sp.                TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Veltheimia capensis*       TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAT-
Veltheimia bracteata       TACGTACGTT----------------GACATATCAAACGATTAATCAT-
Aloe vera                  GACATACGTATA----CATACT-----GACATAGCAAACAATTAATCAC-
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Aloe bakeri                GACATACGTATA----CATACT-----GACATAGCAAACAATTAATCAC-
Bulbine wiesei             TACATACGTATA----CATACT-----GACATAGCAAACGATTAATCAC-
Bulbine semibarbata        TACATACGTATA----CATACT-----GACATAGCAAACGATTAATCAC-
Bulbine succulenta         TACATACGTATA----CATACT-----GACATAGCAAACGATTAATCAC-
Bulbinella cauda-felis     TACATACGTATA----CATACT-----GACATAGCAAACGATTAATCAC-
Dipcadi viride             TACGTACGTATA----CATACTGACATGACATATCAAACGATTAATCAC-
Dipcadi fulvum             TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Drimia elata               TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Drimia fugax               TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Drimia calcarata           TACGTACGTATA-----CTACT-----GACATATCAAACGATTAATCAC-
Drimia undata              TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Drimiopsis botryoides      TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAT-
Drimiopsis maculata        TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAT-
Drimiopsis barteri         TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAT-
Galtonia princeps          TACATACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Galtonia viridiflora       TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Galtonia candicans         TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Gasteria bicolorvar. lili.TACATACGTATA----CATACT-----GACATAGCAAACAATTAATCAC-
Haworthia fasciata         TACATACGTATA----CATACT-----GACATAGCAAACAATTAATCAT-
Kniphofia uvaria           TACATACGTATA----CATACT-----GACATAGCAAACGATTAATCAC-
Muscari comosum            TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Nivenia corymbosa          ----TACGTATA----CATATT-----ACCATATCAAACGATTAATCAT-
Nothoscordum bivalve       TACATACGTATA----CATACT-----GGCATATCAAACGATTAATCAC-
Rhadamanthus sp.           TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Schizobasis sp.            TACGTACGTATA----CNTACT-----GGCATATCAAACGATTAATCAC-
Drimia intricata           TACGTACGTATA----CATACT-----GGCATATCAAACGATTAATCAC-
Thuranthos indicum         TACATACGTATA----CATACT-----GACATATCAAACGATTAATCAC-
Tulbaghia violacea         TACGTACGTATA----CATACT-----GGCATATCAAACGATTAATCAC-
Whiteheadia bifolia        TACGTACGTATA----CATACT-----GACATATCAAACGATTAATCAT-
Witsenia maura             ----TACGTATA----CATATT-----ACCATATCAAACGATTAATCAT-

Albuca sp.*                ----GACCC--GAATCCATAATA--------------------------
Albuca nelsonii            ----GACCC--GAATCCATAATA--------------------------
Albuca sp.                 ----GACCC--GAATCCATAATA--------------------------
Albuca shawii              ----GACCC--GAATCCATAATA--------------------------
Bowiea volubilis*          ----GACTC--GAATCCATATA---------------------------
Bowiea volubilis           ----GACTC--GAATCCATATA---------------------------
Eriospermum cooperi*       ----GACCC--GAATGCATAATA-----------------------TAT
Eriospermum flagelliforme  ----GACCC--GAATGCATAATA-----TTA------------ATATAT
Eucomis autumnalis*        ----GACCC--GAATCCATATA---------------------------
Eucomis punctata           ----GACCC--GAATCCATATA---------------------------
Gloriosa sp.               ACTCAAATCTGGAATCCATA--------TTATTAACTATAACTATATATA
Ledebouria revoluta*       ----GACCC--GAATCCATATA---------------------------
Ledebouria revoluta        ----GACCC--GAATCTATATA---------------------------
Ledebouria socialis        ----GACCC--GAATCCATATA---------------------------
Ledebouria somalensis      ----GACCC--GAATCCATATA---------------------------
Ledebouria cordifolia      ----GACCC--GAATCCATATA---------------------------
Ledebouria urceolata       TCATGACCC--GAATACATATA---------------------------
Ornithogalum amphibolum    ----GACTC--GAATCCATATACATATAT--------------------
Ornithogalum angustif.     ----GACTC--GAATCCATATACATATAT--------------------
Ornithogalum fimbriatum    ----GACTC--GAATCCATATACATATAT--------------------
Ornithogalum gussonei      ----GACTC--GAATCCATATACATATAT--------------------
Ornithogalum longibr       ----GACTC--GAATCCATA-----------------------------
Ornithogalum montanum      ----GACTC--GAATCCATATACATATAT--------------------
Ornithogalum pannonic.     ----GACTC--GAACCCATATACATATAT--------------------
Ornithogalum paschean.     ----GACTC--GAATCCATAGACATATAT--------------------
Ornithogalum tenuifol.     ----GACCC--GAATCCATA-----------------------------
Ornithogalum umbellat.     ----GACTC--GAATCCATATACATATAT--------------------
Ornithogalum wiedeman.     ----GACTC--GAATCCATATACATATAT--------------------
Ornithoglossum viride      ACTCGAATCTGGAATCCATA--------TTATTAACTATATATTATAGTT
Asparagus laricin.         ----GACCC--GAATCCATA-----------------------------
Sansevieria aethiopic.     ----GACCT--GAATTCA-------------------------------
Scadoxus membranaceus      -------------------------------------------------
Schizocarphus nervosus*    ----GACCC--GAATCCATATA---------------------------
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Schizocarphus nervosus    ----GACCC--GAATACATATA----------------------------
Scilla peruviana          ----GACCC--GAATCCATATA----------------------------
Scilla lazulina           ----GACCC--GAATCTATATA----------------------------
Trachyandra sp.*          ----GAACC--GAATACA-------------------------------
Trachyandra sp.           ----GAACC--GAATACA-------------------------------
Drimia altissima*         ----GACCC--GAATCCATATA----------------------------
Urginea undulata          ----GACCC--GAATCCATATA----------------------------
Urginea sp.               ----GACCC--GAATCCATATA----------------------------
Veltheimia capensis*      ----GACCC--GAATCCATATA----------------------------
Veltheimia bracteata      ----GACCC--GAATCCATATA----------------------------
Aloe vera                 ----AAACC--GAATACA-------------------------------
Aloe bakeri               ----AAACC--GAATACA-------------------------------
Bulbine wiesei            ----GAACC--GAATACA-------------------------------
Bulbine semibarbata       ----GAACC--GAATATA-------------------------------
Bulbine succulenta        ----GAACC--GAATACA-------------------------------
Bulbinella cauda-felis    ----GAACT--AAATACA-------------------------------
Dipcadi viride            ----GACTC--GAATCCATATACATATA----------------------
Dipcadi fulvum            ----GACTC--GAATCCATATACATATA----------------------
Drimia elata              ----GACCC--GAATCCATATA----------------------------
Drimia fugax              ----GACYC--GAATCCATATA----------------------------
Drimia calcarata          ----GACCC--GAATCCATATA----------------------------
Drimia undata             ----GACCC--GAATCCATATA----------------------------
Drimiopsis botryoides     ----GACCC--GAATCCATATA----------------------------
Drimiopsis maculata       ----GACCC--GAATCCATCTA----------------------------
Drimiopsis barteri        ----GACCC--GAATCCATATA----------------------------
Galtonia princeps         ----GACTC--GAATCCATATACATATA----------------------
Galtonia viridiflora      ----GACTC--GAATCCATATACATATA----------------------
Galtonia candicans        ----GACTC--GAATCCATA-----ATA----------------------
Gasteria bicolorvar. lili.----GAATC--GAATACA-------------------------------
Haworthia fasciata        ----GAACC--GAATACA-------------------------------
Kniphofia uvaria          ----GAACC--GAATACA-------------------------------
Muscari comosum           ----GACCC--GAATACATATA----------------------------
Nivenia corymbosa         ----GACCC--AAATCCAAA-----------------------------
Nothoscordum bivalve      ----GACCC--AAATCCA-------------------------------
Rhadamanthus sp.          ----GACCC--GAATCCATATATATA-----------------------
Schizobasis sp.           ----GACTC--GAATCCATAATATAT-----------------------
Drimia intricata          ----GACTC--GAATCCATAATATAT-----------------------
Thuranthos indicum        ----GACCC--GAATCCATATA----------------------------
Tulbaghia violacea        ----GACCC--GAATGCA-------------------------------
Whiteheadia bifolia       ----GACCC--GAATCCATATA----------------------------
Witsenia maura            ----GACCC--AAATCCATATA----------------------------

Albuca sp.*               ------------------------------------------------
Albuca nelsonii           ------------------------------------------------
Albuca sp.                ------------------------------------------------
Albuca shawii             ------------------------------------------------
Bowiea volubilis*         ------------------------------------------------
Bowiea volubilis          ------------------------------------------------
Eriospermum cooperi*      A-GATATATTATATG----------------------------------
Eriospermum flagelliforme AGGATATATTATATG----------------------------------
Eucomis autumnalis*       ------------------------------------------------
Eucomis punctata          ------------------------------------------------
Gloriosa sp.              TAGATATTATAGTTATTATTATAACTA-----TTTTCTTTATATATTTAA
Ledebouria revoluta*      ------------------------------------------------
Ledebouria revoluta       ------------------------------------------------
Ledebouria socialis       ------------------------------------------------
Ledebouria somalensis     ------------------------------------------------
Ledebouria cordifolia     ------------------------------------------------
Ledebouria urceolata      ------------------------------------------------
Ornithogalum amphibolum   ------------------------------------------------
Ornithogalum angustif.    ------------------------------------------------
Ornithogalum fimbriatum   ------------------------------------------------
Ornithogalum gussonei     ------------------------------------------------
Ornithogalum longibr      ------------------------------------------------
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Ornithogalum montanum     ------------------------------------------------
Ornithogalum pannonic.    ------------------------------------------------
Ornithogalum paschean.    ------------------------------------------------
Ornithogalum tenuifol.    ------------------------------------------------
Ornithogalum umbellat.    ------------------------------------------------
Ornithogalum wiedeman.    ------------------------------------------------
Ornithoglossum viride     ATTATTATATATATATATATTTTTATATTTTCTTTATATTTATATTTTCA
Asparagus laricin.        ------------------------------------------------
Sansevieria aethiopic.    ------------------------------------------------
Scadoxus membranaceus     ------------------------------------------------
Schizocarphus nervosus*   ------------------------------------------------
Schizocarphus nervosus    ------------------------------------------------
Scilla peruviana          ------------------------------------------------
Scilla lazulina           ------------------------------------------------
Trachyandra sp.*          ------------------------------------------------
Trachyandra sp.           ------------------------------------------------
Drimia altissima*         ------------------------------------------------
Urginea undulata          ------------------------------------------------
Urginea sp.               ------------------------------------------------
Veltheimia capensis*      ------------------------------------------------
Veltheimia bracteata      ------------------------------------------------
Aloe vera                 ------------------------------------------------
Aloe bakeri               ------------------------------------------------
Bulbine wiesei            ------------------------------------------------
Bulbine semibarbata       ------------------------------------------------
Bulbine succulenta        ------------------------------------------------
Bulbinella cauda-felis    ------------------------------------------------
Dipcadi viride            ------------------------------------------------
Dipcadi fulvum            ------------------------------------------------
Drimia elata              ------------------------------------------------
Drimia fugax              ------------------------------------------------
Drimia calcarata          ------------------------------------------------
Drimia undata             ------------------------------------------------
Drimiopsis botryoides     ------------------------------------------------
Drimiopsis maculata       ------------------------------------------------
Drimiopsis barteri        ------------------------------------------------
Galtonia princeps         ------------------------------------------------
Galtonia viridiflora      ------------------------------------------------
Galtonia candicans        ------------------------------------------------
Gasteria bicolorvar. lili.------------------------------------------------
Haworthia fasciata        ------------------------------------------------
Kniphofia uvaria          ------------------------------------------------
Muscari comosum           ------------------------------------------------
Nivenia corymbosa         ------------------------------------------------
Nothoscordum bivalve      ------------------------------------------------
Rhadamanthus sp.          ------------------------------------------------
Schizobasis sp.           ------------------------------------------------
Drimia intricata          ------------------------------------------------
Thuranthos indicum        ------------------------------------------------
Tulbaghia violacea        ------------------------------------------------
Whiteheadia bifolia       ------------------------------------------------
Witsenia maura            ------------------------------------------------

Albuca sp.*               --------TTATAT------------------------------------
Albuca nelsonii           --------TTATAT------------------------------------
Albuca sp.                --------TTATATATATGAT-----------------------------
Albuca shawii             --------TTATATATATGAT-----------------------------
Bowiea volubilis*         ------TTATATATATACA----TGTATATGCAATAC-------------
Bowiea volubilis          ------TTATATATATACA----TGTATATGCAATAC-------------
Eriospermum cooperi*      ------------------------------------------------
Eriospermum flagelliforme ------------------------------------------------
Eucomis autumnalis*       --------TTATATATACA----TGTATATGCAATAT-----------T
Eucomis punctata          --------TTATATATACA----TGTATATGCAATAT-----------T
Gloriosa sp.              TAAAGATATATTTTTTTAAAAATTTATAGATT-----------------
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Ledebouria revoluta*      ------TTATATATATACA----TGTATATGCA----------------
Ledebouria revoluta       --------TTATATATAGA----TGTATATGCA----------------
Ledebouria socialis       --------TTATATATACA----TGTATATGTA----------------
Ledebouria somalensis     --------TTATATATACA----TGTATATGCA----------------
Ledebouria cordifolia     ---TTATATATACATGACA----TGTATATGCA----------------
Ledebouria urceolata      --------TTATATATACA----TGTATATGCA----------------
Ornithogalum amphibolum   --------------------------------------------------
Ornithogalum angustif.    --------------------------------------------------
Ornithogalum fimbriatum   --------------------------------------------------
Ornithogalum gussonei     --------------------------------------------------
Ornithogalum longibr      ----------------------------------ATAT------------T
Ornithogalum montanum     --------------------------------------------------
Ornithogalum pannonic.    --------------------------------------------------
Ornithogalum paschean.    --------------------------------------------------
Ornithogalum tenuifol.    ----------------------------------ATAT------------T
Ornithogalum umbellat.    --------------------------------------------------
Ornithogalum wiedeman.    --------------------------------------------------
Ornithoglossum viride     TAAAGATATATTAATAAAGATATATTTTTTTATAAAT------------T
Asparagus laricin.        --------TTATATATA-----------------------------------
Sansevieria aethiopic.    --------TTATAATTATATAATTATAATTATAATGAATT----------
Scadoxus membranaceus     --------------------------------------------------
Schizocarphus nervosus*   --------TTATATATACA----TGTATATGCAATAT------------T
Schizocarphus nervosus    --------TTATATATACA----TGTATATGCAATAT------------T
Scilla peruviana          --------TTAT----ACA----TGTATAT--------------------
Scilla lazulina           --------TTATATATACA----TGTATAT--------------------
Trachyandra sp.*          --------TTATATATA-----------------------------------
Trachyandra sp.           --------TTAT--ATACA------TATA---------------------
Drimia altissima*         ------TTATATATATACA----TGTATATGCAATAT-------------
Urginea undulata          ------TTATATATATACA----TGTATATGCAATAT-------------
Urginea sp.               ------TTATATATATACA----TGTATATGCAATAT-------------
Veltheimia capensis*      --------TTATATATACA----TGTATATGCAATAT------------T
Veltheimia bracteata      --------TTATATATACA----TGTATATGCAATAT------------T
Aloe vera                 --------TTATATATA--------TATAT--------------------
Aloe bakeri               --------TTATATATA--------TATAT--------------------
Bulbine wiesei            --------TTATATA--------TGTATAT--------------------
Bulbine semibarbata       --------TTATATATA--------TATAT--------------------
Bulbine succulenta        --------TTATATATA--------TATAT--------------------
Bulbinella cauda-felis    --------TTATATA--------TGTATAT--------------------
Dipcadi viride            --------TTAT----------------------------------------
Dipcadi fulvum            --------TTAT----------------------------------------
Drimia elata              ------TTATATATATACA----TGTATATGCAAT---------------
Drimia fugax              ------TTATATATATACA----TGTATATGCAAT---------------
Drimia calcarata          ------TTATATATA--CA----TGTATATGCAATATATATATGCGAAAT
Drimia undata             ------TTATATATATACA----TGTATATCGAAT---------------
Drimiopsis botryoides     --------TTATATATACA----TGTATATGCAAT---------------
Drimiopsis maculata       --------TTATATATACA----TGTATATGCAAT---------------
Drimiopsis barteri        --------TTATATATGCA----TGTATATGCAAT---------------
Galtonia princeps         --------TTAT----------------------------------------
Galtonia viridiflora      --------TTAT----------------------------------------
Galtonia candicans        --------TTAT----------------------------------------
Gasteria bicolorvar. lili.--------TTATATATA--------TATAT--------------------
Haworthia fasciata        --------TTATATATA--------TATAT--------------------
Kniphofia uvaria          --------TTATATATA--------TATAT--------------------
Muscari comosum           --------TTATATA--------TGTATATGCAAT---------------
Nivenia corymbosa         --------------------------------------------------
Nothoscordum bivalve      --------TTATATATA--------TATAT--------------------
Rhadamanthus sp.          ------TTATATATATACA----TGTATATGCAAT---------------
Schizobasis sp.           --------------------------------------------------
Drimia intricata          --------------------------------------------------
Thuranthos indicum        ----TTATATATATATACA----TGTATATGCAAT---------------
Tulbaghia violacea        ----TTATATATATATAT----------------------------------
Whiteheadia bifolia       --------TTATATATACA----TGTATATGCAAT---------------
Witsenia maura            --------------------------------------------------
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Albuca sp.*                -------ATATGCGCAATATATGCAA--------------AATTCAG---
Albuca nelsonii            -------ATATGCGCAATATATGCAA--------------AATTCAG---
Albuca sp.                 -------ATGTGCGCAATATATGCAA--------------AATTCAG---
Albuca shawii              -------ATGTGCGCAATATATGCAA--------------AATTCAG---
Bowiea volubilis*          -------ATATGCGAAATATATGCAA-------AATTCAGAATTAA----
Bowiea volubilis           -------ATATGCGAAATATATGCAA-------AATTCAGAATTAA----
Eriospermum cooperi*       -------ATATGC--AATATATGCAA--------------AATTCAG--A
Eriospermum flagelliforme  -------ATATGC--AATATATGCAA--------------AATTTAG--A
Eucomis autumnalis*        ATATGCAATATGCGCAATATATGCAA--------------AATTCGG--A
Eucomis punctata           ATATGCAATATGCGCAATATATGCAA--------------AATTCGG--A
Gloriosa sp.               ----------------------------------------AATTAAG--A
Ledebouria revoluta*       -------ATATGCGCAATATATGCAA--------------AATTCAG--A
Ledebouria revoluta        -------ATATGCGCAATATATGCAA--------------AATTCAG--A
Ledebouria socialis        -------ATATGCGCAATATATGCAA--------------AATTCAG--A
Ledebouria somalensis      -------ATATGCGCAATATATGCAA--------------AATTCAG--A
Ledebouria cordifolia      -------ATATGCGCAATATATGCAA--------------AATTCAG--A
Ledebouria urceolata       -------ATATGCGCNATATATGCAA--------------AATTCAG--A
Ornithogalum amphibolum    --TATATATATGCGCAATACATGCAA--------------AATGA----A
Ornithogalum angustif.     --TATATATATGCGCAATACATGCAA--------------AATGA----A
Ornithogalum fimbriatum    --TATATATATGCGCAATACATGCAA--------------AATGA----A
Ornithogalum gussonei      --TATATATATGCGCAATACATGCAA--------------AATGA----A
Ornithogalum longibr       ATAT---ATATGCGCAATATATGCAA--------------AATGC----A
Ornithogalum montanum      --TATATATATGCGCAATACATGCAA--------------AATGA----A
Ornithogalum pannonic.     --TATATATATGCGCAATACATGCAA--------------AATGA----A
Ornithogalum paschean.     --TATATATATGCGCAATACATGCAA--------------AATGA----A
Ornithogalum tenuifol.     ATAT---ATATGCGCAATATATGCAA--------------AATTC----A
Ornithogalum umbellat.     --TATATATATGCGCAATACATGCAA--------------AATGA----A
Ornithogalum wiedeman.     --TATATATATGCGCAATACATGCAA--------------AATGA----A
Ornithoglossum viride      TATATATT--------------------------------AATTAAG--A
Asparagus laricin.         -------ATATATGCAAGACATGCAA--------------AATTCAG--A
Sansevieria aethiopic.     ------------TGCAATATATGCAA--------------AATTCAA--A
Scadoxus membranaceus      ------------------------------------------------
Schizocarphus nervosus*    ATATGCAATATGCGCAATATATGCAA--------------AATTCGG--A
Schizocarphus nervosus     ATATGCAATATGTGCAATATATGNAA--------------AATTCAG--A
Scilla peruviana           --ATGCAATATGCGCAATATATGNAA--------------AATTCAG--A
Scilla lazulina            ----GCAATATGCGCAATATATGCAA--------------AATTCAG--A
Trachyandra sp.*           ------TATATG--CAA-ATATGCAA--------------AATTCAG--A
Trachyandra sp.            ------TATATG-----TATATGCAA--------------AATTCAG--A
Drimia altissima*          -------ATATGCGAAATATATGCAA--------------AATTCAG--A
Urginea undulata           -------ATATGCGAAATATATGCAA--------------AATTCAG--A
Urginea sp.                -------ATATGCGAAATATATGCAA--------------AATTCAG--A
Veltheimia capensis*       ATATGTAATATGCGCAATATATGCAA--------------AATTCAG--A
Veltheimia bracteata       ATATGTAATATGCGCAATATATGCAA--------------AATTCAG--A
Aloe vera                  ----------------ATATATGCAA--------------AATTCAG--A
Aloe bakeri                --------------------ATGCAA--------------AATTCAG--A
Bulbine wiesei             ----------------------GCAA--------------AATTCAG--A
Bulbine semibarbata        ----------------------GCAA--------------AATTCAG--A
Bulbine succulenta         ----------------GTATATGCAA--------------AATTCAG--A
Bulbinella cauda-felis     ----------------------GCAA--------------AATTCAG--A
Dipcadi viride             -----ATATATGCGCAATATATGCAA--------------AATTCAG---
Dipcadi fulvum             -----ATATATGCGCAATATATGCAA--------------AATTCAG---
Drimia elata               -----ATATATGCGANATATATGCAA--------------AATTCAG--A
Drimia fugax               -----AYATATGCGAAATATATGCAA--------------AATTCAG--A
Drimia calcarata           ATATG---TATGCGANATATATGCAA--------------AATTCAG--A
Drimia undata              -----ATATATGCGANATATATGCAA--------------AATTCAG--A
Drimiopsis botryoides      ---------ATGTGCAATATATGCAA--------------AATTCAG--A
Drimiopsis maculata        ---------ATGTGCAATATATGCAA--------------AATTCAG--A
Drimiopsis barteri         ---------ATGTGCAATATATGCAA--------------AATTCAG--A
Galtonia princeps          -----ATATATGCGCAATATATGCAA--------------AATTCAG---
Galtonia viridiflora       -----ATATATGCGCAATATATGCAA--------------AATTCAG---
Galtonia candicans         -----ATATATGCGCAATATATGCAA--------------AATGCAG---
Gasteria bicolorvar. lili.-ATATATATATG-----TATATGCAA--------------AATTCAG--A
Haworthia fasciata         -----------G-----TATATGCAA--------------AATGCAG--A
Kniphofia uvaria           -------ATATG-----TATATGCAA--------------AATTCAG--A
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Muscari comosum           ---------ATGCGCAATATATGCAA-------------AATTCAG--A
Nivenia corymbosa         -----ATATAT---ATATATATGCAA-------------AATGGAG--A
Nothoscordum bivalve      --------------ATATATATGCAA-------------AATTCAG--A
Rhadamanthus sp.          -----ATATATGCGAAATATATGAAA-------------AATTCAG--A
Schizobasis sp.           -----------GCGANATATATGCAA-------------AATTCAG--A
Drimia intricata          -----------GCGAAATATATGCAA-------------AATTCAG--A
Thuranthos indicum        -----ATATATGCGAAATATATGAAA-------------AATTCAG--A
Tulbaghia violacea        ------------GCAA-TATATGCAA-------------AATTCAG--A
Whiteheadia bifolia       ---------ATGCGCAATATATGCAA-------------AATTCAG--A
Witsenia maura            -----------------TATATGCAA-------------AATGGAG--A

Albuca sp.*               ----------TGTGGGTCTATTCCAATC-----------GAAG-------
Albuca nelsonii           ----------TGTGGGTCTATTCCAATC-----------GAAG-------
Albuca sp.                ----------TGTGGGTCTATTCCAATC-----------GAAG-------
Albuca shawii             ----------TGTGGGTCTATTCCAATC-----------GAAG-------
Bowiea volubilis*         -TTATT-----GTGAATCTATTCCAATC-----------GAAG-------
Bowiea volubilis          -TTATT-----GTGAATCTATTCCAATC-----------GAAG-------
Eriospermum cooperi*      GTTATT-----GTGGATTTATGCTAATC-----------CAAG-------
Eriospermum flagelliforme GTTATT-----GTGGATTTATGCTAATC-----------GAAG-------
Eucomis autumnalis*       GTTATT-----GTGGATCTATTCCAATC-----------GAAA-------
Eucomis punctata          GTTATT-----GTGGATCTATTCCAATC-----------GAAA-------
Gloriosa sp.              GTTATT-----ATAAATATATTCCAGTC-----------GAAG-------
Ledebouria revoluta*      GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Ledebouria revoluta       GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Ledebouria socialis       GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Ledebouria somalensis     GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Ledebouria cordifolia     GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Ledebouria urceolata      GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Ornithogalum amphibolum   AT---------GTGGATCTATTCCAATC-----------GAAG-------
Ornithogalum angustif.    AT---------GTGGATCTATTCCAATC-----------GAAG-------
Ornithogalum fimbriatum   GT---------GTGGATCTATTCCAATCCAATC------GAAG-------
Ornithogalum gussonei     GT---------GTGGATCTATTCCAATC-----------GAAG-------
Ornithogalum longibr      GT---------GTGGATCTATTCCAATC-----------GAAG-------
Ornithogalum montanum     GT---------GTGGATCTATTCCAATC-----------GAAG-------
Ornithogalum pannonic.    AT---------GTGGATCTATTCCAATC-----------GAAG-------
Ornithogalum paschean.    GT---------GTGGATCTATTCCAATC-----------GAAG-------
Ornithogalum tenuifol.    GT---------GTGGATCTATTCCAATC-----------GAAG-------
Ornithogalum umbellat.    AT---------GTGGATCTATTCCAATC-----------GAAG-------
Ornithogalum wiedeman.    AT---------GTGGATCTATTCCAATC-----------GAAG-------
Ornithoglossum viride     GTTATTTTAA-----ATATATTCCA-----------GTCGAAG-------
Asparagus laricin.        GTTATT-----ATGGATCTATGCCAATA-----------GAAG-------
Sansevieria aethiopic.    GTTATT-----GTGGATCTATGCCAATC-----------AAAG-------
Scadoxus membranaceus     ----------------------------------------------------
Schizocarphus nervosus*   GTTATT-----GTGGATCTATTCCAATC-----------GAAA-------
Schizocarphus nervosus    GTTATTTTATTGTGGATCTATTCCAATC-----------AAAG-------
Scilla peruviana          GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Scilla lazulina           GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Trachyandra sp.*          GTTATT-----GTGGATCTATTCCAATC-----------GAGG-------
Trachyandra sp.           GTTATT-----GTGGATCTATTCCAGTC-----------GAGG-------
Drimia altissima*         GTTATT-----GTGAATCTATTCCAATC-----------GAAG-------
Urginea undulata          GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Urginea sp.               GTTATT-----GTAAATCTAT-CCAATC-----------GAAG-------
Veltheimia capensis*      GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Veltheimia bracteata      GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Aloe vera                 GTTATT-----GTGGATCTATTCCAATC-----------GAGG-------
Aloe bakeri               GTTATT-----GTGGATCTATTCCAATC-----------GAGG-------
Bulbine wiesei            GTTATT-----GTGGATCTATTCCAATC-----------AAGG-------
Bulbine semibarbata       GTTATT-----GTGGATCTATTCCAATC-----------GAGG-------
Bulbine succulenta        GTTATT-----GTGGATCTATTCCAATC-----------GAGG-------
Bulbinella cauda-felis    GTTATT-----GTGGATTTATTCCAATC-----------GAGG-------
Dipcadi viride            ----------TGTGGATCTATTCCAATC-----------GAAG-------
Dipcadi fulvum            ----------TGTGGATCTATTCCAATC-----------GAAG-------
Drimia elata              GTTATT-----GTGAATCTATTCCAATC-----------GAAG-------
Drimia fugax              GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
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Drimia calcarata          GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Drimia undata             GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Drimiopsis botryoides     GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Drimiopsis maculata       GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Drimiopsis barteri        GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Galtonia princeps         ----------TGTGGATCTATTCCAATC-----------GAAG-------
Galtonia viridiflora      ----------TGTGGATCTATTCCAATC-----------GAAG-------
Galtonia candicans        ----------TGTGGATCTATTCCAATC-----------GAAG-------
Gasteria bicolorvar. lili.GTTATT-----GTGGATCTATTCCAATC-----------GAGG-------
Haworthia fasciata        GTTATT-----GTGGATCTATTCCAATC-----------GAGG-------
Kniphofia uvaria          ATTATT-----GTGGATCTATTCCAATC-----------GAGG-------
Muscari comosum           GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Nivenia corymbosa         GTTATT-----GTGGATCTATTCCAATC-----------GA---------
Nothoscordum bivalve      GTTATT-----GTGGATCTATTCCATTC-----------GAAG-------
Rhadamanthus sp.          GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Schizobasis sp.           GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Drimia intricata          GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Thuranthos indicum        GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Tulbaghia violacea        GTTATT-----GCGGATCTATTCCATTC-----------GAAGCGGATCT
Whiteheadia bifolia       GTTATT-----GTGGATCTATTCCAATC-----------GAAG-------
Witsenia maura            GCTATT-----GTGGATCTATTCCAATC-----------GA---------

Albuca sp.*               -------------TTGACGG-AAGAATCGA------------ATATTCA
Albuca nelsonii           -------------TTGACGG-AAGAATCGA------------ATATTCA
Albuca sp.                -------------TTGACGG-AAGAATCGA------------ATATTCA
Albuca shawii             -------------TTGACGG-AAGAATCGA------------ATATTCA
Bowiea volubilis*         -------------TTGACGG-AAGAATCGA------------ATATTCA
Bowiea volubilis          -------------TTGACGG-AAGAATCGA------------ATATTCA
Eriospermum cooperi*      -------------TTGAAGG-AAGAATCGA------------ATATTCA
Eriospermum flagelliforme -------------TTGAAGG-AAGAATCGA------------ATATTCA
Eucomis autumnalis*       -------------TTGACGG-AAGAATCGA------------ATA----
Eucomis punctata          -------------TTGACGG-AAGAATCGA------------ATA----
Gloriosa sp.              -------------TTGAAGG-AAGAATCGA------------ATATTCA
Ledebouria revoluta*      -------------TTGAAGG-AAGAATCGA------------ATATTCA
Ledebouria revoluta       -------------TTGAAGG-AAGAATCGA------------ATATTCA
Ledebouria socialis       -------------TTGAAGG-AAGAATCGA------------ATATTCA
Ledebouria somalensis     -------------TTGAAGG-AAGAATCGA--------ATATAATATTCA
Ledebouria cordifolia     -------------TTGAAGG-AAGAGTCGA------------ATATTCA
Ledebouria urceolata      -------------TTGAAGG-AAGAATCGA------------ATATTCA
Ornithogalum amphibolum   -------------TTGACGG-AAGAATAAA------------ATATTCA
Ornithogalum angustif.    -------------TTGACGG-AAGAATAAA------------ATATTCA
Ornithogalum fimbriatum   -------------TTGACGG-AAGAATAAA------------ATATTCA
Ornithogalum gussonei     -------------TTGACGG-AAGAATCAA------------ATATTCA
Ornithogalum longibr      -------------TTGACGG-AAGAATCGA------------ATATTCA
Ornithogalum montanum     -------------TTGACGG-AAGAATAAA------------ATATTCA
Ornithogalum pannonic.    -------------TTGACGG-AAGAATAAA------------ATATTCA
Ornithogalum paschean.    -------------TTGACGG-AAGAATAAA------------ATATTCA
Ornithogalum tenuifol.    -------------TTGACGG-AAGAATCGA------------ATATTCA
Ornithogalum umbellat.    -------------TTGACGG-AAGAATAAA------------ATATTCA
Ornithogalum wiedeman.    -------------TTGACGG-AAGAATAAA------------ATATTCA
Ornithoglossum viride     -------------TTGAAGG-AAGAATCGA------------ATATTCA
Asparagus laricin.        -------------TTGAAGG-AAGAATCGA------------ATATTCA
Sansevieria aethiopic.    -------------TTGAAGG-AAAAATCGA------------ATATTCA
Scadoxus membranaceus     ----------------AGA-AAGAATCGA------------ATATTCC
Schizocarphus nervosus*   -------------TTGACGG-AAGAATCGA------------ATA----
Schizocarphus nervosus    -------------TTGACGG-AAGAATCGA------------ATATTAA
Scilla peruviana          -------------TTGACGG-AAGAATCGA------------ATATTCA
Scilla lazulina           -------------TTGACGG-AAGAATCGA------------AAATTCA
Trachyandra sp.*          -------------TTGAAGG-AAGAATCGA------------ATATTTA
Trachyandra sp.           -------------TTGAAGG-AAGAATCGA----ATATAATATATATTTA
Drimia altissima*         -------------TTGACGG-AAGAATCGA------------ATATTCA
Urginea undulata          -------------TTGACGG-AAGAATCGA------------ATATTCA
Urginea sp.               -------------TTGACGG-AAGAATCGA------------ATATTCA
Veltheimia capensis*      -------------TTGACGG-AAGAATCGA------------ATATTCA
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Veltheimia bracteata      ----------TTGACGG-AAGAATCGA----------ATATTCA
Aloe vera                 ----------TTGAAGG-AAGAATCGA----------ATATTCA
Aloe bakeri               ----------TTGAAGG-AAGAATCGA----------ATATTCA
Bulbine wiesei            ----------TTGAAGG-AAGAATCGA----------ATATTCA
Bulbine semibarbata       ----------TTGAAGG-AAGAATCGA----------ATATTCA
Bulbine succulenta        ----------TTGAAGG-AAGAATCGA----------ATATTCA
Bulbinella cauda-felis    ----------TTGAAGG-AAAAATGGA----------ATATTCA
Dipcadi viride            ----------TTGACGG-AAGAATCGA----------ATATTCA
Dipcadi fulvum            ----------TTGACGG-AAGAATCGA----------ATATTCA
Drimia elata              ----------TTGACGG-AAGAATCGN----------ATATTCA
Drimia fugax              ----------TTGACGG-AAGAATCGA----------ATATTCA
Drimia calcarata          ----------TTGACGG-AACAATCGA----------ATATTCA
Drimia undata             ----------TTGACGG-AAGAATCGA----------ATATTCA
Drimiopsis botryoides     ----------TTGAAGG-AAGAATCGA----------ATATTCA
Drimiopsis maculata       ----------TTGAAGG-AAGAATCGA----------ATATTCA
Drimiopsis barteri        ----------TTGAAGG-AATAATCGA----------ATATTCA
Galtonia princeps         ----------TTGACGG-AAGAATCAA----------ATATTCA
Galtonia viridiflora      ----------TTGACGG-AAGAATCAA----------ATATTCA
Galtonia candicans        ----------TTGACGG-AAGAATCGA----------ATATTCA
Gasteria bicolorvar. lili.----------TTGAAGG-AAGAATCGA----------ATATTCA
Haworthia fasciata        ----------TTGAAGG-AAGAATCGA----------ATATTCA
Kniphofia uvaria          ----------TTGAAGG-AAGAATCGA----------ATATTCA
Muscari comosum           ----------TTGACGG-AAGAATCGA----------ATATTAA
Nivenia corymbosa         ------------------G-AAGAATCGA----------ATATTCG
Nothoscordum bivalve      ----------TTGAAGG-AAGAATCGA----------ATATTTA
Rhadamanthus sp.          ----------TTGACGG-AAGAATCGA----------ATATTCA
Schizobasis sp.           ----------TTGACGG-AAGAATCGA----------ATATTCA
Drimia intricata          ----------TTGACAG-AAGAATCGA----------ATATTCA
Thuranthos indicum        ----------TTGACGG-AAGAATCGA----------ATATTCA
Tulbaghia violacea        ATTCCATTCGAAGTTGAAGG-AAGAATCGA----------ATATTTA
Whiteheadia bifolia       ----------TTGACGG-AAGAATCGA----------ATATTCA
Witsenia maura            ------------------G-AAGAATCGA----------ATATTTG

Albuca sp.*               GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Albuca nelsonii           GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Albuca sp.                GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Albuca shawii             GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Bowiea volubilis*         GTAATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Bowiea volubilis          GTAATCAAATCATTC--ATTC-----CAGAGGT--------TAATAGA--
Eriospermum cooperi*      GTGATCAAATCATTC--ATTC-----CTGAGTT--------TG-------
Eriospermum flagelliforme GTGATCAAATCATTC--ATTC-----CAGAGTT--------TGATAGA--
Eucomis autumnalis*       GTGATCAAATCATTC-----------CAGAGTT--------TAATAAA--
Eucomis punctata          GTGATCAAATCATTC-----------CAGAGTT--------TAATAAA--
Gloriosa sp.              GTGATCAAATCATTC--ATTC-----CGGGGTC--------GGATAGAT-
Ledebouria revoluta*      GTGATCAAATCATTC--ATTC-----CAGAGCT--------TAATAGA--
Ledebouria revoluta       GTGATCAAATCATTC--ATTC-----CAGAGCT--------TAATAGA--
Ledebouria socialis       GTGATCAAATCATTC--ATTC-----CAGAGCT--------TAATAGA--
Ledebouria somalensis     GTGATCAAATCATTC--ATTC-----CAGAGCT--------TAATAGA--
Ledebouria cordifolia     GTGATCAAATCATTC--ATTC-----CAGATCT--------TAATAGA--
Ledebouria urceolata      GTGATCAAATCATTC--ATTC-----CAGA-GT--------TAATAGA--
Ornithogalum amphibolum   GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Ornithogalum angustif.    GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Ornithogalum fimbriatum   GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Ornithogalum gussonei     GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Ornithogalum longibr      GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Ornithogalum montanum     GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Ornithogalum pannonic.    GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Ornithogalum paschean.    GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Ornithogalum tenuifol.    GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Ornithogalum umbellat.    GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Ornithogalum wiedeman.    GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Ornithoglossum viride     GTGATCAAATCATTC--ATTC-----CGGAGTC--------GGATAGAT-
Asparagus laricin.        GTGATCAAATGATTC--ATTC-----CAGAGTT--------TGATATA--
Sansevieria aethiopic.    GTGATCAAATCGTTC--ATTC-----CAGAGTT--------TGATAGG--
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Scadoxus membranaceus      GTGATCAAATCATTC--ATTC-----CAGAGTT--------TGATAGA--
Schizocarphus nervosus*    GTGATCAAATCATTC-----------CAGAGTT--------TAATAAA--
Schizocarphus nervosus     GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Scilla peruviana           GTGATCAAATCATTC--GTTC-----CAGAGTT--------TAATAGAT-
Scilla lazulina            GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Trachyandra sp.*           GTGATCAAATCACTC--ATTC-----CAGAGTT--------TGATAGG--
Trachyandra sp.            GTGATCAAATCACTC--ATTC-----CAGAGTT--------TGATAGG--
Drimia altissima*          GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Urginea undulata           GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Urginea sp.                GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Veltheimia capensis*       GTGATCAAATCATTT--ATTC-----CAGAGTT--------TAATAGA--
Veltheimia bracteata       GTGATCAAATCATTT--ATTC-----CAGAGTT--------TAATAGA--
Aloe vera                  GTGATCCTATCACTC--ATTC-----CAGAGTT--------TGATAGG--
Aloe bakeri                GTGATCCTATCACTC--ATTC-----CAGAGTT--------TGATAGG--
Bulbine wiesei             GTGATCCTATCACTC--ATTC-----TATAGTT--------TGATAGGA-
Bulbine semibarbata        GTGATCCTATCACTC--ATTCCAGACCAGAGTT--------TGATAGG--
Bulbine succulenta         GTGATCCTATCACTC--ATTC-----CAGAGTT--------TGATAGG--
Bulbinella cauda-felis     GTGATCAAATCACTT--ATTC-----CAGAGTT--------TGATAGG--
Dipcadi viride             GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Dipcadi fulvum             GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Drimia elata               GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Drimia fugax               GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Drimia calcarata           GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Drimia undata              GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Drimiopsis botryoides      GTGATCAAATCATTC--ATTC-----CAGAGCT--------TAATAGA--
Drimiopsis maculata        GTGATCAAATCATTC--ATTC-----CAGAGCT--------TAATAGA--
Drimiopsis barteri         GTGATCAAATCATTC--ATTC-----CAGAGCT--------TAATAGA--
Galtonia princeps          GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Galtonia viridiflora       GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Galtonia candicans         GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Gasteria bicolorvar. lili.GTGATCCTATCACTC--ATTC-----CAGAGTT--------TGATAGG--
Haworthia fasciata         GTGATCCTATCACTC--ATTC-----CAGAGTT--------TGATAGG--
Kniphofia uvaria           GTGATCAAATCACTC--ATTC-----CAGAGTT--------TGATAGA--
Muscari comosum            GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Nivenia corymbosa          GTGATCTATCATTTC-----------AGAGTT--------TGATAGAT-
Nothoscordum bivalve       GTGATCAAATCATTC--ATTC-----CAGAGTT--------TGATAGA--
Rhadamanthus sp.           GTGATCAAATCATTC--ATTC-----CAGAGTT---TAATATAATAGA--
Schizobasis sp.            GTGATCAAATCATTC--ATTC-----CAGAATT--------TAATAGA--
Drimia intricata           GTGATCAAATCATTC--ATTC-----CAGAATT--------TAATAGA--
Thuranthos indicum         GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Tulbaghia violacea         GTGATCAAATCATTC--ATTC-----CAGAGTT--------TGATAGA--
Whiteheadia bifolia        GTGATCAAATCATTC--ATTC-----CAGAGTT--------TAATAGA--
Witsenia maura             GTGATCAAATCTATC--ATTC-----CAGAGTT--------TGATAGAT-

Albuca sp.*                --CCC---------TTTTTTGAAAAA----------CTGATTAATCGGA
Albuca nelsonii            --CCC---------TTTTTTGAAAAA----------CTGATTAATCGGA
Albuca sp.                 --CCC---------TTTTTTGAAAAA----------CTGATTAATCGGA
Albuca shawii              --CCC---------TTTTTTGAAAAA----------CTGATTAATCGGA
Bowiea volubilis*          --CC----------TTTTTTTGAAAAA----------CTGATTAATCGGA
Bowiea volubilis           --CC----------TTTTTTTGAAAAA----------CTGATTAATCGGA
Eriospermum cooperi*       --C-----------TTTTTTGAAAAA----------CTGATTAATCGGA
Eriospermum flagelliforme  --CC----------TTTTTTGAAAAA----------CTGATTAATCGGA
Eucomis autumnalis*        --CCC----------TTTTTGAAAAA----------CGGATTA-TCGGA
Eucomis punctata           --CCC----------TTTTTGAAAAA----------CGGATTAATCGGA
Gloriosa sp.               --C------------TTTTGAAAAAA----------TGATTAATCGGA
Ledebouria revoluta*       --CCC--------TTTTTTTGAAAAN----------CTGATTAATCGGA
Ledebouria revoluta        --CCC--------TTTTTTTGAAAAA----------CTGATTAATCGGA
Ledebouria socialis        --CCC--------TTTTTTTGAAAAA----------CTGATTAATCGGA
Ledebouria somalensis      --CCC--------TTTTTTTGAAAAA----------CTGATTAATCAGA
Ledebouria cordifolia      --CCC--------TTTTTTTGAAAAA----------CGGATTAATCGGA
Ledebouria urceolata       --CCC--------TTTTTTTGAAAAA----------CTGATTAATCAGA
Ornithogalum amphibolum    --CCC---------TTTTTTGAAAAA----------CTGATTAATCGGA
Ornithogalum angustif.     --CCC---------TTTTTTGAAAAA----------CTGATTAATCGGA
Ornithogalum fimbriatum    --CCC---------TTTTTTGAAAAA----------CTGATTAATCGGA
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Ornithogalum gussonei      --CCC---------TTTTTTGAAAAA----------CTGATTAATCGGA
Ornithogalum longibr       --CCC---------TTTTTTGAAAAA----------CGGATTAATCGGA
Ornithogalum montanum      --CCC---------TTTTTTGAAAAA----------CTGATTAATCGGA
Ornithogalum pannonic.     --CCC---------TTTTTTGAAAAA----------CTGATTAATCGGA
Ornithogalum paschean.     --CCC---------TTTTTTGAAAAA----------CTGATTAATCGGA
Ornithogalum tenuifol.     --CCC---------TTTTTTGAAAAA----------CGGATTAATCGAA
Ornithogalum umbellat.     --CCC---------TTTTTTGAAAAA----------CTGATTAATCGGA
Ornithogalum wiedeman.     --CCC---------TTTTTTGAAAAA----------CTGATTAATCGGA
Ornithoglossum viride      --C-------------TTTTGAAAAAAAAA------AATGATTAATCGGA
Asparagus laricin.         --CC---------TTTTTTTGAAAAA----TTGATTAATGATTAATCGGA
Sansevieria aethiopic.     --CCC--------TTTTTTTGAAAAAA----------TGATTAATCGGA
Scadoxus membranaceus      --CC-------TTTTTTTTTGAAAAAAAAAA------TGATTAATCGGG
Schizocarphus nervosus*    --CCC----------TTTTTGAAAAA----------CGGATTAATCGGA
Schizocarphus nervosus     --CCC--------TTTTTTTGAAAAA----------CTGATTAATCGAA
Scilla peruviana           --CC--------TTTTTTTTGAAAAA----------CTGATTAGATTAA
Scilla lazulina            --CCC--------TTTTTTTGAAAAA----------CTGATTAATCGGA
Trachyandra sp.*           --CC--------TTTTTTTTGAAAAA----------CTGATTAATCGGA
Trachyandra sp.            --CC-------TTTTTTTTTGAAAAAA----------TGATTAATTGGG
Drimia altissima*          ------------TTTTTTTTGAAAAA----------CTGATTAACCGGA
Urginea undulata           --C---------TTTTTTTT-AAAAA----------CTGATTAACCGGA
Urginea sp.                ------------TTTTTTTTGAAAAA----------CTGATTAACCGGA
Veltheimia capensis*       --CCC---------TTTTTTGAAAAA----------CTGATTAATCGGA
Veltheimia bracteata       --CCC------TTTTTTTTTGAAAAA----------CTGATTAATCGGA
Aloe vera                  --CC-----TTTTTTTTTTTTGAAAAA----------CTGATGAATTGGA
Aloe bakeri                --CC---TTTTTTTTTTTTTTGAAAAA----------CTGATGAATTGGA
Bulbine wiesei             --C-----TTTTTTTTTTTT-AA--------------CTGATTAATTGGA
Bulbine semibarbata        --CC-------TTTTTTTTT-AA--------------CTGATTAATCGGA
Bulbine succulenta         --CC------TTTTTTTTTT-AA--------------CTGATTAATCGGA
Bulbinella cauda-felis     --CC------TTTTTTTTTTGAAAAA----------CTGATTAATCGTA
Dipcadi viride             --CCC---------TTTTTTGAAAAA----------CTGATTAATCGGA
Dipcadi fulvum             --CCC---------TTTTTTGAAAAA----------CTGATTAATCGGA
Drimia elata               ------------TTTTTTTTGAAAAA----------CTGATTAACCGGA
Drimia fugax               --C---------TTTTTTTT-AAA-------------CTGATTAACCGGA
Drimia calcarata           --C----------TTTTTTTGAAAAA----------CTAATTAACCGGA
Drimia undata              --C---------TTTTTTTT-AAAAA----------CTGATTAACCGGA
Drimiopsis botryoides      --CCC--------TTTTTTTGAAAAA----------CTGATTAGATTAA
Drimiopsis maculata        --CCC--------TTTTTTTGAAAAA----------CTGATTAATCGAA
Drimiopsis barteri         --CCC--------TTTTTTTGAAAAA----------CTGATTAATCGGA
Galtonia princeps          --CCC-------TTTATTTT-AAAAA----------CTGATTAATCGGA
Galtonia viridiflora       --CCC-------TTTATTTT-AAAAA----------CTGATTAATCGGA
Galtonia candicans         --CCC---------TTTTTTGAAAAA----------CTGATTAATCGGA
Gasteria bicolorvar. lili.--CC------TTTTTTTTTTGAAAAA----------CTGATTAATTGGA
Haworthia fasciata         --CC-------TTTTTTTTTGAAAAA----------CTGATTAATTGGA
Kniphofia uvaria           --CC--------TTTTTTTTGAAAAA----------ATGATTAATCGGA
Muscari comosum            --CCC--------TTTTTTTGAAAAA----------CTGATTAATCGGA
Nivenia corymbosa          --C-------------TTTTGAAAAA----------CGGATTAATCGG-
Nothoscordum bivalve       --CCC-------TTTTTTTT-A---------------ATGATTAATCGGA
Rhadamanthus sp.           --C----------TTTTTTTGAAAAA----------CTGATTAACCGGA
Schizobasis sp.            --C----------TTTTTTT-AAAAAA----------CAGATTAACCGGA
Drimia intricata           --C----------TTTTTTT-AAAAAA----------CTGATTAACCGGA
Thuranthos indicum         --C-------TTTTTTTTTT-AAA-------------CTGATTAACCGGA
Tulbaghia violacea         --C--------TTTTTTTTTCAAAAAAAAAAAA-----TGATTAATCGGA
Whiteheadia bifolia        --CCC--------TTTTTTTGAAAAA----------CTGATTAATCGTA
Witsenia maura             --C-------------TTTTGAAAAA----------CGGATTAATCGGA

Albuca sp.*                -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Albuca nelsonii            -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Albuca sp.                 -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Albuca shawii              -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Bowiea volubilis*          -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Bowiea volubilis           -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Eriospermum cooperi*       -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Eriospermum flagelliforme  -------CGAGAATAAAGAGAGAGTCCNATTCTACATGTCAATA------
Eucomis autumnalis*        -------CGAGAATAAAGAGAGAGTCCCGTTCTACATGTCAATA-----T
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Eucomis punctata          -------CGAGAATAAAGAGAGAGTCCCGTTCTACATGTCAATA-----T
Gloriosa sp.              -------CGAGAATAAAGAGAGAGTCCTGTTCTACGTGTCAAT-------
Ledebouria revoluta*      -------CGAGAATAAAGAGAGAGTCCCGTTCTACATGTCAATA------
Ledebouria revoluta       -------CGAGAATAAAGAGAGAGTCCCGTTCTACATGTCAATA------
Ledebouria socialis       -------CGAGAATAAAGAGAGAGTCCCGTTCTACATGTCAATA------
Ledebouria somalensis     -------CGAGAATAAAGAGAGAGTCCCGTTCTACATGTCAATA------
Ledebouria cordifolia     -------CGAGAATAAAGAGAGAGTAAAGTTCTACATGTCAATA------
Ledebouria urceolata      -------CGAGAATAAAGAGAGAGTCCCGTTCTACATGTCAATA------
Ornithogalum amphibolum   -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Ornithogalum angustif.    -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Ornithogalum fimbriatum   -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Ornithogalum gussonei     -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Ornithogalum longibr      -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Ornithogalum montanum     -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Ornithogalum pannonic.    -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Ornithogalum paschean.    -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Ornithogalum tenuifol.    -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Ornithogalum umbellat.    -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Ornithogalum wiedeman.    -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Ornithoglossum viride     -------CGAGAATAAAGAGAGAGTCCTGTTCTACGTGTCAATA------
Asparagus laricin.        -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Sansevieria aethiopic.    -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Scadoxus membranaceus     -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Schizocarphus nervosus*   -------CGAGAATAAAGAGAGAGTCCCGTTCTACATGTCAATA-----T
Schizocarphus nervosus    -------CGAGAATAAAGAGAGAGTCCCGTTCTACATGTCAATACTGAAT
Scilla peruviana          TCGGA--CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATAC-----
Scilla lazulina           -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATAC-----
Trachyandra sp.*          -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Trachyandra sp.           -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Drimia altissima*         -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Urginea undulata          -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Urginea sp.               -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Veltheimia capensis*      -------CGAGAATAAAGAGAGAGTCCCGTTCTACATGTCAATA------
Veltheimia bracteata      -------CGAGAATAAAGAGAGAGTCCCGTTCTACATGTCAATA------
Aloe vera                 -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Aloe bakeri               -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Bulbine wiesei            -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Bulbine semibarbata       -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Bulbine succulenta        -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Bulbinella cauda-felis    -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Dipcadi viride            -------CGAGAATAAAGAGAGAGTCCCGTTCTACATGTCAATA------
Dipcadi fulvum            -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Drimia elata              -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Drimia fugax              -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Drimia calcarata          -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Drimia undata             -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Drimiopsis botryoides     TCGGA--CGAGAATAAAGAGAGAGTCCCGTTCTACATGTCAATA------
Drimiopsis maculata       -------CGAGAATAAAGAGAGAGTCCCGTTCTACATGTCAATA------
Drimiopsis barteri        -------CGAGAATAAAGAGAGAGTCCCGTTCTACATGTCAATA------
Galtonia princeps         -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Galtonia viridiflora      -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Galtonia candicans        -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Gasteria bicolorvar. lili.-------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Haworthia fasciata        -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Kniphofia uvaria          -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Muscari comosum           -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Nivenia corymbosa         -----GTAGAGAATAAAGAGAGAGTCCCATTCTACATGTTAATA------
Nothoscordum bivalve      -------CGAGAATAAAGAGAGAGTCCCGTTCTACATGTCAATA------
Rhadamanthus sp.          -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Schizobasis sp.           -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Drimia intricata          -------CGAGAACAAAGAGAGAGTCCCATTCTACATGTCAATA------
Thuranthos indicum        -------CGAGAATAAAGAGAGAGTCCCATTCTACATGTCAATA------
Tulbaghia violacea        -------CAAGAATAAAGAGAGAGTCCCGTTCTACATGTCAATA------
Whiteheadia bifolia       -------CGAGAATAAAGAGAGAGTCCCGTTCTACATGTCAATA------
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Witsenia maura              ------TAGAGAATAAAGAGAGAGTCCCATTCTACATGTTAATA------

Albuca sp.*                 -------CCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Albuca nelsonii             -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Albuca sp.                  -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Albuca shawii               -------CCGACAACAATGAA-TTTATAGTAAGAGGAAAATCCGTCGACT
Bowiea volubilis*           -------CCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Bowiea volubilis            -------CCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Eriospermum cooperi*        -------CCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Eriospermum flagelliforme   -------CCGANAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Eucomis autumnalis*         GTCAATANCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Eucomis punctata            GTCAATACCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Gloriosa sp.                -------CCG-CAGCAATGAAATTTATAGTATTAGGAAAATCCGTCGACT
Ledebouria revoluta*        -------CCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Ledebouria revoluta         -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Ledebouria socialis         -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Ledebouria somalensis       -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Ledebouria cordifolia       -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Ledebouria urceolata        -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Ornithogalum amphibolum     -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Ornithogalum angustif.      -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Ornithogalum fimbriatum     -------CCGACAACAATGAAATTTATAGTAAGNGGNNNNNNNNNNNNN
Ornithogalum gussonei       -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Ornithogalum longibr        -------CCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Ornithogalum montanum       -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Ornithogalum pannonic.      -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Ornithogalum paschean.      -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Ornithogalum tenuifol.      -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Ornithogalum umbellat.      -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Ornithogalum wiedeman.      -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Ornithoglossum viride       -------CCGACAGCAATGAAATTTATAGTATTAGGAAAATCCGTCGACT
Asparagus laricin.          -------CCGACAACAATGAAATTTATAGTAAAAGGAAAATCCGTCGACT
Sansevieria aethiopic.      -------CCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Scadoxus membranaceus       -------CCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Schizocarphus nervosus*     GTCAATAC-GACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Schizocarphus nervosus      GTCAATACTGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Scilla peruviana            --------CGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Scilla lazulina             --------CGACAACAATGAAATTTATAGTAAGAGGATAAANNNNNNNNN
Trachyandra sp.*            -------CCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Trachyandra sp.             -------CCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Drimia altissima*           -------CCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Urginea undulata            -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Urginea sp.                 -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Veltheimia capensis*        -------CCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Veltheimia bracteata        -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Aloe vera                   -------CCGACAACAATGAAATTTATAGTAAGAGGAAA-TCCGTCGACT
Aloe bakeri                 -------CCGACAACAATGAA-TTTATAGTAAGAG-AA--TC-GTCGACT
Bulbine wiesei              -------CCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Bulbine semibarbata         -------CCGACAACAAGGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Bulbine succulenta          -------CCGACAACAAGGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Bulbinella cauda-felis      -------CCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Dipcadi viride              -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Dipcadi fulvum              -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Drimia elata                -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Drimia fugax                -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Drimia calcarata            -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Drimia undata               -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Drimiopsis botryoides       -------CCGACANNAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Drimiopsis maculata         -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Drimiopsis barteri          -------CCGACAANAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Galtonia princeps           -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Galtonia viridiflora        -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Galtonia candicans          -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNN
Gasteria bicolorvar. lili.-------CCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
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Haworthia fasciata          -------CCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Kniphofia uvaria            -------CCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Muscari comosum             -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNNN
Nivenia corymbosa           -------ACGACAACAATGAAATTTTTAGTAAAAGGAAAATCCGTCGACT
Nothoscordum bivalve        -------ACGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Rhadamanthus sp.            -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNNN
Schizobasis sp.             -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNNN
Drimia intricata            -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNNN
Thuranthos indicum          -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNNN
Tulbaghia violacea          -------CCGACAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGACT
Whiteheadia bifolia         -------CCGACAACAATGAAATTTATAGTAAGAGGNNNNNNNNNNNNNN
Witsenia maura              -------ACGACAACAATGAAATTTATAGTAAAAGGAAAATCCGTCGACT

Albuca sp.*                 TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAATAAACTGTCCCCA
Albuca nelsonii             NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATAAACTGTCCCCA
Albuca sp.                  NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Albuca shawii               TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCNNNNNNNNNNNNNNA
Bowiea volubilis*           TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAATA-----------
Bowiea volubilis            TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAATA-----------
Eriospermum cooperi*        TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAATA-----------
Eriospermum flagelliforme   NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATA-----------
Eucomis autumnalis*         TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAATAAACTGTCCCCA
Eucomis punctata            NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATAAACTGTCCCCA
Gloriosa sp.                TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAATA-----------
Ledebouria revoluta*        TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAATA-----------
Ledebouria revoluta         NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATA-----------
Ledebouria socialis         NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATA-----------
Ledebouria somalensis       NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATA-----------
Ledebouria cordifolia       NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATA-----------
Ledebouria urceolata        NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATA-----------
Ornithogalum amphibolum     NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATAAATTGTCCCCA
Ornithogalum angustif.      NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATAAATTATCCCCA
Ornithogalum fimbriatum     NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATAAATTGTCCCCA
Ornithogalum gussonei       NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATAAATTGTCCCCA
Ornithogalum longibr        TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAATAAACTGTCCCCA
Ornithogalum montanum       NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATAAATTGTCCCCA
Ornithogalum pannonic.      NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATAAATTATCCCCA
Ornithogalum paschean.      NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATAAATTGTCCCCA
Ornithogalum tenuifol.      NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATAANCTGTCCCCA
Ornithogalum umbellat.      NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATAAATTATCCCCA
Ornithogalum wiedeman.      NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNAGAAATTGTCCCCA
Ornithoglossum viride       TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAATA-----------
Asparagus laricin.          TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAATA-----------
Sansevieria aethiopic.      TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAATA-----------
Scadoxus membranaceus       TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAGTA-----------
Schizocarphus nervosus*     TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAATAA-CTGTCCCCA
Schizocarphus nervosus      NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATAAACTGTCCCCA
Scilla peruviana            NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATAAACTGTCCCCA
Scilla lazulina             NNNNNNNNNNNNNNNNNNNCTGTCCC------------------------
Trachyandra sp.*            TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAATC-----------
Trachyandra sp.             TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAATA-----------
Drimia altissima*           TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAATA-----------
Urginea undulata            NNNNNNNNNNNNNNNNNNNNNNNNNNNNNN--------------------
Urginea sp.                 NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATA-----------
Veltheimia capensis*        TTAGAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAATAAACTGTCCCCA
Veltheimia bracteata        NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATAAACTGTCCCCA
Aloe vera                   TTAGAAATCGTGAGNNNNNNNNNNNNNNNNNNNGGTTCAAGTCCCTCTAT
Aloe bakeri                 TT---AATCGTGAGGGTTCAAGTCCCNNNNNNNNNNNNNNNNNNNNNNNN
Bulbine wiesei              TTAGAAATCGTGAGGGTTCAAGTCCCTCTAT--------------CCCCA
Bulbine semibarbata         TTAGAAATCGTGAGGGTTCAAGTCCCTCTAT--------------CCCCA
Bulbine succulenta          TTAGAAATCGTGAGGGTTCAAGTCCCTCTAT--------------CCCCA
Bulbinella cauda-felis      TTAGAAATCGTGAGGGTTCAAGTCCCTCTAT--------------CCCCA
Dipcadi viride              NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATAAACTGTCCCCA
Dipcadi fulvum              NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNATAAACTGTCCCCA
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Drimia elata                NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Drimia fugax                NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Drimia calcarata            NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Drimia undata               NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Drimiopsis botryoides       NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Drimiopsis maculata         NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Drimiopsis barteri          NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Galtonia princeps           NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Galtonia viridiflora        NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Galtonia candicans          NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Gasteria bicolorvar. lili.  TTAGAAATCGTGAGGGTTCAAGTCCTTCTAT--------------CCCCA
Haworthia fasciata          TTAGAAATCGTGAGGGTTCAAGTCCCTCTAT--------------CCCCA
Kniphofia uvaria            TTAGAAATCGTGAGGGTTCAAGTCCCTCTAT--------------CCCCA
Muscari comosum             NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Nivenia corymbosa           TTAGAAATCGTGAGGGTTCAAGTCCCTCTAT--------------CCCCA
Nothoscordum bivalve        TTAGAAATCGTGAGGGTTCATGTCCCTCTAT--------------CCCCA
Rhadamanthus sp.            NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Schizobasis sp.             NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Drimia intricata            NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Thuranthos indicum          NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Tulbaghia violacea          TTAGAAATCGTGAGGGTTCAAGTCCCTCTAT--------------CCCCA
Whiteheadia bifolia         NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Witsenia maura              TTAGAAATCGTGAGGGTTCAAGTCCCTCTAT--------------CCCCA

Albuca sp.*                 ATAAAATAAAAAGCCCATTTTACTTCT--------------------TAA
Albuca nelsonii             ATAAAATAAAAAGCCCATTTTACTTCT--------------------TAA
Albuca sp.                  ATAAAA-AAAAAGCCCATTTTACTTCT--------------------TAA
Albuca shawii               ATAAAA---AAAGCCCATTTTACTTCT--------------------TAA
Bowiea volubilis*           ---------AAAGCCCATTTTACTTCT--------------------TAA
Bowiea volubilis            ---------AAAGCCCATTTTACTTCT--------------------TAA
Eriospermum cooperi*        --------AAAAGCCCATTTTACTTCT--------------------TAA
Eriospermum flagelliforme   --------AAAAGTCCATTTTACTTCT--------------------TAA
Eucomis autumnalis*         A-----TAAAAAGCCCGTTTTACTTCT--------------------TAA
Eucomis punctata            A-----TAAAAAGCCCGTTTTACTTCT--------------------TAA
Gloriosa sp.                ---------AAAGCTCCTTTGACTTTC--------------------TAA
Ledebouria revoluta*        ---------AAAGCCCATTTTACTTCT---------------TTACTATA
Ledebouria revoluta         ---AAATAAAAAGCCCATTTTAATTCT--------------------TTA
Ledebouria socialis         --------AAAAGCCCATTTTACTTCT--------------------TTA
Ledebouria somalensis       ---AAATAAAAAGCCCATTTTAATTCT--------------------TTA
Ledebouria cordifolia       --------AANNNCCCATTTTACTTCT--------------------TTA
Ledebouria urceolata        ---AAATAAAAAGCCCATTTTACTTCT--------------------TTA
Ornithogalum amphibolum     ATA-----AAAAGCCCATTTTACT-----------------------ATA
Ornithogalum angustif.      ATA-----AAAAGCCCATTTTACT-----------------------ATA
Ornithogalum fimbriatum     ATA-----AAAAGCCCATTTTACT-----------------------ATA
Ornithogalum gussonei       ATA-----AAAAGCCCATTTTACT-----------------------ATA
Ornithogalum longibr        ATAAAATAAAAAGCCCATTTTACTTCT--------------------TAA
Ornithogalum montanum       ATA-----AAAAGCCCATTTTACT-----------------------ATA
Ornithogalum pannonic.      ATA-----AAAAGCCCATTTTACT-----------------------ATA
Ornithogalum paschean.      ATA-----AAAAGCCCATTTTACT-----------------------ATA
Ornithogalum tenuifol.      CTAAAATAAAAAGCCCATTTTACTTCT--------------------TAA
Ornithogalum umbellat.      ATA-----AAAAGCCCATTTTACT-----------------------ATA
Ornithogalum wiedeman.      ATA-----AAAAGCCCATTTTACT-----------------------ATA
Ornithoglossum viride       ---------AAAGCCCCTTTGACTTAC--------------------TAA
Asparagus laricin.          --------AAAAGCCCATTTT---------------------TTAATTAA
Sansevieria aethiopic.      --------AAAAGCCCATTTTACTTCT--------------------TAC
Scadoxus membranaceus       --------AAAAGCCCATTTCACTTCT--------------------TAA
Schizocarphus nervosus*     NTA-----AAANGCCNGTTTNACTTCT----------------AACTATA
Schizocarphus nervosus      ATA-----AAAAGCCCATTTTACTTCT--------------------TAA
Scilla peruviana            ATAAAATAAAAAGCCCATTTTACTATTTTCCGGCGGAACTATTTATTTAA
Scilla lazulina             --------CAAAGCCCATTTTACTTCT--------------------TAA
Trachyandra sp.*            --------AAAAGCCCATTTTACTTCT--------------------TAA
Trachyandra sp.             --------AAAAGCCCATTTTACTTCT--------------------TAA
Drimia altissima*           ---------AAAGCCCATTTTACTTCT--------------------TAA
Urginea undulata            ------AAAAAAGCCCATTTTACTTCT--------------------TAA
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Urginea sp.                --------AAAAGCCCATTTTCAGTCT--------------------TAA
Veltheimia capensis*       ATA-----AAAAGCCCATTTGACTTCT--------------------TAA
Veltheimia bracteata       ATA-----AAAAGCCCATTTGACTTCT--------------------TAA
Aloe vera                  CCCCAATAAAAAGCCCATTTTACTTCT--------------------TAA
Aloe bakeri                NNNNNNNNNNNNNNNNNNNTTACTTCT--------------------TAA
Bulbine wiesei             ATA-----AAAAGCCCATTTTACKTCT----------TAAGTATAGTTAA
Bulbine semibarbata        ATA-----AAAAGCCCATTTTACTTCT----------TAAG---AGTTAA
Bulbine succulenta         ATA-----AAAAGCCCATTTTACTTCT----------TAAGTATAGTTAA
Bulbinella cauda-felis     ATA-----AAAAGCCCCTTTTTACTTC-----------TTAACTATTTAA
Dipcadi viride             ATA-----AAAAGCCCATTTTATTTCT--------------------TAA
Dipcadi fulvum             ATA-----AAAAGCCCATTTTATTTCT--------------------TAA
Drimia elata               ATA------AAAGCCCATTTTACTTCT--------------------TAA
Drimia fugax               ATA------AAAGCCCATTTTACTTCT--------------------TAA
Drimia calcarata           ATA------AAAGCCCATTTTACTTCT--------------------TAA
Drimia undata              AAA------AAAGCCCATTTTACTTCT--------------------TAA
Drimiopsis botryoides      ATA-----AAAAGCCCATTTTACTTCT--------------------TTA
Drimiopsis maculata        ATA-----AAAAGCCCATTTTACTTCT--------------------TTA
Drimiopsis barteri         ATN-----AAAAGCCCATTTTACTTCT--------------------TTA
Galtonia princeps          ATA-----AAAAGCCCATTTTACTTCT--------------------TAA
Galtonia viridiflora       ATA-----AAAAGCCCATTTTACTTCT--------------------TAA
Galtonia candicans         ATA-----AAAAGCCCATTTTACTTCT--------------------TAA
Gasteria bicolorvar. lili.ATA-----AAAAGCCCTTTTTACTTCT--------------------TAA
Haworthia fasciata         ATA-----AAAAGCCCATTTTACTTCT--------------------TAA
Kniphofia uvaria           ATA-----AAAAGCCCATTTTACTTCT--------------------TAA
Muscari comosum            ATAAAATAAAAAGCCCGTTTTACTTCC----------------------
Nivenia corymbosa          ATA-----AAAAGTCCATTTTACTTCC--------------------TCA
Nothoscordum bivalve       GTA-----AAAAGCCCATTTTACTTCT--------------------TAA
Rhadamanthus sp.           ATA------AAAGCCCATTTTACTTCT--------------------TAA
Schizobasis sp.            ATA------AAAGCCCATTTTACTTCT--------------------TAA
Drimia intricata           ATA------AAAGCCCATTTTACTTCT--------------------TAA
Thuranthos indicum         ATA-------AAGACCATTTTACTTCT--------------------TAA
Tulbaghia violacea         GTA-----AAAAGCCCATTTTACTTCT--------------------TAA
Whiteheadia bifolia        ATA-----AAAAGACCATTTGANTTCT--------------------TAA
Witsenia maura             ATA-----AAAAGTCCATTTTACTTCC--------------------TAA

Albuca sp.*                CTA----------------------TTTATCCTCT----TTTTTTT----
Albuca nelsonii            CTA----------------------TTTATCCTCT----TTTTTTT----
Albuca sp.                 GTA----------------------TTTATCCTCT----TTTTTTTT---
Albuca shawii              GTA----------------------TTTATCCTCT----TTTTTTTTT--
Bowiea volubilis*          CTA----------------------TTT--CTTCT----TTTTTTT----
Bowiea volubilis           CTA----------------------TTT--CTTCT----TTTTTTT----
Eriospermum cooperi*       CTA----------------------TTTATCCTCT----TTTTT------
Eriospermum flagelliforme  CTA----------------------TTTATCCTCT----TTTTTT-----
Eucomis autumnalis*        CTATACTA-----------------TTTATCCTCC----TTTTTTTTT--
Eucomis punctata           CTATACTA-----------------TTTATCCTCC----TTTTTTTTT--
Gloriosa sp.               CTAGACTTCCTAATTATTTTC-TTATCCTAT--------TTTTT------
Ledebouria revoluta*       CTA----------------------TTTATCCTCTCC--TTTTT------
Ledebouria revoluta        CTA----------------------TTTATCCTCCCC--TTTTT------
Ledebouria socialis        CTA----------------------TTTATCCTCCCC--TTTTT------
Ledebouria somalensis      CTATTTATTAATTTTTTACTAT----TTATCCTCCCC--TTTTT------
Ledebouria cordifolia      CTA----------------------TTTATCCTCCCC--TTTTT------
Ledebouria urceolata       TTTACTAT-----------------ATTATCCTCCCC--TTTTT------
Ornithogalum amphibolum    CTA----------------------TTTATCCTCT----TTTTTTT----
Ornithogalum angustif.     CTA----------------------TTTATCCTCT----TTTTTTT----
Ornithogalum fimbriatum    CTA----------------------TTTATCCTCT----TTTTTTT----
Ornithogalum gussonei      CTA----------------------TTTATCCTCT----TTTTTTT----
Ornithogalum longibr       CTA----------------------TTTATCCTCT----TTTTTTTT---
Ornithogalum montanum      CTA----------------------TTTATCCTCT----TTTTTTTT---
Ornithogalum pannonic.     CTA----------------------TTTATCCTCT----TTTTTTT----
Ornithogalum paschean.     CTA----------------------TTTATCCTCT----TTTTTTT----
Ornithogalum tenuifol.     CTA------------------TTTATTTATCCTCT----TTTTTTT----
Ornithogalum umbellat.     CTA----------------------TTTATCCTCT----TTTTTTT----
Ornithogalum wiedeman.     CTA----------------------TTTATCCTCT----TTTTTTT----
Ornithoglossum viride      CTAGACTTCCTAATTATTTT-----CTTATTCCCA----TTTTTATCT--
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Asparagus laricin.          CTA------------------TTTATTTATCCTCT----TTTTTTTTT--
Sansevieria aethiopic.      CTA------------------TTTAGTTATTCTCT----TTTTTTTTT--
Scadoxus membranaceus       CTA----------------------TTTATCCTCT----TTTTT------
Schizocarphus nervosus*     CTA----------------------TTTATCCTCC----TTTTTTTTT--
Schizocarphus nervosus      CTA----------------------TTTATCCTCC----TTTTTTTTTT-
Scilla peruviana            CTA----------------------TTTATCCTCC----TTTTTT-----
Scilla lazulina             CTA----------------------TTTATCCTCC----TTTTTTT----
Trachyandra sp.*            CTATACTA-----------------TTTATCCTCT----TTTTTTT----
Trachyandra sp.             CTATACTA-----------------TTTATCCTCT----TTTTTTTT---
Drimia altissima*           CTA----------------------TTT--CTTCT----TTTTTTTTTTG
Urginea undulata            CTA----------------------TTT--CTTCT----TTTTTTTTT--
Urginea sp.                 CTA----------------------TTT--CTTCT----TTTTTTTTT--
Veltheimia capensis*        CTA----------------------TTTATCCTCT----TTTTTTTTTT-
Veltheimia bracteata        CTA----------------------TTTATCCTCT----TTTTTTTTT--
Aloe vera                   CTATACTA-----------------TTTATCTTCT----TTTTTTTTTT-
Aloe bakeri                 CTATACTA-----------------TTTACCTTCT----TTTTTT-----
Bulbine wiesei              CTATA--------------------ATTATCTTCT----TTTTTTTTTT-
Bulbine semibarbata         CTATAA---------------TTAATTATTCTCT----TTTTTTTTT--
Bulbine succulenta          CTATACTATAAAACTATAAATTCAAATTATCCTCT----TTTTTTTTT--
Bulbinella cauda-felis      CTATACTA-------------TTTATTTATCTTCT----TTTTTTT----
Dipcadi viride              CTA----------------------TTTATCCTC-----TTTTTTTT---
Dipcadi fulvum              CTA----------------------TTTATCCTC-----TTTTTTTTT--
Drimia elata                CTA----------------------TTTCTTCTT-----TTTTTTTTTTT
Drimia fugax                CTA----------------------TTTCTTCTT-----TTTTTTT----
Drimia calcarata            CTA----------------------TTTCTTCTT-----TTTTTTTT---
Drimia undata               CTA----------------------TTTCTTCTT-----TTTTTTTT---
Drimiopsis botryoides       CTA----------------------TTTATCCTCCCC--TTTTT------
Drimiopsis maculata         CTA----------------------TTTATCCTCCCC--TTTTT------
Drimiopsis barteri          CTA----------------------TTTATCCTCCCCG-TTTT-------
Galtonia princeps           CTA----------------------TTTATCCTC-----TTTTTTT----
Galtonia viridiflora        CTA----------------------TTTATCCTC-----TTTTTTT----
Galtonia candicans          CTA----------------------TTTATCCTC-----TTTTTTT----
Gasteria bicolorvar. lili.CTATACTA-----------------TTTATCCTC-----TTTTTTT----
Haworthia fasciata          CTATACTA-----------------TTTATCCTC-----TTTTTTT----
Kniphofia uvaria            CTATACTA-----------------TTTATCCTT-----TTTTTTTT---
Muscari comosum             ---------------------------------------TTTTTT-----
Nivenia corymbosa           CGATTTCTATTATT-----------ATTATATTC-----TTTTTTTTT--
Nothoscordum bivalve        CTA--------------TTTATCCTCTTATCCTCC----TTTTTTTTTT-
Rhadamanthus sp.            CTA----------------------TTTCTTCTT-----TTTTTTT----
Schizobasis sp.             CTA----------------------TTTCTTCTT-----TTTTTTTT---
Drimia intricata            CTA----------------------TTTCTTCTT-----TTTTTTTT---
Thuranthos indicum          CTA----------------------TTTCTTCTT-----TTTTTT-----
Tulbaghia violacea          CTA--------------TTTATCC--TTATCCTC-----TTTTTTTT---
Whiteheadia bifolia         CTA----------------------TTTATCTTCC----TTTTTTT----
Witsenia maura              CTATACTATTTCT------------ATTATATTC-----TTTTTTTTTT

Albuca sp.*                 -------------------TGTAAGCGGTTCAAAGAAAATTCAA-----T
Albuca nelsonii             -------------------TGTAAGCGGTTCAAAGAAAATTCAA-----T
Albuca sp.                  -------------------CGTAAGCGGTTCAAAGAAAATTCAA-----T
Albuca shawii               -------------------CGTAAGCGGTTCAAAGAAAATTCAA-----T
Bowiea volubilis*           -------------------CGTAAGTGGTTCAAAGAAAATTCAA-----T
Bowiea volubilis            -------------------CGTAAGTGGTTCAAAGAAAATTCAA-----T
Eriospermum cooperi*        -------------------CATAAGAGGTTCAAAGAAAATTCAA-----T
Eriospermum flagelliforme   -------------------CATAATAGGTTCAAAGAAAATTCAA-----T
Eucomis autumnalis*         -------------------CGTAAGCGGTTCAA------TTCAA-----T
Eucomis punctata            -------------------CGTAAGCGGTTCAA------TTCAA-----T
Gloriosa sp.                ---------------ATCTTATTGGGGATTCAAACAAAATTGAC-----T
Ledebouria revoluta*        -------------------CGTAAGCGGTTCAAATAAA-TTCAA-----T
Ledebouria revoluta         -------------------CGTAAGCGGTTCAAATAAA-TTCAA-----T
Ledebouria socialis         -------------------CGTAAGCGGTTCAAATAAA-TTCAA-----T
Ledebouria somalensis       -------------------CGTAAGCGGTTCAAATAAA-TTCAA-----T
Ledebouria cordifolia       -------------------CGTAAGCGGTTNNAATAAA-TTCAA-----T
Ledebouria urceolata        -------------------CGTAAGCGGTTCAAATAAA-TTCAA-----T
Ornithogalum amphibolum     -------------------CGTAAGCGGTTCAAAGAAAATTCAA-----T
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Ornithogalum angustif.    -------------------CGTAAGCGGTTCAAAGAAAATTCAA-----T
Ornithogalum fimbriatum   -------------------CGTAAGCGGTTCAAAGAAAATTCAA-----T
Ornithogalum gussonei     -------------------CGTAAGCGGTTCAAAGAAAATTCAA-----T
Ornithogalum longibr      -------------------CGTAAGCGGTTCAAAGAAAATTCAA-----T
Ornithogalum montanum     -------------------CGTAAGCGGTTCAAAGAAAATTCAA-----T
Ornithogalum pannonic.    -------------------CGTAAGCGGTTCAAAGAAAATTCAA-----T
Ornithogalum paschean.    -------------------CGTAAGCGGTTCAAAGAAAATTCAA-----T
Ornithogalum tenuifol.    -------------------CGTAAGCGGTTCAAAGAAAATTCAA-----T
Ornithogalum umbellat.    -------------------CGTAAGCGGTTCAAAGAAAATTCAA-----T
Ornithogalum wiedeman.    -------------------CGTAAGCGGTTCAAAGAAAATTCAA-----T
Ornithoglossum viride     -------------------TATTGGGGATTCAAACAAAATTGRC-----T
Asparagus laricin.        -------------------CATAAGAAGTTCAAAGAAAATTCAA-----T
Sansevieria aethiopic.    -------------------CATAAGAAGTTCAAGGAAAATTCAA-----T
Scadoxus membranaceus     -------------------CATAAGCGGTTCAAAGAAAATTCAA-----T
Schizocarphus nervosus*   -------------------CGTAAGCGGTTCAA------TTCAA-----T
Schizocarphus nervosus    -------------------CGTAAGCGGTTCAAATAAA-TTCAA-----T
Scilla peruviana          -------------------CGTAAGCGATTCAAAGAAA-TTCAA-----T
Scilla lazulina           -------------------CGTAAGCGGTTCAAAGAAA-TTCAA-----T
Trachyandra sp.*          -------------------CATAAGTAGTTCAAAGAAAATTCAA-----T
Trachyandra sp.           -------------------CATAAGTAGTTCAAAGAAAATTAAA-----T
Drimia altissima*         -------------------CGTAAGTGGTTCAAAGAAAATTCAA-----T
Urginea undulata          -------------------CGTAAGTGGTTCAAAGAAAATTCAA-----T
Urginea sp.               -------------------CATAAGTGGTTCAAAGAAAATTCAA-----T
Veltheimia capensis*      -------------------CGTAAGCGGTTTAAATAAA-TTCAA-----T
Veltheimia bracteata      -------------------CGTAAGCGGTTTAAATAAA-TTCAA-----T
Aloe vera                 -------------------CATAAGTAGTTCAAAGAAAATTCAA-----T
Aloe bakeri               -------------------CATAAGTAGTTCAAAGAAAATTCAA-----T
Bulbine wiesei            --CATAA----TTTCATAACATAAGTAGTTCAAAGAAAATTAAA-----T
Bulbine semibarbata       --CA-------TTTCATAACATAAGTAGTTCAAAGAAAATTAAC-----T
Bulbine succulenta        --CA-------TTTCATAA-----GTAGTTCAAAGAAAATTAAA-----T
Bulbinella cauda-felis    --CATAAATTAAATATGAAATGAAGTAGTTCAAAGAAAATTCAA-----T
Dipcadi viride            -------------------CGTAAGCGGTTCAAAGAAAATTCAA-----T
Dipcadi fulvum            --------------------GTAAGCGGTTCAAAGAAAATTCAA-----T
Drimia elata              -------------------CGTAAGTGGTTCAAAGAAAATTCAA-----T
Drimia fugax              -------------------CGTAAGCGGTTCAAAGAAAATTCAA-----T
Drimia calcarata          -------------------CGTAAGTGGTTCAAAGAAAATTCAA-----T
Drimia undata             ----------------CGTAGTAAGTGGTTCAAAGAAAATTCAA-----T
Drimiopsis botryoides     -------------------CGTAAGCGGTTCAAATAAA-TTCAA-----T
Drimiopsis maculata       -------------------CGTAAGCGGTTCAAATAAA-TTCAA-----T
Drimiopsis barteri        -------------------AGTAAGNNNNNCAAATAAA-TTCAA-----T
Galtonia princeps         -------------------CGTAAGCGGTTCAAAGAAAATTCAA-----T
Galtonia viridiflora      -------------------CGTAAGCGGTTCAAAGAAAATTCAA-----T
Galtonia candicans        -------------------CGTAAGCGGTTCAAAGAAAATTCAA-----T
Gasteria bicolorvar. lili.-------------------CATAAGTAGTTCAAAGAAAATTCAA-----T
Haworthia fasciata        -------------------CATAAGTAGTTCAAAGAAAATTCAA-----T
Kniphofia uvaria          --CATTTTT----------CATAAGTAGTTTAAAGAAAATTCAA-----T
Muscari comosum           -------------------CGTAAGCGGTTCAAAGAAA-TTTAA-----T
Nivenia corymbosa         --CATCTTCCTCGATCAG-CATCAGTGGTTCCAACAAAATTCAA-----T
Nothoscordum bivalve      -------------------CATAAGCGGTTCAAAGAAAATGCAA-----T
Rhadamanthus sp.          -------------------AGTAAGTGGTTCAAAGAAAATTCAA-----T
Schizobasis sp.           -------------------CGTAAGTGGTTCAAAGAAAATTCAA-----T
Drimia intricata          -------------------CGTAAGTGGTTCAAAGAAAATTCAA-----T
Thuranthos indicum        -------------------CGTAAGCGGTTCAAAGAAAATTCAA-----T
Tulbaghia violacea        -------------------CATAAGCGGTTCAAAGAAAATTCAA-----T
Whiteheadia bifolia       --------------------------CGTAAGCNGTTCAAATA------
Witsenia maura            TTCATCTTCCTCGATCAG-CATCAGTGGTTCCAACAAAATTCAA-----T

Albuca sp.*               ATTTTTCTCATTCATTCTACTCTTT--------CGCAAA----TGGATCC
Albuca nelsonii           ATTTTTCTCATTCATTCTACTCTTT--------CGCAAA----TGGATCC
Albuca sp.                ATTTTTCTCATTCATTCTACTCTTT--------CGCAAA----TGGATCC
Albuca shawii             ATTTTTCTCATTCATTCTACTCTTT--------CGCAAA----TGGATCC
Bowiea volubilis*         ATCTTTCTCATTCATTCTACTCTTT--------CAAAAA----TGGATCC
Bowiea volubilis          ATCTTTCTCATTCATTCTACTCTTT--------CAAAAA----TGGATCC
Eriospermum cooperi*      ATCTTTCTCATTCATTCTACTCTTT--------CACAAA----CGGATCC
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Eriospermum flagelliforme ATCTTTCTTATTCATTCTACTCTTT--------CACAAA----CGGATCC
Eucomis autumnalis*       ATCTTTCTCATTCATTATACTCTTT--------CGCAAATA----GATCC
Eucomis punctata          ATCTTTCTCATTCATTATACTCTTT--------CGCAAATA----GATCC
Gloriosa sp.              ATCTTTTTTATTCACTTTACTCAAT-------CCACAAA----TGGATGT
Ledebouria revoluta*      ATCTTTCTCATTCATTATACTCTTT--------CGCAAATA----GATCC
Ledebouria revoluta       ATCTTTCTCATTTATTATACTCTTT--------CGCAAATA----GATCC
Ledebouria socialis       ATCTTTCTCATTCATTATACTCTTT--------CGCAAATA----GATCC
Ledebouria somalensis     ATCTTTCTCATTTATTATACTCTTT--------CGCAAATA----GATCC
Ledebouria cordifolia     ATCTTTCTCATTCATTATACTCTTT--------CGCAAATA----GATCC
Ledebouria urceolata      ATCTTTCTCATTTATTATACTCTTT--------CGCAAATA----GATCC
Ornithogalum amphibolum   ATTTTTTTCATTCATTCTACTCTTT--------CGCAAA----TGGATAC
Ornithogalum angustif.    ATTTTTTTCATTCATTCTACTCTTT--------CGCAAA-----GGATCC
Ornithogalum fimbriatum   ATTTTTTTCATTCATTCTACTCTTT--------CGCAAA----TGGATCC
Ornithogalum gussonei     ATTTTTTTCATTCATTCTACTCTTT--------CGCAAA----TGGATCC
Ornithogalum longibr      ATTTTTCTCATTCATTCTACTCTTT--------CGCAAA----TGGATCC
Ornithogalum montanum     ATTTTTTTCATTCATTCTACTCTTT--------CGCAAA----TGGATCC
Ornithogalum pannonic.    ATTTTTTTCATTCATTCTACTCTTT--------CGCAAA----TGGATCC
Ornithogalum paschean.    ATTTTTTTCATTCATTCTACTCTTT--------CGCAAA----TGGATCC
Ornithogalum tenuifol.    ATTTTTCTCATTCATTCTACTCTTT---CGCAACTCAAA----TGGATCC
Ornithogalum umbellat.    ATTTTTTTCATTCATTCTACTCTTT--------CGCAAA----TGGATCC
Ornithogalum wiedeman.    ATTTTTTTCATTCATTCTACTCTTT--------CGCAAA----TGGATCC
Ornithoglossum viride     ATCTTTTTTATTCCCTTTACTTACT-------CCCCAAA----TGGATAT
Asparagus laricin.        ATCTGTCTCATTCATTCGACTCTTT--------CAAAAACA----GATTC
Sansevieria aethiopic.    ATCTTTCTCATTCATTCTACTCTTT--------CACAAA----CGGATCC
Scadoxus membranaceus     ATC---------------------------------------------
Schizocarphus nervosus*   ATCTTTCTCATTCATTATACTCTTT--------CGCAAATA----GATCC
Schizocarphus nervosus    ATCTTTCTCATTCATTATACTCTTT--------CGCAAATA----GATCC
Scilla peruviana          ATCTTTCTCATTCATTCTACTCTTT--------CGCAAATA----GATCC
Scilla lazulina           ATCTTTCTCATTCATTCTACTCTTT--------CGCAAATA----CATCC
Trachyandra sp.*          ATCTTTATCATTGATTCTACCCTTT--------CCCAAATAAATGGGTCC
Trachyandra sp.           ATCTTTCTCATTGATTCTACCCCTT--------CCCAAACAAATGGGTCC
Drimia altissima*         ATCTTTCTTATTCATTCTACTCTTT----------CAAAA---TGGATCC
Urginea undulata          ATCTTTCTTATTCATTCTACTCTTT----------CAAAA---TGGATCT
Urginea sp.               ATCTTTCTTATTCATTCTACTCTTT----------CAAAA---TGGATCC
Veltheimia capensis*      ATCTTTCTCATTCATTATACTCTTT--------CGCAAA----TAGATCC
Veltheimia bracteata      ATCTTTCTCATTCATTATACTCTATACTCTTT-CGCAA------------
Aloe vera                 ATCTTTCTCATTGATTCTACCCTTT----CCCAAACAAA----TGAGTCC
Aloe bakeri               ATCTTTCTCATTGATTCTACCCTTT----CCCAAACAAA----TGGGTCC
Bulbine wiesei            ATCTTTCTCATTGATTCTATCCTTT----CCAAAACAAA----TGGGTCC
Bulbine semibarbata       ATCTTTCTCATTGATTCTACCCTTT----CCAAAACAAA----TGGGTCC
Bulbine succulenta        ATCTTTCTCATTGATTCTACCCTTT----CCAAAACAGA----TGGGTCC
Bulbinella cauda-felis    ATCTTTCTCATTGATTCTACCCTTT----CCCAAACAAA----TGGGTCC
Dipcadi viride            ATTTTTCTCATT----CTACTCTTT--------CGCAAA----TGGATCC
Dipcadi fulvum            ATTTTTCTCATT----CTACTCTTT--------CGCAAA----TGGATCC
Drimia elata              ATCTTTCTTATTCATTCTACCCTTT----------CAAAA----TGGATCC
Drimia fugax              ATCTTTCTTATTCGTTCTACNCTTT----------CAAAA----TGGATCC
Drimia calcarata          ATCTTTCTTATTCATTCTACYCTTT----------CAAAA----TGGATCC
Drimia undata             ATCTTTCTTATTCATTCTACYCTTT----------CAAAA----TGGATCT
Drimiopsis botryoides     ATCTTTCTCATTCATTATACTCTTT--------CGCAAATA----GATCC
Drimiopsis maculata       ATCTTTCTCATTCATTATACTCTTT--------CGCAAAGA----GATCC
Drimiopsis barteri        ATCTTTCTCATTCATTATACTCTTT--------CGCAAATA----GATCC
Galtonia princeps         ATTTTTTTCATTCATTCTACTCTTT--------CGCAAA----TGGATCC
Galtonia viridiflora      ATTTTTTTCATTCATTCTACTCTTT--------CGCAAA----TGGATCC
Galtonia candicans        ATTTTTTTCATTCATTCTACTCTTT--------CGCAAA----TGGATCC
Gasteria bicolorvar. lili.ATCTTTCTCATTGATTCTACCCTTT----CCCAAACAAA----TGGGTCC
Haworthia fasciata        ATCTTTCTCATTGATTCTACCCTTT----CCCAAACAAA----TGGGTCC
Kniphofia uvaria          ATCTTTCTCATTGATTCTACCCTTT----CCCAAACAAATA----GGTCT
Muscari comosum           ATCTTTCTCATTCATTCTACTCTTT--------CGCAAATA----GATTC
Nivenia corymbosa         ATCTTTCTCATTAATTCTACTCTTT--------CGCAAACA----GATCC
Nothoscordum bivalve      ATCTTTCTCATGCATTCTACTCTTT--------CACAAA----TGGATCC
Rhadamanthus sp.          ATCTTTCTTATTCATTCTACTCTTT---------CAAAA----TGGATCC
Schizobasis sp.           ATCTTTCTTATTCATTCTACTCTTT---------CAAAA----TGGATCC
Drimia intricata          ATCTTTCTTATTCATTCTACCCTTT---------CAAAA----TGGATCC
Thuranthos indicum        ATCTTTCTTATTCGTTCTACTCTTT---CAAATTCAAAA----AGGATCC
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Tulbaghia violacea        ATCTTTCTCATGCATTCTACTCTTT--------CACAAATA----GATCC
Whiteheadia bifolia       ------------------------------------------------
Witsenia maura            ATCTTTCTCATTAATTCTACTCTTT--------CGCAAACA----GATCC

Albuca sp.*               GGACAGAAATCTTTGGAC-----CTTATCC-----CTA----TTAGGTTT
Albuca nelsonii           GGACAGAAATCTTTGGAC-----CTTATCC-----CTA----TTAGGTTT
Albuca sp.                GGACAGAAATCTTTGGAC-----CTTATCC-----CTA----TTAGGTTT
Albuca shawii             GGACAGAAATCTTTGGAC-----CTTATCC-----CTA----TTAGGTTT
Bowiea volubilis*         GGACAGAAATTTTTGGAT-----CTTATCT-----CTAA---TTAGGTTT
Bowiea volubilis          GGACAGAAATTTTTGGAT-----CTTATCT-----CTA----TTAGGTTT
Eriospermum cooperi*      GAACAGAAATCTTTGGAT-----CTTTTC------CTAATT---TGGTTT
Eriospermum flagelliforme GAACAGAAATCTTTGGAT-----CTTTTC------CTAATC---TGGTTT
Eucomis autumnalis*       GGACATAAATCTTTGGAT-----CTTATCC-----CTA----TTAGGTTT
Eucomis punctata          GGACATAAATCTTTGGAT-----CTTATCC-----CTA----TTAGGTTT
Gloriosa sp.              GTACAGAAATCTTTGAAT-----CTTAATC-----CTAAG--TT--CTTT
Ledebouria revoluta*      GGACAGAAATCCTTGGAT-----CTTATCC-----CTA----TTAGGTTT
Ledebouria revoluta       GGACAGAAATCCTTGGAT-----CTTATCC-----CTA----TTAGGTTT
Ledebouria socialis       GGACAGAAATCCTTGGAT-----CTTATCC-----CTA----TTAGGTTT
Ledebouria somalensis     GGACAGAAATCCTTGGAT-----CTTATCC-----CTA----TTAGGTTT
Ledebouria cordifolia     GGACAGAAATCCTTGGAT-----CTTATCC-----CTA----TTAGGTTT
Ledebouria urceolata      GGACAGAAATCCTTGGAT-----CTTATCC-----CTA----TTAGGTTT
Ornithogalum amphibolum   GGATAAAAATCTTTGGAC-----CTTATCC-----CTA----TTAGGTTT
Ornithogalum angustif.    GGATAGAAATCTTTGGAC-----CTTATCC-----CTA----TTAGGTTT
Ornithogalum fimbriatum   AGATAGAAATCTTTGGAC-----CTTATCC-----CTA----TTAGGTTT
Ornithogalum gussonei     GGATAGAAATCTTTGGAC-----CTTATCC-----CTA----TTAGGTTT
Ornithogalum longibr      GGACAGAAATCTTTGGAC-----CTTATCC-----CTA----TTAGGTTT
Ornithogalum montanum     GGATAGAAATCTTTGGAC-----CTTATCC-----CTA----TTAGGTTT
Ornithogalum pannonic.    GGATAGAAATCTTTGGAC-----CTTATCC-----CTA----TTAGGTTT
Ornithogalum paschean.    GGATAGAAATCTTTGGAC-----CTTATCC-----CTA----TTAGGTTT
Ornithogalum tenuifol.    GGACAGAAATCTTTGGAC-----CTTATCC-----CTA----TTAGGTTT
Ornithogalum umbellat.    GGATAGAAATCTTTGGAC-----CTTATCC-----CTA----TTAGGTTT
Ornithogalum wiedeman.    GGATAGAAATCTTTGGAC-----CTTATCC-----CTA----TTAGGTTT
Ornithoglossum viride     GTACAGAAATCTTTGAATYTTNTCTTAATC-----CTAA----GTTCTTT
Asparagus laricin.        GAACAGAAATCTTTGGAT-----CTTATC------CTAATT---TGGTTT
Sansevieria aethiopic.    GAACAGAAATCTTTTGAT-----CTTATC------CTAA---TTTGGTTT
Scadoxus membranaceus     ------------------------------------------------
Schizocarphus nervosus*   GGACATAAATCTTTGGAT-----CTTATCC-----CTA----TTAGGTTT
Schizocarphus nervosus    GGACAGAAATCTTTGGAT-----CTTATCC-----CTA----TTAGGTTT
Scilla peruviana          GGACAGAAATCTTTGGAT-----CTTATCC-----CTA----TTAGGTTT
Scilla lazulina           GGACAGAAATCTTTGGAT-----CTTATCC-----CTA----TTAGGTTT
Trachyandra sp.*          GAACAGAAATCTTTTTGT-----CTTATCC-----CAA----TTTGGTTT
Trachyandra sp.           GAACATAAATCTTTTTGT-----CTTATCC-----CAA----TTTGGTTT
Drimia altissima*         GGACAGAAATTTTTGGAT-----CTTATCT-----CTA----TTAGGTTT
Urginea undulata          GGACAAAAATTTTTGGAT-----CTTATCT-----CTA----TTAGGTTT
Urginea sp.               GGACAGAAATTTTTGTAT-----CTTATCT-----CTA----TTAGGTTT
Veltheimia capensis*      GGGCAGAAATCTTTGGAT-----CTTATCC-----CTATTAATTAGGTTT
Veltheimia bracteata      --GCAGAAATCTTTGGAT-----CTTATCC-----CTA----TTAGGTTT
Aloe vera                 GAATAGA--TTTTTGT-------CTTATCC-----CAA----TTTGGTTT
Aloe bakeri               GAATAGA--TTTTTGT-------CTTATCC-----CAA----TTTGGTTT
Bulbine wiesei            AAACAGAAATCTTTTTGT-----CTTATCC-----TAA----TTTGGTTT
Bulbine semibarbata       GAACAGAAATCTTTTTGT-----CTTACCC-----CAA----TTTGGTTT
Bulbine succulenta        GAACAGAAATCTTTTTGT-----CTTACCC-----CAA----TTTGGTTT
Bulbinella cauda-felis    GAACAGAAATCTTTTTGT-----CTTATCC-----CAA----TTTGGTTT
Dipcadi viride            GGACAGAAATCTTTGGAC-----CTTATCC-----CTA----TTAGATTT
Dipcadi fulvum            GGACAGAAATCTTTGGAC-----CTTATCC-----CTA----TTAGATTT
Drimia elata              GGACAGAAATTTTTGGAT-----CTTATCT-----CTA----TTAGGTTT
Drimia fugax              GGACAGAAATTTTTGGAT-----CTTATCT-----CTA----TTAGGTTT
Drimia calcarata          GGACAGAAATTTTTGGAT-----CTTATCT-----CTA----TTAGGTTT
Drimia undata             GGACAAAAATTTTTGGAT-----CTTATCT-----CTA----TTAGGTTT
Drimiopsis botryoides     GGACAGAAATCCTTGGAT-----CTTATCC-----CTA----TTAGGTTT
Drimiopsis maculata       GGACAGAAATCCTTGGAT-----CTTATCC-----CTA----TTAGGTTT
Drimiopsis barteri        GGACAGAAATCCTTGGAT-----CTTATCC-----CTA----TTAGGTTT
Galtonia princeps         GGACAGAAATCTTTGGAC-----CTTATCC-----CTA----TTAGGTTT
Galtonia viridiflora      GGACAGAAATCTTTGGAC-----CTTATCC-----CTA----TTAGGTTT
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Galtonia candicans          GGACAGAAATCTTTGGAC-----CTTATCC-----CTA----TTAGGTTT
Gasteria bicolorvar. lili.GAATAGAAATCTTTTTGT-----CTTATCC-----CAA----TTTGGTTT
Haworthia fasciata          GAATAGAAATCTTTTTGT-----CTTATCC-----CAA----TTTGGTTT
Kniphofia uvaria            GAACAGAAATCTTTTTGT-----CTTATCC-----CAAA---TTTGGTTT
Muscari comosum             GGACAGAAATCTTTGGAT-----CTTATCC-----CTA----TTAGGTTT
Nivenia corymbosa           GAACAGAAATCTTTGGAT-----CTTATCC-----CAA----TTGGGTTT
Nothoscordum bivalve        GAACAGAAATCTTTTGAT-----CTTATAC-----CAT----TTA-GTTT
Rhadamanthus sp.            GGACAGAAATTTTTTGAT-----CTTATCT-----CTA----TTAGGTTT
Schizobasis sp.             AGACAGAAATTTTTGGAT-----CTTATCT-----CTA----TTAGGTTT
Drimia intricata            AGACAGAAATTTTTGGAT-----CTTATCT-----CTA----TTACCTTT
Thuranthos indicum          GGACAGAAATTTTTGGAT-----CTTATCT-----CTA----TTAGGTTT
Tulbaghia violacea          GAACAGAAATCTTTTGAT-----CTTATAC-----CAT----TTAG-TTT
Whiteheadia bifolia         --------------------------------------------------
Witsenia maura              GAACAGAAATCTTTGGAT-----CTTATCC-----CAA----TTGGGTTT

Albuca sp.*                 ---GAATA----------GATACCTGTACAAATAA-----ACATA-TAT-
Albuca nelsonii             ---GAATA----------GATACCTGTACAAATAA-----ACATA-TAT-
Albuca sp.                  ---GAATA----------GATACCTGTACAAATAA-----ACATA-TAT-
Albuca shawii               ---GAATA----------GATACCTGTACAAATAA-----ACATA-TAT-
Bowiea volubilis*           ---GAATAAATAC-----GATACCTGTACAAATGA-----ACATA-TAT-
Bowiea volubilis            ---GAATAAATAC-----GATACCTGTACAAATGA-----ACATA-TAT-
Eriospermum cooperi*        ---GAATA----------GATACCTGTACAAATGA-----ACATA-TAT-
Eriospermum flagelliforme   ---GAATA----------GATACCTGTACAAATGA-----ACATA-TAT-
Eucomis autumnalis*         ---GAATA----------GATACCTGTACAAATGA-----ACATA-TAT-
Eucomis punctata            ---GAATA----------GATACCTGTACAAATGA-----ACATA-TAT-
Gloriosa sp.                G-----------GATA-GATACCCCTACAAATGA-----ACATT-TGTA
Ledebouria revoluta*        ---GAATA-----GATACGATACCTGTACAAATGA-----ACATA-TAT-
Ledebouria revoluta         ---GAATA-----GATACGATNCCTGTACAAATGA-----ACATA-TAT-
Ledebouria socialis         ---GAATA-----GATACGATACCTGTACAAATGA-----ACATA-TAT-
Ledebouria somalensis       ---GAATA-----GATACGATACCTGTACAAATGA-----ACATA-TAT-
Ledebouria cordifolia       ---GAATA-----GATACGATACCTGTACAAATGA-----ACATA-TAT-
Ledebouria urceolata        ---GAATA-----GATACGATACCTGTACAAATGA-----ACATA-TAT-
Ornithogalum amphibolum     ---GAATA----------GATACCTGTACAAATAA-----ACATA-TAT-
Ornithogalum angustif.      ---GAATA----------GATACCTGTACAAATAA-----ACATA-TAT-
Ornithogalum fimbriatum     ---GAATA----------GATACCTGTACAAATAA-----ACATA-TAT-
Ornithogalum gussonei       ---GAATA----------GATACCTGTACAAATAA-----ACATA-TAT-
Ornithogalum longibr        ---GAATA----------GATACCTGTACAAATAA-----ACATA-TAT-
Ornithogalum montanum       ---GAATA----------GATACCTGTACAAATAA-----ACATA-TAT-
Ornithogalum pannonic.      ---GAATA----------GATACCTGTACAAATAA-----ACATA-TAT-
Ornithogalum paschean.      ---GAATA----------GATACCTGTACAAATAA-----ACATA-TAT-
Ornithogalum tenuifol.      ---GAATA----------GATACCTGTACAAATAA-----ACATA-TAT-
Ornithogalum umbellat.      ---GAATA----------GATACCTGTACAAATAA-----ACATA-TAT-
Ornithogalum wiedeman.      ---GAATA----------GATACCTGTACAAATAA-----ACATA-TAT-
Ornithoglossum viride       G-----------GAT-GGATACCCCTNCAAATGA-----ACATT-TGTA
Asparagus laricin.          ---GAATA-----GATACCATACATGTACAAATGA-----ACATA-TAT-
Sansevieria aethiopic.      ---GAATA-----GATACGATACCTGTACAACTAA-----ACATA-TATA
Scadoxus membranaceus       --------------------------------------------------
Schizocarphus nervosus*     ---GAATA----------GATCCCTGTACAAATGA-----ACATA-TAT-
Schizocarphus nervosus      ---GAATA-----GATACGATACCTGTACAAATGA-----ACATA-TAT-
Scilla peruviana            ---GAATA-----GATACGATACCTGTACAAATGA-----ACATA-TAT-
Scilla lazulina             ---GAATA-----GATACGATACCTGTACAAATGA-----ACATA-TAT-
Trachyandra sp.*            ---GAATA-----GACACGATACCTGTGCATATGA-----ATATA-TAT-
Trachyandra sp.             ---GAATA-----GATATGATACCTGTGCATATGA-----ATATA-TAT-
Drimia altissima*           ---GAATA-----GATATGATACCTGTACAAATGA-----ACATA-TAT-
Urginea undulata            ---GAATA-----GATATGATACCTGTACAAATGA-----GCATA-TAT-
Urginea sp.                 ---GAATA-----GATATGATACCTGTACAAATGA-----ACATA-TAT-
Veltheimia capensis*        ---GAATA-----GATACGATACCTGTACAAATGA-----ACAGG-TAT-
Veltheimia bracteata        ---GAATA----------GATACCTGTACAAATGA-----ACAGG-TAT-
Aloe vera                   ---GAATA-----GATACGATATCTGTGCATATGA-----ATATA-TAT-
Aloe bakeri                 ---GAATA-----GATACGATATCTGTGCATATGA-----ATATA-TAT-
Bulbine wiesei              ---GAATA-----GATACAATATCTGTGTATATGA-----ATATA-GAT-
Bulbine semibarbata         ---GAACG-----GATACGATATCCGTGTATATGA-----ATACA-TAT-
Bulbine succulenta          ---GAACA-----TATACGATATCTGTGTATATGA-----ATACA-TAT-
Bulbinella cauda-felis      ---GAATA-----GATATGATACCTGTGCATATGA-----ATATA-TAT-
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Dipcadi viride             ---GAATA----------GATACCTGTACAAATAA-----ACATA-TAT-
Dipcadi fulvum             ---GAATA----------GATACCTGTACAAATAA-----ACATA-TAT-
Drimia elata               ---GAATA-----GATATGATACCTGTACAAATGA-----ACA-A-TAT-
Drimia fugax               ---GAATA-----GATATGATACCTGTACAAATGA-----ACATA-TAT-
Drimia calcarata           ---GAATA-----GATATGATACCTGTACAAACGA-----ACATA-TAT-
Drimia undata              ---GAATA-----GATATGATACCTGTACAAATGA-----GCATA-TAT-
Drimiopsis botryoides      ---GAATA-----GATACGATACCTGTACAAATGA-----ACATA-TAT-
Drimiopsis maculata        ---GAATA-----GATATGATACCTGTACAAATGA-----ACATA-TAT-
Drimiopsis barteri         ---GAATA-----GATACGATACCTGTACAAATGA-----ACATA-TAT-
Galtonia princeps          ---GAATA-----GATACATGTACAAATAAACATA-----------TAT-
Galtonia viridiflora       ---GAATA-----GATACCTGTACAAATAAACATA-----------TAT-
Galtonia candicans         ---GAATA-----GATACCTGTACAAATAAACATA-----------TAT-
Gasteria bicolorvar. lili.---GAATA-----GATACGATATCTGTGCATATGA-----ATATA-TAT-
Haworthia fasciata         ---GAATA-----GATACGATATCTGTGCATATGA-----ATATA-TAT-
Kniphofia uvaria           ---GAATA-----GATACGATACCTGTGCATATGA-----ATATA-TAT-
Muscari comosum            ---GAATA-----GATACGATACCTGTACAAATGA-----ACATA-TAT-
Nivenia corymbosa          ---GGATA-----GATATGATACCTGTACAAATGA-----GCATA-TAT-
Nothoscordum bivalve       ---GAATA-----AATATGATACCCGTACAAATGA-----ACATA-TAT-
Rhadamanthus sp.           ---GAATA-----GATATGATACCTGTACAAATGA-----ACATA-TAT-
Schizobasis sp.            ---GAATA-----GATATGATACCCGTACAAATGA-----ACATA-TAT-
Drimia intricata           ---GAATA-----GATATGATACCCGTACAAATGA-----ACATA-TAT-
Thuranthos indicum         ---GAGTA-----GATATGATACCTGTACAAATGA-----ACATA-TAT-
Tulbaghia violacea         ---GAATA-----AATATGATACCCGTACAAATGA-----ACATA-TAT-
Whiteheadia bifolia        ----------------------------AATTGA-----ACATA-TAT-
Witsenia maura             ---GGATA-----GATATGATACCTGTACAAATGA-----GCATA-TAT-

Albuca sp.*                ---GGTCAAGGAATT----CCCATTAT----------------------
Albuca nelsonii            ---GGTCAAGGAATT----CCCATTAT----------------------
Albuca sp.                 ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Albuca shawii              ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Bowiea volubilis*          ---GGTCGAGGAATT----CCCATTATTGAATTATTCAGAG-----CCCA
Bowiea volubilis           ---GGTCGAGGAATT----CCCATTATTGAATTATTCAGAG-----CCCA
Eriospermum cooperi*       ---GGTCAGAGAATT----GCCATTATTGAATTATTCACAG-----TCCA
Eriospermum flagelliforme  ---GGTCATAGAATT----GCCATTATGGAATTATTCACAG-----TCCA
Eucomis autumnalis*        ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Eucomis punctata           ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Gloriosa sp.               ---GGT-AAGGAATT----CCTGTTATTGAATCATTCACAG-----TCCA
Ledebouria revoluta*       ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Ledebouria revoluta        ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Ledebouria socialis        ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----TCCA
Ledebouria somalensis      ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Ledebouria cordifolia      ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Ledebouria urceolata       ---GGTCAAGGAATTCATTCCCATTATTGAATTATTCACAG-----CCCA
Ornithogalum amphibolum    ---GGTCAAGGAATT----TCCATTATTGAATTATTCACAG-----CCCA
Ornithogalum angustif.     ---GGTCAAGGAATT----TCCATTATTGAATTATTCACAG-----CCTA
Ornithogalum fimbriatum    ---GGTCAAGGAATT----TCCATTATTGAATTATTCACAG-----CCCA
Ornithogalum gussonei      ---GGTCAAGGAATT----TCCATTATTGAATTATTCACAGCACAGCCCA
Ornithogalum longibr       ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Ornithogalum montanum      ---GGTCAAGGAATT----TCCATTATTGAATTATTCACAG-----CCCA
Ornithogalum pannonic.     ---GGTCAAGGAATT----TCCATTATTGAATTATTCACAG-----CCTA
Ornithogalum paschean.     ---GGTCAAGGAATT----TCCATTATTGAATTATTCACAG-----CCCA
Ornithogalum tenuifol.     ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Ornithogalum umbellat.     ---GGTCAAGGAATT----TCCATTATTGAATTATTCACAG-----CCTA
Ornithogalum wiedeman.     ---GGTCAAGGAATT----TCCATTATTGAATTATTCACAG-----CCCA
Ornithoglossum viride      ---GGT-AAGGAATT----CCTGTTATTGAATCATTCMCAG-----TCCA
Asparagus laricin.         ---GGTCAAGGAATT----ACCATTATTGAATTATTCACAG-----TCCA
Sansevieria aethiopic.     ---------------------------------ATTGA-AG-----TCCA
Scadoxus membranaceus      --------------------------------------------------
Schizocarphus nervosus*    ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Schizocarphus nervosus     ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Scilla peruviana           ---GGTCAAGTAATT----CCCATTATTGAATTATTCACAG-----CCCA
Scilla lazulina            ---GGTCAGGGAATT----CCCATTATTGAATTATTCACAG-----CC--
Trachyandra sp.*           ---GGGCAAGGAATT----TCCATTGTTGAATCATTCACAG-----TCCA
Trachyandra sp.            ---GGGCAAGGAATT----TCCATTGTGAAATCATTCACAG-----TCCA
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Drimia altissima*          ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CTCA
Urginea undulata           ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAA-----CCCA
Urginea sp.                ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Veltheimia capensis*       ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Veltheimia bracteata       ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Aloe vera                  ---GGGCAAGGAATT----TCCATTGTTGAATCATTCACAG-----CCCA
Aloe bakeri                ---GGGCAAGGAATT----TCCATTGTTGAATCATTCACAG-----CCCA
Bulbine wiesei             ---GGGCAAGGAATT----TCCATTGTTGAATCATTCACAG-----TCCA
Bulbine semibarbata        ---GGGCAAGGAATT----TCCGTTGTTGAATCATTGACAT-----TCAC
Bulbine succulenta         ---GGGCAAGGGATT----TCCATTGTTGAATCATTCACAT-----TCAC
Bulbinella cauda-felis     ---GGGCAAGGAATT----TCCATTGTGGAATCATTCACAG-----TCCA
Dipcadi viride             ---GGTCAAGGAATT----TCCATTATTGAATTATTCACAG-----CCCA
Dipcadi fulvum             ---GGTCAAGGAATT----TCCATTATTGAATTATTCACAG-----CCCA
Drimia elata               ---GGTCAAGGAATT---CCCAGTTATTGAATTATTCACAG-----CCCA
Drimia fugax               ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Drimia calcarata           ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Drimia undata              ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAA-----CCCA
Drimiopsis botryoides      ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Drimiopsis maculata        ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAT---------
Drimiopsis barteri         ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAC-ACAGCCCA
Galtonia princeps          ---GGTCAAGGAATT----TCCATTATTGAATTATTCACAG-----CCCA
Galtonia viridiflora       ---GGTCAAGGAATT----TCCATTATTGAATTATTCACAG-----CCCA
Galtonia candicans         ---GGTCAAGGAATT----TCCATTATTGAATTATTCACAG-----CCCA
Gasteria bicolorvar. lili.---GGGCAAGGAATT----TCCATTGTTGAATCATTCACAG-----CCCA
Haworthia fasciata         ---GGGCAAGGAATT----TCCATTGTTGAATCATTCACAG-----CCCA
Kniphofia uvaria           ---GGGCAAGGAATT----TCCATTGTTGAATCATTCACAG-----TCCA
Muscari comosum            ---GGTCAAGGAACT----CCCATTATTGAATTATTCACAG-----CCCA
Nivenia corymbosa          ---GGGAAAGGAATT----CTCATTATTGAATCATTCACAG-----TCCA
Nothoscordum bivalve       ---AGTCGAGGACTT----CCCATTATTGAATCATTCACAG-----TCCA
Rhadamanthus sp.           ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Schizobasis sp.            ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Drimia intricata           ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA

Thuranthos indicum         ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Tulbaghia violacea         ---GGTCGAGGACTT----CCCATTATTGAATTATTCACAG-----TCCA
Whiteheadia bifolia        ---GGTCAAGGAATT----CCCATTATTGAATTATTCACAG-----CCCA
Witsenia maura             ---GGGAAAGGAATT----CTCATTATTGAATCATTCACAG-----CCCA

Albuca sp.*                --------------------------------------------------
Albuca nelsonii            --------------------------------------------------
Albuca sp.                 TA-TCA-TT-----------ATCCTTA-CATTCAC-------AAAAAAAG
Albuca shawii              TA-TCA-TT-----------ATCCTTA-CATTCAC-------AAAAAAAG
Bowiea volubilis*          TA-TCA-TT-----------ATCCTTA-CATTCCTC-------AAAAAAG
Bowiea volubilis           TA-TCA-TT-----------ATCCTTA-CATTCCTC-------AAAAAAG
Eriospermum cooperi*       TA-TCACTTACAA----------CTTA-CATTCAC-------AAAGAAAG
Eriospermum flagelliforme  TA-TCACTTACAA----------CTTA-CATTCAC-------AAATAAAG
Eucomis autumnalis*        TA-TCA-TT-----------ATCCTTA-CATTCAA--------AAAAAAG
Eucomis punctata           TA-TCA-TT-----------ATCCTTA-CATTCAA--------AAAAAAG
Gloriosa sp.               TA-TCAC---------------------------------CAAAGAAAA-
Ledebouria revoluta*       TA-TCA-TT-----------ATCCTTA-CATTCAT-------AAAAAAAG
Ledebouria revoluta        TA-TCA-TT-----------ATCCTTA-CATTCAC-------AAAAAAAG
Ledebouria socialis        TA-TCA-TT-----------ATCCTTA-CATTCAC-------AAAAAAAG
Ledebouria somalensis      TA-TCA-TT-----------ATCCTTA-CGCTCAC-------AAAAAAAG
Ledebouria cordifolia      TA-TCA-TT-----------ATCCTTA-CATTCAC-------AAAAAGAG
Ledebouria urceolata       TA-TCA-TT-----------ATCCTTA-CATTCAC-------AAAAAAAG
Ornithogalum amphibolum    TA-TCA-TT-----------ATCCTTA-CATTCAC------AAAAAAAA-
Ornithogalum angustif.     TA-TCA-TT-----------ATCCTTA-CATTCAC------AAAAAAAA-
Ornithogalum fimbriatum    TA-TCA-TT-----------ATCCTTA-CATTCAC------AAAAAAAA-
Ornithogalum gussonei      TA-TCA-TT-----------ATCCTTA-CATTCAC------AAAAAAAA-
Ornithogalum longibr       TA-TCA-TT-----------ATCCTTA-CATTCAC-------AAAAAAAG
Ornithogalum montanum      TA-TCA-TT-----------ATCCTTA-CATTCAC------AAAAAAAA-
Ornithogalum pannonic.     TA-TCA-TT-----------ATCCCTA-CATTCAC------AAAAAAAA-
Ornithogalum paschean.     TA-TCA-TT-----------ATCCTTA-CATTCAC------AAAAAAAA-
Ornithogalum tenuifol.     TA-TCA-TT-----------ATCCTTA-CATTCAC-------AAAAAAAG
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Ornithogalum umbellat.    TA-TCA-TT----------ATCCTTA-CATTCAC------AAAAAAAA-
Ornithogalum wiedeman.    TA-TCA-TT----------ATCCTTA-CATTCAC------AAAAAAAA-
Ornithoglossum viride     TA-TCC-CC--------------------------------AAAGAAAA-
Asparagus laricin.        TA-TCA-CT--------------TACA-ACTTACA----------GAAAG
Sansevieria aethiopic.    TA-TCA-CT---------TACTACTTA-CATTCAA-------AAAGAAAG
Scadoxus membranaceus     ----------------------CTTA-CATTCAC-------AAAGAAAG
Schizocarphus nervosus*   TA-TCA-TT----------ATCCTTA-CATTCAA--------AAAAAAG
Schizocarphus nervosus    TA-TCA-TT----------ATCCTTA-CATTCAC-------AAAAAAAG
Scilla peruviana          TA-TCA-TT----------ATCTTTC-CATTCAA---------AAAAAG
Scilla lazulina           --------------------ATCCTTA-CATTCAC-------AAAAAAAG
Trachyandra sp.*          TA-TCA-TC--------ATTCTTTTTC-CATTTACAAAT-CCAAAGAAAG
Trachyandra sp.           TA-TCA-TT----------CTTTTTC-CATTTACAAAT-ACAAAGAAAG
Drimia altissima*         TA-TCA-TT----------ATCCTTA-CATTCCTC-------AAAAAAG
Urginea undulata          TA-TCA-TT----------ATCCTTA-CATTCCTC-------AAAAAAG
Urginea sp.               TA-TCA-TT----------ATCCTTA-CATTTCTC-------AAAAAAG
Veltheimia capensis*      TA-CCA-TT----------ATCCTTA-CATTCAC-------AAAAAAAG
Veltheimia bracteata      TA-CCA-TT----------ATCCTTA-CATTCAC-------AAAAAAAG
Aloe vera                 TA-TCA-GT----------ATTTTTC-CATTTACAAATACAAAGAAA-G
Aloe bakeri               TA-TCA-GT----------ATTTTTC-CATTTACAAATACAAAG-AAAG
Bulbine wiesei            TA-TCA-TT----------ATTTTTG-TATTTATAAATACAAAG-AAAG
Bulbine semibarbata       AG-TCCATATCATTA------TTTTTG-TATTTATAAATACAAAGTAAAG
Bulbine succulenta        AG-TCCATATCATTATTTTTTTTTTGG-TATTTATAAATACAAAGTAAAG
Bulbinella cauda-felis    TA-TCATTC----------TTTTTC-CATTTACAAATACAAAG-AAAG
Dipcadi viride            TA-TCATTA----------TCCTTA-CATTCGC-------AAAAAAAG
Dipcadi fulvum            TA-TCATTA----------TCCTTA-CATTCGC--------AAAAAAG
Drimia elata              TA-TCATTA----------TCCTTA-CATTCCTC-------AAAAAAG
Drimia fugax              TA-TCATTA----------TCCTTA-CATTCCTC-------AAAAAAG
Drimia calcarata          TA-TCATTA----------TCCTTA-CATTCCTC-------AAAAAAG
Drimia undata             TA-TCATTA----------TCCTTA-CATTCCTC-------AAAAAAG
Drimiopsis botryoides     TA-TCATTA----------TCCTTA-CATTCAC-------AAAAAAAG
Drimiopsis maculata       -A-TCATT----------------TA-CATTCAC-------AAAAAAAG
Drimiopsis barteri        TA-TCATTA----------TCCTTA-CATTCAC-------AAAAAAAG
Galtonia princeps         TA-TCATTA----------TCCTTA-CATTCAA-------AAAAAAAG
Galtonia viridiflora      TA-TCATTA----------TCCTTA-CATTCAA------AAAAAAAAG
Galtonia candicans        TA-TCATTA----------TCCTTA-CATTCAA------AAAAAAAAG
Gasteria bicolorvar. lili.TA-TCATTA----------TTTTTC-CATTTACAAAT-ACAAAGAAAG
Haworthia fasciata        TA-TCATTA----------TTTTTC-CATTTACAAAT-ACAAAGAAAG
Kniphofia uvaria          TA-TCATTC----------TTTTTC-CGTTTACAAAT-ACAAAGAAAG
Muscari comosum           TA-TCACTA----------TCTTTA-CATT--------CACAAAAAAG
Nivenia corymbosa         TA-TCATTA----------TTCTTA-CGTTTCCA---AAGAAAGAAAG
Nothoscordum bivalve      TA-TCATTT----------TCCTTG-CATTCAC-------AAAGAAAG
Rhadamanthus sp.          TA-TCATTA----------TCCTTA-CATTCCTC-------AAAAAAG
Schizobasis sp.           TA-TCATTA----------TCCTTA-CATTCCTC-------AAAAAAG
Drimia intricata          TA-TCATTA----------TCCTTA-CATTCCTC-------AAAAAAG
Thuranthos indicum        TA-TCATTA----------TCCTTA-CATTCCTC-------AAAAAAG
Tulbaghia violacea        TA-TCATTT----------TCCTTG-CATTCAC-------AAAGAAAG
Whiteheadia bifolia       TA-TCATTA----------TCCTTA-CATTCAC-------AAAAAAAG
Witsenia maura            TA-TCATTA----------TCCTTA-CGTTTCC-----AAAG--AAAG

Albuca sp.*               ------------------------------------------------
Albuca nelsonii           ------------------------------------------------
Albuca sp.                TCTTCTTTTT-----AAAGATTT----------CAAAAATTAGGGGACTA
Albuca shawii             TCTTCTTTTT-----AAAGATTT----------CAAAAATTAGGGGACTA
Bowiea volubilis*         TCTTCTTTTT-----GAAGATCT----------AACAAATTCGGAAACTA
Bowiea volubilis          TCTTCTTTTT-----GAAGATCT----------AACAAATTCGGAAACTA
Eriospermum cooperi*      TCTTCTTTTT-----GCATT-----------------------------
Eriospermum flagelliforme TCTTCTTTTT-----GCATTTTT--GAAGATCTAAGAAATTCGGGAATTA
Eucomis autumnalis*       TCTTCTTTTT-----GAAGATCT----------AA--AATTCGGGGACTA
Eucomis punctata          TCTTCTTTTT-----GAAGATCT----------AAGAAATTCGGGGACTA
Gloriosa sp.              TCTTTTTTTT-------AGATCT----------AAGAAATTTTGGGGTTG
Ledebouria revoluta*      TTTTCTTTTT-----GAAGATCT----------AAGAAATTCGGGGACTA
Ledebouria revoluta       TTTTCTTTTT-----AAAGATCT----------AAGAAATTCGGGGACTA
Ledebouria socialis       TTTTCTTTTT-----AAAGATCT----------AAGAAATTCGGGGACTA
Ledebouria somalensis     TTTTCTTTTT-----AAAGATCT----------AAGAAATTCGGGGACTA
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Ledebouria cordifolia      TTTTCTTTTT-----AAAGATCTATCT------AAGAAATTCGGGGACTA
Ledebouria urceolata       TTTTCTTTTT-----AAAGATCT----------AAGAAATTCGGGGACTA
Ornithogalum amphibolum    TCTTCTTTTT-----AAAGATTT----------AAGAAATTCGGGGACTA
Ornithogalum angustif.     TCTTCTTTTT-----AAAGATTT----------AAGAAATTCGGGGACTA
Ornithogalum fimbriatum    TCTTCTTTTT-----AAAGATTT----------AAGAAATTCGGGGACTA
Ornithogalum gussonei      TCTTTTTTTT-----AAAGATTT----------AAGAAATTCGGGGACTA
Ornithogalum longibr       TCTTCTTTTT-----AAAGATTT----------CAAAAATTAGGGGACTA
Ornithogalum montanum      TCTTCTTTTT-----AAAGATTT----------AAGAAATTCGGGAACTA
Ornithogalum pannonic.     TCTTCTTTTT-----AAAGATTT----------AAGAAATTCGGGGACTA
Ornithogalum paschean.     TCTTCTTTTT-----AAAGATTT----------AAGAAATTCGGGGACTA
Ornithogalum tenuifol.     TCTTCTTTTT-----AAAGATTT----------CAAAAATTAGGGGACTA
Ornithogalum umbellat.     TCTTCTTTTT-----AAAGATTT----------AAGAAATTCGGGGACTA
Ornithogalum wiedeman.     TCTTCTTTTT-----AAAGATTT----------AAGAAATTCGGGGACTA
Ornithoglossum viride      TTTTTTTTTTTTTT---ACATCT----------AAGAAATTTGGGGATTG
Asparagus laricin.         TCTTCTTTTT-----GAAGATCT----------AAGAAAT-CGGGGACTA
Sansevieria aethiopic.     TCTTCTTTTT-----GAAGATC----------GAAGAAATTCGGGGACTA
Scadoxus membranaceus      TCTTCTTTTTTT----AA-ATCT----------AATAAATTCGGGGACTA
Schizocarphus nervosus*    TCTTCTTTTT-----GAAGATCT----------AAGAAATTCGGGGACTA
Schizocarphus nervosus     TCTTCTTTTT-----GAAGATCT----------AA-----TCGGGGACTA
Scilla peruviana           TCTTCTTTTT-----GAAGATCT----------AAGAAATTCGGGGACTA
Scilla lazulina            TCTTCTTTTT-----GAAGATCT----------AAGAAATTCGGGGACTA
Trachyandra sp.*           TCTTCTTTTT-----GAAGATCT---AAGAAATAAGAAATTCATGGACTA
Trachyandra sp.            TCTTCTTTTT-----GAAGATCT---AAGAAATAAGAAATTCATGGACTA
Drimia altissima*          TCTTCTTTTT-----GAAGATCT----------AACAAATTAGGAGACTA
Urginea undulata           TCTTCTTTTT-----GAAGATCT----------AACAAAT-CGGAGACTA
Urginea sp.                TCTTCTTTTT-----GAAGATCT----------AACAAATTCGGAGACTA
Veltheimia capensis*       TCTTCTTTTT-----GAAGATCTAA---------------TCGGGGACTG
Veltheimia bracteata       TCTTCTTTTT-----GAAGATCTAA----------GAAATTCGGGGGCTG
Aloe vera                  TCTTCTTTTT-----GAAGATCT----------AAGAAATTCATGGACTA
Aloe bakeri                TCTTCTTTTT-----GAAGGTCT----------AAGAAATTCATGGACTA
Bulbine wiesei             TTTTCTTTAT----TGAAGATCT----------AAGAAATTCACGGACTA
Bulbine semibarbata        TTTTCTTTTT-----GAAGATCT----------AAGAAATTCACGGACTT
Bulbine succulenta         TTTTCTTTTT-----GAAGATCT----------AAGAAATTCACGGACTA
Bulbinella cauda-felis     TCTTCTT----------------------------------------TAG
Dipcadi viride             TCTTCTTTTT-----AAAGATTT----------AAGAAATTGGGGGACTA
Dipcadi fulvum             TCTTCTTTTT-----AAAGATTT----------AAGAAATTGGGGGACTA
Drimia elata               TCTTCTTTTT-----GAAGATCT----------AACAAATTAGGAGACTA
Drimia fugax               TCTTCTTTTT-----GAAGATCT----------AACAAATTCGGAGACTA
Drimia calcarata           TCTTCTTTTT-----GAAGATCT----------AACAAATTAGGAGACTA
Drimia undata              TCTTCTTTTT-----GAAGATCT----------AACAAATTCGGAGACTA
Drimiopsis botryoides      TTTTCTTTTT-----AAAGATCT----------AAGAAATTCGGGGACTA
Drimiopsis maculata        TTTTCTTTTT-----AAAGATCT----------AAGAAATTCGGGGACTA
Drimiopsis barteri         TTTTCTTTTT-----AAAGATCT----------AAGAAATTCGGGGACTA
Galtonia princeps          TCTTCTTTTT-----AAAGATTT----------AAGAAATTAGGGGACTA
Galtonia viridiflora       TCTTCTTTTT-----AAAGATTT----------AAGAAATTAGGGGACTA
Galtonia candicans         TCTTCTTTTT-----AAAGATTT----------AAGAAATTAGGGGACTA
Gasteria bicolorvar. lili.TCTTCTTTTT-----GAAGATCT----------AAGAAATTCATGGACTA
Haworthia fasciata         TCTTCTTTTT-----GAAGATCT----------AAGAAATTCGTGGACTA
Kniphofia uvaria           TCTTCTTTTT-----GAAGATCT----------AAGAAATTCATGGACTA
Muscari comosum            TCTTCTTTTT-----GAAGATCT----------AAGAAATTCGGGGACTC
Nivenia corymbosa          TCTTCTTTTT-GAATGAAGATCTAAAACT----AAGAAATTTCGGGTACT
Nothoscordum bivalve       TCTTCTTTT------GAAAATCG----------AAAAAATTCTGGGACGG
Rhadamanthus sp.           TCTTCTTTTT-----GAAGATCT----------AACAAATTAGGAGACTA
Schizobasis sp.            TCTTCTTTTT-----GAAGATCT----------AACAAATTCGGGGAATA
Drimia intricata           TCTTCTTTTT-----GAAGATCT----------AACAAATTCGGGGAATA
Thuranthos indicum         TCTTCTTTTT-----GAAGATCT----------AACAAATTCGGAGATTA
Tulbaghia violacea         TCTTCTTTTT-----GAAAATCT----------AAAAAATTCGGGGACGA
Whiteheadia bifolia        TCTTCTTTTT-----GAAGATCT----------AAGAAATTCGGGGACTA
Witsenia maura             TCTTCTTTTT-----GAATAAAGATCTAAAACTAAGAAATTTCGGGTGCT

Albuca sp.*                ------------------------------------------------
Albuca nelsonii            ------------------------------------------------
Albuca sp.                 GACCCAAATTT------------------------------------
Albuca shawii              GACCCAAATTT------------------------------------
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Bowiea volubilis*          GGTCAAAATTT----------------------------------------
Bowiea volubilis           GGTCAAAATTT----------------------------------------
Eriospermum cooperi*       ----------------------------------------------------
Eriospermum flagelliforme  GGTCAAATTTTTGAC-------------------------------------
Eucomis autumnalis*        GGTCAAAATTT----------------------------------------
Eucomis punctata           GGTCAAAATTT----------------------------------------
Gloriosa sp.               GGT-AAGATTTATT-AAT-----AATTAATAATAATCCTTTTAATTTACA
Ledebouria revoluta*       GGTCAAAATTT----------------------------------------
Ledebouria revoluta        GGTCAAAATTT----------------------------------------
Ledebouria socialis        GGTCAAAATTT----------------------------------------
Ledebouria somalensis      GGTCAAAATTT----------------------------------------
Ledebouria cordifolia      GGTCAAAATTT----------------------------------------
Ledebouria urceolata       GGTCAAAATTT----------------------------------------
Ornithogalum amphibolum    GACCCAAATTT----------------------------------------
Ornithogalum angustif.     GACCAAAATTT----------------------------------------
Ornithogalum fimbriatum    GACCCAAATTT----------------------------------------
Ornithogalum gussonei      GACCCAAATTT----------------------------------------
Ornithogalum longibr       GACCCAAATTT----------------------------------------
Ornithogalum montanum      GACCCAAATTT----------------------------------------
Ornithogalum pannonic.     GACCCAAATTT----------------------------------------
Ornithogalum paschean.     GACCCAAATTT----------------------------------------
Ornithogalum tenuifol.     GACCCAAATTT----------------------------------------
Ornithogalum umbellat.     GACCAAAATTT----------------------------------------
Ornithogalum wiedeman.     GACCCAAATTT----------------------------------------
Ornithoglossum viride      GGT----------------------AAGATATATT-AA-----AAATT-T
Asparagus laricin.         GGTTAAA-TTT----------------------------------------
Sansevieria aethiopic.     GGTCAAATTTT----------------------------------------
Scadoxus membranaceus      GGTCAAAATTT----------------------------------------
Schizocarphus nervosus*    GGTCAAAATTT----------------------------------------
Schizocarphus nervosus     GGTCAAAATTT----------------------------------------
Scilla peruviana           GATCAAAATTG----------------------------------------
Scilla lazulina            GGTCAAAATTT----------------------------------------
Trachyandra sp.*           AGTCAA--TTTTTTGAATGGTTTAATTAATAATAA----------------
Trachyandra sp.            GGTCAA--TTTAATGAATACTTTAATTAATAATTAATATAATAATTAATA
Drimia altissima*          GGTCAAAATTT----------------------------------------
Urginea undulata           GGTCAAAATTT----------------------------------------
Urginea sp.                GGTCAAAATTT----------------------------------------
Veltheimia capensis*       GGTCAAAATTT----------------------------------------
Veltheimia bracteata       GGTCAAAATTT----------------------------------------
Aloe vera                  GGTCAATTTTTT--GAATACTTTAA--TTTAAATATTTCAATGATTTTTT
Aloe bakeri                GGTCAATTTTTT--GAATACTTTAA--TTTAAATATTTCAATGATTTTTT
Bulbine wiesei             GGTCCATTTTTT--GAATATTTTAAA-------TTGAAAAAATGTATTTC
Bulbine semibarbata        AGGTCAATTTTTT-GAATACTTTAAA-------TTGAAAAATTAAAAA-T
Bulbine succulenta         GGTCAATTTTTT--GATTTTTGAATACTTTAATTTGAAA--TTGAAAAAT
Bulbinella cauda-felis     GTCAATTTTTT---GAATACTTTAATTTAAAACTA----------------
Dipcadi viride             GACCCAAATTT----------------------------------------
Dipcadi fulvum             GACCCAAATTT----------------------------------------
Drimia elata               GGTCAAAATTT----------------------------------------
Drimia fugax               GGTCAAAATTT----------------------------------------
Drimia calcarata           GATCAAAATTT----------------------------------------
Drimia undata              GGTCAAAATTT----------------------------------------
Drimiopsis botryoides      GGTCAAAATTT----------------------------------------
Drimiopsis maculata        GGTCAAAATTT----------------------------------------
Drimiopsis barteri         GGTCAAAATTT----------------------------------------
Galtonia princeps          GACCCAAATTT----------------------------------------
Galtonia viridiflora       GACCCAAATTT----------------------------------------
Galtonia candicans         GACCCAAATTT----------------------------------------
Gasteria bicolorvar. lili.G-GTCAATTTTTT-GAATACTTTAAATTGAAAATTTCAATATTGAAATGA
Haworthia fasciata         G-GTCAATTTTTT-GAATACTTTAATTTAAAATTTCAATATTGAAATGAT
Kniphofia uvaria           G-GTCAATTTTTT-GAATACTTTAAAATTAATAT------------TGAT
Muscari comosum            G-GTCAAAATTT----------------------------------------
Nivenia corymbosa          ATACCATACCA-----------------------------------AAT
Nothoscordum bivalve       GATCAAAATTT----------------------------------------
Rhadamanthus sp.           GTTCAAAATTT----------------------------------------
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Schizobasis sp.           GGTCAAAATTG-----------------------------------------
Drimia intricata          GGTCAAAATTG-----------------------------------------
Thuranthos indicum        GGTCAAAATTT-----------------------------------------
Tulbaghia violacea        GGTCAAAATTT-----------------------------------------
Whiteheadia bifolia       GGTCAAAATTT-----------------------------------------
Witsenia maura            ATACCAAATTT-----------------------------------------

Albuca sp.*               -------------------------------------------------
Albuca nelsonii           -------------------------------------------------
Albuca sp.                ----------------------------TTAATAGTTTTTTT--AGTCTA
Albuca shawii             ----------------------------TTAATAGTTTTTTT--AGTCTA
Bowiea volubilis*         ----------------------------TTAATAGTTTTTTT--AGTCTA
Bowiea volubilis          ----------------------------TTAATAGTTTTTTT--AGTCTA
Eriospermum cooperi*      -------------------------------------------------
Eriospermum flagelliforme ---------------------------------TACTTTTTTT--AGTCTA
Eucomis autumnalis*       ----------------------------TTAATAGTTTTT----AGTCTA
Eucomis punctata          ----------------------------TTAATAGTTTTT----AGTCTA
Gloriosa sp.              TTGA-------------------------------------------------
Ledebouria revoluta*      ----------------------------TTAATAGTTTTT----AGTCTA
Ledebouria revoluta       ----------------------------TTAATAGTTTTT----AGTCTA
Ledebouria socialis       ----------------------------TGAATAGTTTTT----AGTCTA
Ledebouria somalensis     ----------------------------TTAATAGTTTTT----AGTCTA
Ledebouria cordifolia     ----------------------------TTAATAGTTTTT----AGTCTA
Ledebouria urceolata      ----------------------------TTAATAGTTTTT----AGTCTA
Ornithogalum amphibolum   ----------------------------GGAATAGTTTTTTT--AGTCTA
Ornithogalum angustif.    ----------------------------GGAATAGTTTTTTT--AGTCTA
Ornithogalum fimbriatum   ----------------------------GGAATAGTTTTTTT--AGTCTA
Ornithogalum gussonei     ----------------------------GGAATAGTTTTTTT--AGTCTA
Ornithogalum longibr      ----------------------------TTAATAGTTTTTTT--AGTCTA
Ornithogalum montanum     ----------------------------AGAATAGTTTTTTT--AGTCTA
Ornithogalum pannonic.    ----------------------------GGAATAGTTTTTTT--AGTCTA
Ornithogalum paschean.    ----------------------------GGAATAGTTTTTTT--AGTCTA
Ornithogalum tenuifol.    ----------------------------TTAATAGTTTTTTT--AGTCTA
Ornithogalum umbellat.    ----------------------------GGAATAGTTTTTTT--AGTCTA
Ornithogalum wiedeman.    ----------------------------GGAATAGTTTTTTT--AGTCTA
Ornithoglossum viride     CTTATTAATTGAA------------TTGAAATTGA--------------
Asparagus laricin.        ---------------------------TTAAATACTTTTTTT--AGTCTA
Sansevieria aethiopic.    ----------------------------TGAATACTTTTTT--GAGTCTA
Scadoxus membranaceus     ----------------------------TTAAGACCTTTTTTTTAGTCTA
Schizocarphus nervosus*   ----------------------------TTAATAGTTTTT----AGTCTA
Schizocarphus nervosus    ----------------------------TTAATAGTTTTT----AGTCTA
Scilla peruviana          ----------------------------TTAATAGTTTTTT---AGTCTA
Scilla lazulina           ----------------------------TTAATAGTTTTT----AGTCTA
Trachyandra sp.*          ----------------------------TTAATTGCTTTTTT--AGTCTA
Trachyandra sp.           ATAA------------------------TTAATTTCTTTTTT--AGTTTA
Drimia altissima*         ----------------------------TTAATAGTTTTTTT--AGTCTA
Urginea undulata          ----------------------------TTAATAGTTTTTTT--AGTCTA
Urginea sp.               ----------------------------TTAATAGTTTTTTT--AGTCTA
Veltheimia capensis*      ----------------------------TTAATAGTTTTT----AGTCTA
Veltheimia bracteata      ----------------------------TTAATAGTTTTT----AGTCTA
Aloe vera                 TTTCATATTC--ATATTGAATT------TCTTTATTTTTT----AGTCTA
Aloe bakeri               TTTTTTTTATTAATATTGAATT------TCTTTATTTTTT----AGTCTA
Bulbine wiesei            YT--------------------------TCTTTTTTTCT-----TGTCTA
Bulbine semibarbata       TAAATTGAAAAATTTAATT---------TCTTTATTTTTT----AGTCTA
Bulbine succulenta        TGCATTTCTT------------------TCTTTTCTTTTTT---AGTCAA
Bulbinella cauda-felis    ----------------------------AATTTATTTTTG----AGTCTA
Dipcadi viride            ----------------------------TTAATAGTTTTTT---AGTCTA
Dipcadi fulvum            ----------------------------TTAATAGTTTTTTT--AGTCTA
Drimia elata              ----------------------------TTAATAGTTTTTTT--AGTCTA
Drimia fugax              ----------------------------TTAATAGTTTTTTT--AGTCTA
Drimia calcarata          ----------------------------TTAATAGTTTTTTT--AGTGTA
Drimia undata             ----------------------------TTAATAGTTTTTTT--AGTCTA
Drimiopsis botryoides     ----------------------------TGAATAGTTTTT----AGTCTA
Drimiopsis maculata       ----------------------------TTAATAGTTTTT----AGTCTA
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Drimiopsis barteri          ----------------------------TTTATAGTTTTT----AGTCTA
Galtonia princeps           ----------------------------TTAATAGGTTTTTT--AGTCTA
Galtonia viridiflora        ----------------------------TTAATAGTTTTTCT--AGTCTA
Galtonia candicans          ----------------------------TTAATAGTTTTTCT--AGTCTA
Gasteria bicolorvar. lili.AATGATTTTTTTTTCATACTAAATATTTAATTTCTTTATTTTTTAGTCTA
Haworthia fasciata          TTTTTTCATACTAATATTTAATT-----TCTTTATTTTTT----AGTCTA
Kniphofia uvaria            TTCT------------------------ATTAAATTTATT----GGTCTA
Muscari comosum             ----------------------------GTAATAGTTTTTT---AGTCTA
Nivenia corymbosa           TTTTTAATACTTTGGC----------------------------AGTCTC
Nothoscordum bivalve        ----------------------------TTAATACTTTTTTTT-AGTGTA
Rhadamanthus sp.            ----------------------------TTAATAGTTTTTTT--AGTCTA
Schizobasis sp.             ----------------------------TTAATAGTTTTTTT--AGTCTA
Drimia intricata            ----------------------------TTAATAGTTTTTTT--AGTCTA
Thuranthos indicum          ----------------------------GAAATAGTTTTTTT--AGTCTA
Tulbaghia violacea          ----------------------------TGAATACTTTTTTTTGAGTGTA
Whiteheadia bifolia         ----------------------------TTAATAGTTTTT----GGTCTA
Witsenia maura              ----------------------------TTTAATACTTTGGT---AGTCTC

Albuca sp.*                 ------------------------AGATACAAGTACTCTACT-----AGG
Albuca nelsonii             ------------------------AGATACAAGTACTCTACT-----AGG
Albuca sp.                  TTTAATTTACATACATA-TTACATAGATACAAGTACTCTACT-----AGG
Albuca shawii               TTTAATTTACATACATA-TTACATAGATACAAGTACTCTACT-----AGG
Bowiea volubilis*           TTTTATTTACATACATA-TTATATAGATACNNNNNNNNNNNN-----NNN
Bowiea volubilis            TTTTATTTACATACATA-TTATATAGATAC--GTACTCTACT-----AGG
Eriospermum cooperi*        ----------------------ATAGATACAAGTACTCTACT-----AGG
Eriospermum flagelliforme TTTAAT------------TTCCATAGATACAAGTACTATACT-----AGG
Eucomis autumnalis*         TTTAATTTACATACATA-TTACATAGATACAAGTACTATACT-----AGG
Eucomis punctata            TTTAATTTACATACATA-TTACATAGATACAAGTACTATACT-----AGG
Gloriosa sp.                ---AATTGACATAGATA-----------CAAGTACTTTACT-----AGG
Ledebouria revoluta*        TTTAATTTACATACATA-TTACGTAGATACAAGTACTCTACT-----AGG
Ledebouria revoluta         TTTAATTTACATACATA-TTACGTAGATACAAGTACTCTACC-----AGG
Ledebouria socialis         TTTAATTTACATACATA-TTACGTAGATACAAGTACTCTACT-----AGG
Ledebouria somalensis       TTTAATTTACATACATA-TTATGTAGATACAAGTACTCTACC-----AGG
Ledebouria cordifolia       TTTAATTTACATACATA-TTACGTAGATACAAGTACTCTACT-----AGG
Ledebouria urceolata        TTTAATTTACATACATA-TTACGTAGATACAAGTACTCTACC-----AGG
Ornithogalum amphibolum     TTTAATTTACATACATA-TTACATAGATACAAGTACTCTACT-----AGA
Ornithogalum angustif.      TTTAATTTACATACATA-TTACATAGATACAAGTACTCTACT-----AGG
Ornithogalum fimbriatum     TTTAATTTACATACATA-TTACATAGATACAAGTACTCTACT-----AGG
Ornithogalum gussonei       TTTAATTTACATACATA-TTACATAGATACAAGTACTCTACT-----GGG
Ornithogalum longibr        TTTAATTTACATACATA-TTACATAGATACAAGTACTCTACT-----AGG
Ornithogalum montanum       TTTAATTTACATACATA-TTACATAGATACAAGTACTCTACT-----AGG
Ornithogalum pannonic.      TTTAATTTACATACATA-TTACATAGATACAAGTACTCTACT-----AGG
Ornithogalum paschean.      TTTAATTTACATACATA-TTACATAGATACAAGTACTCTACT-----AGG
Ornithogalum tenuifol.      TTTAATTTACATACATA-TTACATAGATACAAGTACTCTACT-----AGG
Ornithogalum umbellat.      TTTAATTTACATACATA-TTACATAGATACAAGTACTCTACT-----AGG
Ornithogalum wiedeman.      TTTAATTTACATACATA-TTACATAGATACAAGTACTCTACT-----AGG
Ornithoglossum viride       ---------------------CATAGATACAAGTACTTTACT-----AGG
Asparagus laricin.          TTTCATTTCCATAGATA-----------CAAGTACTCTACT-----AGG
Sansevieria aethiopic.      TGTAATTTC------------CATAGATACAAGTACTCCGCT-----AGT
Scadoxus membranaceus       TTTAATTTA------------CATAGATACAAATACTCTACT-----AGG
Schizocarphus nervosus*     TTTAATTTACATACATA-TTACATAGATACAAGTACTMTACT-----AGG
Schizocarphus nervosus      TTTAATTTACATACATA-TTACATAGATACAAGTACTCTACT-----AGG
Scilla peruviana            TTTAATTTGCATACATA-TTACATAGATACAAGTACTCTACT-----AAG
Scilla lazulina             TTTAATTTACATACATA-TTACATAGATACAAGTACTCTACT-AGGATGA
Trachyandra sp.*            TTTAATTTAC-------------------CAAGCACTCTACT-----AGG
Trachyandra sp.             TTTAATTTAC-------------------CAAGTACTCTACT-----AGG
Drimia altissima*           TTTAATTTACATACATA-TTATATAGATACAAGTATTCTACT-----AGG
Urginea undulata            TTTAATTTACATATATA-TTATATGGATACAAGTACTATACT-----AGG
Urginea sp.                 TTTAATTTACATACATA-TTATATAGATACAAGTACTCTACT-----AGG
Veltheimia capensis*        TTTAATTTACATACATA-TTACATAGATACAAGTACTCTACT-----AGG
Veltheimia bracteata        TTTAATTTACATACATA-TTACATAGATACAAGTACTCTACT-----AGG
Aloe vera                   TTTAATTTAC-------------------CAAGCACTCTACT-----AGG
Aloe bakeri                 TTTAATTTAC-------------------CAAGCACTCTACT-----AGG
Bulbine wiesei              TTTCATTTAC-------------------CAAAAAGTCTACT-----AGG
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Bulbine semibarbata        TTTAATTTAC------------------CAAAAAGTCTACT-----AGC
Bulbine succulenta         TTTAATTTAC------------------CAAGCAGTCTACT-----AGG
Bulbinella cauda-felis     TTAAATTTAC------------------CAAGCACTCTACT-----AGT
Dipcadi viride             TTTAATTTACATACATA-TTACATAGATACAAGTACTCTACT-----AGG
Dipcadi fulvum             TTTAATTTACATACATA-TTACATAGATACAAGTACTCTACT-----AGG
Drimia elata               TTTAATTTACATACATA-TTATATAGATACAAGTATTCTACT-----AGG
Drimia fugax               TTTAATTTACGTACATA-TTATATAGATACAAGTACTCTACT-----AGG
Drimia calcarata           TTTAAATTACATACATA-TTATATAGATACAAGTACTCTACT-----AGG
Drimia undata              TTTAATTTACATATATA-TTATATGGATACAAGTACTATACT-----AGG
Drimiopsis botryoides      TTTAATTTACATACATA-TTACGTAGATACAAGTAGTGTACT-----AGG
Drimiopsis maculata        TTTAATTTACATACATA-TTACGTAGATACAAGTACTCTACT-----AGG
Drimiopsis barteri         TTTAATTTACATACATA-TTACGTAGATACAAGTACTCTACT-----AGG
Galtonia princeps          TTTAA-ATACATA-----TTACATAGATACAAGTACTCTACT-----AGG
Galtonia viridiflora       TTTAA-ATACATA-----TTACATAGATACAAGTACTCTACT-----AGG
Galtonia candicans         TTTAA-ATACATA-----TTACATAGATACAAGTACTCTACT-----AGG
Gasteria bicolorvar. lili.TTTAATTTAC------------------CAAGCACTCTACT-----AGG
Haworthia fasciata         TTTAATTTAC------------------CAAGCACTCTACT-----AGG
Kniphofia uvaria           TTTAATTTAC------------------CAAGCACTCTACT-----AGG
Muscari comosum            TTTAATTTACATACATA-TTACATAGATATAAGTACTCTACT-----AAG
Nivenia corymbosa          TTTAATTTCTATA-----------GATAGAAGTACTCTATT-----AGG
Nothoscordum bivalve       TTTCATTTACATAGATA-----------TAAGTACTCTACG-----AGG
Rhadamanthus sp.           TATAATTTACATACATA-TTATATAGATACAAGTACTCTACT-----AGG
Schizobasis sp.            TTTAATTTACATACATA-TTATATAGATACAAGTACTCTACT-----AGG
Drimia intricata           TTTAATTTACATACATA-TTATATAGATACAAGTACTCTACT-----AGG
Thuranthos indicum         TTTAATTTACGTACATA-TTATATAGATACAAGTACTCTACT-----AGG
Tulbaghia violacea         TTTAATTTACATAGATA-----------CAAGTACTCTACG-----AGG
Whiteheadia bifolia        TTTAATTTACATACATA-TTACATAGATATAAGTACTCTACT-----AGG
Witsenia maura             TTTAATTTCCAAAGATA-----------GAAGTACTCTATT-----AGG

Albuca sp.*                ATGATGCGCGGAAAATG--------------------------------
Albuca nelsonii            AT-----GCGGAAAATG--------------------------------
Albuca sp.                 ATG-----CGGAAAATG--------------------------------
Albuca shawii              ATGATGCGCGGAAAATG--------------------------------
Bowiea volubilis*          NNNNNNNNNNNNNNNNN--------------------------------
Bowiea volubilis           ATGATGCGCGGGAAATG--------------------------------
Eriospermum cooperi*       ATGATGCGNNNNNNNNN--------------------------------
Eriospermum flagelliforme  ATGATGCGCGGGAAATN--------------------------------
Eucomis autumnalis*        ATGATGCACGGGAAATG--------------------------------
Eucomis punctata           ATGATGCACGGGAAATG--------------------------------
Gloriosa sp.               AACTCGGACGNNNNNNN--------------------------------
Ledebouria revoluta*       ATGATGCACGGGAAATG--------------------------------
Ledebouria revoluta        ATGATGCACGGGAAATG--------------------------------
Ledebouria socialis        ATGATGCACGGGAAATG--------------------------------
Ledebouria somalensis      ATGATGCACGGGAAATG--------------------------------
Ledebouria cordifolia      ATGATGCACGGGAAATG--------------------------------
Ledebouria urceolata       ATGATGCACGGGAAATG--------------------------------
Ornithogalum amphibolum    ATGATGCGCGGGAAATG--------------------------------
Ornithogalum angustif.     ATGATGCGCGGGAAATG--------------------------------
Ornithogalum fimbriatum    ATGATGCGCGGGAAACG--------------------------------
Ornithogalum gussonei      ATGATGCGCGGGAAATG--------------------------------
Ornithogalum longibr       ATGATGCGCGGAAAATG--------------------------------
Ornithogalum montanum      ATGATGCGCGGGAAACG--------------------------------
Ornithogalum pannonic.     ATGATGCGCGGGAAATG--------------------------------
Ornithogalum paschean.     ATGATGCGCGGGAAACG--------------------------------
Ornithogalum tenuifol.     ATGATGCGCGGAAAATG--------------------------------
Ornithogalum umbellat.     ATGATGCGCGGGAAATG--------------------------------
Ornithogalum wiedeman.     ATGATGCGCGGGAAATG--------------------------------
Ornithoglossum viride      AACTCGGACGGNNNNNN--------------------------------
Asparagus laricin.         ATCATGCGCGGGAAATG--------------------------------
Sansevieria aethiopic.     ATGATGCGCGGGAAATG--------------------------------
Scadoxus membranaceus      ATGATGCGCGGGAAATC--------------------------------
Schizocarphus nervosus*    ATGATGCACGGGAAATG--------------------------------
Schizocarphus nervosus     ATGATGCACGGGAAATG--------------------------------
Scilla peruviana           ATGATGCACGGGAAATG--------------------------------
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Scilla lazulina            TGCACGGGAAGGAAATG--------------------------------
Trachyandra sp.*           ATGGTGTGCGGGAANNN--------------------------------
Trachyandra sp.            ATAGTGTGCGGGAAATA--------------------------------
Drimia altissima*          ATGATGCGCGNNNNNNN--------------------------------
Urginea undulata           ATGATGCGCGGGAAATG--------------------------------
Urginea sp.                ATGATGCGCGGGAAATG--------------------------------
Veltheimia capensis*       ATGATGCACGGGAAATG--------------------------------
Veltheimia bracteata       ATGATGCACGGGAAATG--------------------------------
Aloe vera                  ATGATGCGCGGGAAATG--------------------------------
Aloe bakeri                ATGATGCGCGGGAAATG--------------------------------
Bulbine wiesei             ATGGTGCGCGGGAAATG--------------------------------
Bulbine semibarbata        AAGGTTCGCGGGAAATG--------------------------------
Bulbine succulenta         ATGGTGCGCGGGAAATG--------------------------------
Bulbinella cauda-felis     ATGGTGCGCGGGAAATA--------------------------------
Dipcadi viride             ATGATGCGCGGGAAATG--------------------------------
Dipcadi fulvum             ATGATGCGCGGGAAATG--------------------------------
Drimia elata               ATGATGCGCAGGAAATG--------------------------------
Drimia fugax               ATGATGCGCGGGAAATG--------------------------------
Drimia calcarata           ATGATGCGCGGGAAATG--------------------------------
Drimia undata              ATGATGCGCGGGAAATG--------------------------------
Drimiopsis botryoides      ATGATGTACGAGAAATG--------------------------------
Drimiopsis maculata        ATGATGTACGGGAAATG--------------------------------
Drimiopsis barteri         ATGATGTACGGGAAATG--------------------------------
Galtonia princeps          ATGATGCGCGGGAAATG--------------------------------
Galtonia viridiflora       ATGATGCGCGGGAAATG--------------------------------
Galtonia candicans         ATGATGCGCGGGAAATG--------------------------------
Gasteria bicolorvar. lili.ATGATGCGCGGGAAATG--------------------------------
Haworthia fasciata         ATGATGCGCGGGAAATG--------------------------------
Kniphofia uvaria           ATGGTGCGCGGGAAATG--------------------------------
Muscari comosum            ATGATGCACGGGAAATG--------------------------------
Nivenia corymbosa          ATGATGCGCGGGAAATG--------------------------------
Nothoscordum bivalve       ATGATGCGCGAGAACTG--------------------------------
Rhadamanthus sp.           ATGATGCGCGGGAAATG--------------------------------
Schizobasis sp.            ATGATGCGCGGGAAATG--------------------------------
Drimia intricata           ATGATGCGCGGGAAATG--------------------------------
Thuranthos indicum         ATGATGCGCGGGAAATG--------------------------------
Tulbaghia violacea         ATGATGCGCGG-AAATG--------------------------------
Whiteheadia bifolia        ATGATGCACGGGAAATG--------------------------------
Witsenia maura             ATGATGCGCGGGAAAGG--------------------------------

Albuca sp.*                00000010-0-0001-----0001-0-----00-01--0-001--0--0-
Albuca nelsonii            00000010-0-0001-----0001-0-----00-01--0-001--0--0-
Albuca sp.                 00000010-0-0001-----0001-0-----00-01--0-001--0--0-
Albuca shawii              00000010-0-0001-----0001-0-----00-01--0-001--0--0-
Bowiea volubilis*          00000010-0-0001-----000000001--001000001000010--0-
Bowiea volubilis           00000010-0-0001-----000000001--001000001000010--0-
Eriospermum cooperi*       00000010-0-0001-----0000000000000-1-----0001000-00
Eriospermum flagelliforme  00000010-0-0001-----0000000001000-1-----0001000-00
Eucomis autumnalis*        00000010-0-0001-----0000-01-0-000-001000000010--0-
Eucomis punctata           00000010-0-0001-----0000-01-0-000-001000000010--0-
Gloriosa sp.               0001----------------000-----------00-0000000-1----
Ledebouria revoluta*       00000010-0-0001-----0001-0-----001000001000010--0-
Ledebouria revoluta        00000010-0-0001-----0001-0-----001000001000010--0-
Ledebouria socialis        00000010-0-0001-----0001-0-----001000001000010--0-
Ledebouria somalensis      00000010-0-0001-----0001-0-----001000001000010--0-
Ledebouria cordifolia      00000010-0-0001-----0001-0-----001000001000010--0-
Ledebouria urceolata       00000010-0-0001-----0001-0-----001000001000010--0-
Ornithogalum amphibolum    00000010-0-0001-----0001-0-----001000001000010--0-
Ornithogalum angustif.     00000010-0-0001-----0001-0-----001000001000010--0-
Ornithogalum fimbriatum    00000010-0-0001-----0001-0-----001000001000010--0-
Ornithogalum gussonei      00000010-0-0001-----0001-0-----001000001000010--0-
Ornithogalum longibr       00000010-0-0001-----0001-0-----00-01--0-010-000-00
Ornithogalum montanum      00000010-0-0001-----0001-0-----001000001000010--0-
Ornithogalum pannonic.     00000010-0-0001-----0001-0-----001000001000010--0-
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Ornithogalum paschean.    00000010-0-0001-----0001-0-----001000001000010--0-
Ornithogalum tenuifol.    00000010-0-0001-----0001-0-----00-01--0-010-000-00
Ornithogalum umbellat.    00000010-0-0001-----0001-0-----001000001000010--0-
Ornithogalum wiedeman.    00000010-0-0001-----0001-0-----001000001000010--0-
Ornithoglossum viride     00000010-0-001------001--------------------------
Asparagus laricin.        00000010-0-0001-----000000010-000-00-1001----0--0-
Sansevieria aethiopic.    00000010-0-0001-----0000000000010-00-1001----0--0-
Scadoxus membranaceus     00000010-0-000001--00001-0-----00-1-----000010--0-
Schizocarphus nervosus*   00000010-0-0001-----0000-01-0-000-001000000010--0-
Schizocarphus nervosus    00000010-0-0001-----0001-0-----001000001000010--0-
Scilla peruviana          00000010-0-0001-----0000-01-0-000100000100000000000
Scilla lazulina           00000010-0-0001-----0001-0-----00100001-001--0--0-
Trachyandra sp.*          0000000000100000100100----------0---0-000000--1-
Trachyandra sp.           0000000000010000100100----------0---0-000000--1-
Drimia altissima*         00000010-0-0001-----0001-0-----00100000100010000-00
Urginea undulata          00000010-0-0001-----0001-0-----00100000100010000-00
Urginea sp.               00000010-0-0001-----0001-0-----00100000100010000-00
Veltheimia capensis*      00000010-0-0001-----0001-0-----001000001000010--0-
Veltheimia bracteata      00000010-0-0001-----0001-0-----001000001000010--0-
Aloe vera                 00000001-----0000100100----------0---0-000000000-
Aloe bakeri               00000001-----0000100100----------0---0-000000000-
Bulbine wiesei            00000010-0-000000011-10----------------000000--1-
Bulbine semibarbata       0000000010-000000010100----------0---0-000000--1-
Bulbine succulenta        0000000000100000010100----------0---0-000000--1-
Bulbinella cauda-felis    00001--0-0-000000010100----------0---0-000000--1-
Dipcadi viride            00000010-0-0001-----0001-0-----001000001000010--0-
Dipcadi fulvum            00000010-0-0001-----0001-0-----001000001000010--0-
Drimia elata              00000010-0-0001-----0001-0-----00100000100010000-00
Drimia fugax              00000010-0-0001-----0000-01-0-000100000100010--0-
Drimia calcarata          00000010-0-0001-----0001-0-----00100000100010000-00
Drimia undata             00000010-0-0001-----0001-0-----00100000100010000-00
Drimiopsis botryoides     00000010-0-0001-----0001-0-----001000001000010--0-
Drimiopsis maculata       00000010-0-0001-----0001-0-----001000001000010--0-
Drimiopsis barteri        00000010-0-0001-----0001-0-----001000001000010--0-
Galtonia princeps         00000001-----01-----0001-0-----000000001000010--0-
Galtonia viridiflora      0000000001---01-----0001-0-----000000001000010--0-
Galtonia candicans        00000010-0-0001-----0001-0-----00-01--0-001--0--0-
Gasteria bicolorvar. lili.0000000001---0000100100----------0---0-000000000-
Haworthia fasciata        000000000001-0000100100----------0---0-000000000-
Kniphofia uvaria          000000000001-0000010100----------0---0-000000--1-
Muscari comosum           0000000000000001-----0001-0-----001000001000010--0-
Nivenia corymbosa         000001000000001------000000001--00-1-----0000000000
Nothoscordum bivalve      00000001-----01-----000000001--00-1-----000010--0-
Rhadamanthus sp.          00000010-0-0001-----0001-0-----00100000100010000-00
Schizobasis sp.           00000010-0-0001-----0001-0-----00100000100010000-00
Drimia intricata          00000010-0-0001-----0001-0-----00100000100010000-00
Thuranthos indicum        00000010-0-0001-----0001-0-----00100000100010000-00
Tulbaghia violacea        00000001-----01-----000000001--00-1-----000000--1-
Whiteheadia bifolia       00000010-0-0001-----0001-0-----001000001000010--0-
Witsenia maura            01100100000001------000000001--00-1-----0000001-0-

Albuca sp.*               -0-0-0-1110101-1-1----0010000101-0-0--11-0--0-0000
Albuca nelsonii           -0-0-0-1110101-1-1----0010000101-0-0--11-0--0-0000
Albuca sp.                -0-0-0-1110101-1-1----0010000101-0-0--01-0--0-0000
Albuca shawii             -0-0-0-1110101-1-1----0010000101-0-0--11-0--0-0000
Bowiea volubilis*         -0-0-0-1110101-1-1----0010000101-0-0--11-0--0-0000
Bowiea volubilis          -0-0-0-1110101-1-1----0010000101-0-0--11-0--0-0000
Eriospermum cooperi*      -000-001110101-1-1----01--000101-0-0--1--1----0000
Eriospermum flagelliforme -000-001110101-1-1----01--000101-0-0--1--1----0000
Eucomis autumnalis*       -0-0-0-1110101-1-1----0010000101-0-0--11-0--0-0000
Eucomis punctata          -0-0-0-1110101-1-1----0010000101-0-0--11-0--0-0000
Gloriosa sp.              -0-----1000101-1-1----001000010010-0--1000010-1--0
Ledebouria revoluta*      -0-0-0-1110101-1-1----0010000101-0-0--11-0--0-0000
Ledebouria revoluta       -0-0-0-1110101-1-1----0010000101-0-0--11-0--0-0000
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Ledebouria socialis       -0-0-0-1110101-1-1----0010000101-0-0--11-0--0-0000
Ledebouria somalensis     -0-0-0-1110101-1-1----001000010010-0--11-0--0-0000
Ledebouria cordifolia     -0-0-0-1110101-1-1----0010000101-0-0--100000010000
Ledebouria urceolata      -0-0-0-1110101-1-1----001000010010-0--11-0--0-0000
Ornithogalum amphibolum   -0-0-0-1110101-1-1----000000011--0-0--11-0--0-0000
Ornithogalum angustif.    -0-0-0-1110101-1-1----000000011--0-0--11-0--0-0000
Ornithogalum fimbriatum   -0-0-0-1110101-1-1----000000011--0-0--11-0--0-0000
Ornithogalum gussonei     -0-0-0-1110101-1-1----000000011--0-0--11-0--0-0000
Ornithogalum longibr      -000-001110101-1-1----0010000101-0-0--11-0--0-0000
Ornithogalum montanum     -0-0-0-1110101-1-1----000000011--0-0--11-0--0-0000
Ornithogalum pannonic.    -0-0-0-1110101-1-1----000000011--0-0--11-0--0-0000
Ornithogalum paschean.    -0-0-0-1110101-1-1----000000011--0-0--11-0--0-0000
Ornithogalum tenuifol.    -000-001110101-1-1----0010000101-0-0--11-0--0-0000
Ornithogalum umbellat.    -0-0-0-1110101-1-1----000000011--0-0--11-0--0-0000
Ornithogalum wiedeman.    -0-0-0-1110101-1-1----000000011--0-0--11-0--0-0000
Ornithoglossum viride     -0-----1000101-1-1----0010000101-0-0--10000-1-01-0
Asparagus laricin.        -0-0-0-1110101-1-1----01--000101-0-0--11-0--0-0000
Sansevieria aethiopic.    -0-0-0-1110101-1-1----01--00010000000011-0--0-0000
Scadoxus membranaceus     -0-0-0-1110-1--------------------------------0001
Schizocarphus nervosus*   -0-0-0-1110101-1-1----0001000101-0-0--11-0--0-0000
Schizocarphus nervosus    -0-0-0-1110101-1-1----0001000101-0-0--11-0--0-0000
Scilla peruviana          0010-0-1110101-1-1----000-1-0-0000000111-0--0-0000
Scilla lazulina           -0-0-0-1110101-1-1----0010000101-0-0--11-0--0-0000
Trachyandra sp.*          -0-----1110101-1-1----000100010--1-0--11-0--0-0000
Trachyandra sp.           -0-----1110101-1-1----0001000101-0-0--11-0--0-0000
Drimia altissima*         -000-001110101-1-1----0001000101-0-0--11-0--0-0000
Urginea undulata          -000-001110101-1-1----0001000101-0-0--11-0--0-0000
Urginea sp.               -000-001110101-1-1----0001000101-0-0--11-0--0-0000
Veltheimia capensis*      -0-0-0-1110101-1-0001-00100001000010-011-0--0-0000
Veltheimia bracteata      -0-0-0-1110101-1-0001-0010000101-0-0--10-01000000-
Aloe vera                 -1-----1110101-1-1----0010000101-0-0--11-0--0-0000
Aloe bakeri               -1-----1110101-1-1----0010000101-0-0--11-0--0-0000
Bulbine wiesei            -0-----1110101-011----0010010-0----1--11-0--0-0000
Bulbine semibarbata       -0-----1110101-011----00100-1----0-0--11-0--0-0000
Bulbine succulenta        -0-----1110101-011----00100-1----0-0--11-0--0-0000
Bulbinella cauda-felis    -0-----1110101-1-1----0010000101-0-0--11-0--0-0000
Dipcadi viride            -0-0-0-1110101-1-1----001000011--0-0--11-0--0-0000
Dipcadi fulvum            -0-0-0-1110101-1-1----001000011--0-0--11-0--0-0000
Drimia elata              -000-001110101-1-1----0010000101-0-0--11-0--0-0000
Drimia fugax              -0-0-0-1110101-1-1----0010000101-0-0--11-0--0-0000
Drimia calcarata          -000-001110101-1-1----1001000100000001011-0--0-0000
Drimia undata             -000-001110101-1-1----0010000101-0-0--11-0--0-0000
Drimiopsis botryoides     -0-0-0-1110101-1-1----0010000101-0-0--11-0--0-0000
Drimiopsis maculata       -0-0-0-1110101-1-1----0010000101-0-0--11-0--0-0000
Drimiopsis barteri        -0-0-0-1110101-1-1----0010000101-0-0--11-0--0-0000
Galtonia princeps         -0-0-0-1110101-1-1----001000011--0-0--11-0--0-0000
Galtonia viridiflora      -0-0-0-1110101-1-1----001000011--0-0--11-0--0-0000
Galtonia candicans        -0-0-0-1110101-1-1----0010000101-0-0--11-0--0-0000
Gasteria bicolorvar. lili.-1-----1110101-1-1----0010000101-0-0--11-0--0-0000
Haworthia fasciata        -1-----1110101-1-1----0010000101-0-0--11-0--0-0000
Kniphofia uvaria          -0-----1110101-1-1----0010000101-0-0--11-0--0-0000
Muscari comosum           -0-0-0-1110101-1-1----0010000101-0-0--11-0--0-0000
Nivenia corymbosa         00-1---1110101-1-1----0010000001-0-0--1000010-0010
Nothoscordum bivalve      -0-0-0-1110101-1-1----0010000101-0-0--11-0--0-0000
Rhadamanthus sp.          -000-001110101-1-1----0001000101-0-0--11-0--0-0000
Schizobasis sp.           -000-001110101-1-1----0001000101-0-0--11-0--0-0000
Drimia intricata          -000-001110101-1-1----0001000101-0-0--11-0--0-0000
Thuranthos indicum        -000-001110101-1-1----0001000101-0-0--11-0--0-0000
Tulbaghia violacea        -0-----1110101-1-1----0010000101-0-0--11-0--0-0000
Whiteheadia bifolia       -0-0-0-1110101-1-1----0010000101-0-0--11-0--0-0000
Witsenia maura            -0-0-0-1110101-1-1----0010000101-0-0--1000010-0010

Albuca sp.*               0101--0000110000000000000001--0-0-0--0--0001-----0-
Albuca nelsonii           0101--0000110000000000000001--0-0-0--0--0001-----0-
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Albuca sp.                0101--0000110000000000000001--0-0-0--0--00000000000
Albuca shawii             0101--0000110000000000000001--0-0-0--0--00000000000
Bowiea volubilis*         0101--000011000000000-1--00--0-000--0-000000000001
Bowiea volubilis          0101--000011000000000-1--00--0-000--0-000000000001
Eriospermum cooperi*      0100010000110000000000000001-00000-11----------0-
Eriospermum flagelliforme 0100000000110000000000000000100000101----------0-
Eucomis autumnalis*       0101--000011000000001----0---0-0-0--0--00000000001
Eucomis punctata          0101--000011000000001----0---0-0-0--0--00000000001
Gloriosa sp.              0001--000000000100-000000000-0000000010000000000000
Ledebouria revoluta*      0101--000011000000000-1--00--0-000--0-000000000001
Ledebouria revoluta       0101--000011000000001----0---0-0-0--0--00000000001
Ledebouria socialis       0101--000011000000001----0---0-0-0--0--00000000001
Ledebouria somalensis     01001-000011000000001----0---0-0-0--0--00000000001
Ledebouria cordifolia     0101--000011000000000-01000--00000--0-000000000001
Ledebouria urceolata      0101--000001000000001----0---0-0-0--0--00000000001
Ornithogalum amphibolum   0101--0000110000000000000000000001--0----00--00-0-
Ornithogalum angustif.    0101--0000110000000000000000000001--0----00--00-0-
Ornithogalum fimbriatum   0101--0000110000000000000000000001--0----00--00-0-
Ornithogalum gussonei     0101--0000110000000000000000000001--0----00--00-0-
Ornithogalum longibr      0101--000011000-1--0-----0-----0-0--0----00--00-0-
Ornithogalum montanum     0101--0000110000000000000000000001--0----00--00-0-
Ornithogalum pannonic.    0101--0000110000000000000000000001--0----00--00-0-
Ornithogalum paschean.    0101--0000110000000000000000000001--0----00--00-0-
Ornithogalum tenuifol.    0101--000011000-1--0-----0-----0-0--0----00--00-0-
Ornithogalum umbellat.    0101--0000110000000000000000000001--0----00--00-0-
Ornithogalum wiedeman.    0101--0000110000000000000000000001--0----00--00-0-
Ornithoglossum viride     0001--000000000100-000000000-0000000000000000000000
Asparagus laricin.        0101--000011000-01-0-----0---0-0-0--0--0000001--0-
Sansevieria aethiopic.    0101--01001101--0--0-----0---0-0-0--0--00000000000
Scadoxus membranaceus     0--1--1011-------------------------------------
Schizocarphus nervosus*   0101--000011000000001----0---0-0-0--0--00000000001
Schizocarphus nervosus    0101--000011000000001----0---0-0-0--0--00000000001
Scilla peruviana          0101--000011000000001----0---0-0-0--0--1-000000001
Scilla lazulina           0101--000011000000001----0---0-0-0--0--00000000001
Trachyandra sp.*          0101--00001101--0--0-----0---0-0-0--0--00000001-0-
Trachyandra sp.           0101--00001101--0--0-----0---0-0-0--0--0100000000-
Drimia altissima*         0101--000011000000000-1--00--0-000--0-000000000001
Urginea undulata          0101--000011000000000-1--00--0-000--0-000000000001
Urginea sp.               0101--000011000000000-1--00--0-000--0-000000000001
Veltheimia capensis*      0101--000011000000001----0---0-0-0--0--00000000001
Veltheimia bracteata      1-----000011000000001----0---0-0-0--0--00000000001
Aloe vera                 0101--00001101--0--0-----0---0-0-0--0--0000000010-
Aloe bakeri               0101--00001101--0--0-----0---0-0-0--0--0000000010-
Bulbine wiesei            0101--00001101--0--0-----0---0-0-0--0--00001-0000-
Bulbine semibarbata       0101--00001101--0--0-----0---0-0-0--0--0000000010-
Bulbine succulenta        0101--00001101--0--0-----0---0-0-0--0--0000000010-
Bulbinella cauda-felis    0101--00001101--0--0-----0---0-0-0--0--00001-0000-
Dipcadi viride            0100000000110000000000000000000010--0----10--00-0-
Dipcadi fulvum            0101--0000110000000000000000000010--0----10--00-0-
Drimia elata              0101--000011000000000-1--00--0-000--0-000000000001
Drimia fugax              0101--000011000000000-1--00--0-000--0-000000000001
Drimia calcarata          0-11--000011000000000-1--00--0-000--0-000000100001
Drimia undata             0101--000011000000000-1--00--0-000--0-000000000001
Drimiopsis botryoides     0101--000011000000001----0---0-0-0--0--00000000001
Drimiopsis maculata       0101--000011000000001----0---0-0-0--0--00000000001
Drimiopsis barteri        0101--000011000000001----0---0-0-0--0--00000000001
Galtonia princeps         0101--0000110000000000000000000010--0----10--00-0-
Galtonia viridiflora      0101--0000110000000000000000000010--0----10--00-0-
Galtonia candicans        0101--0000110000001000000000000010--0----10--00-0-
Gasteria bicolorvar. lili.0101--00001101--0--0-----0---0-0-0--0--0000000010-
Haworthia fasciata        0101--00001101--0--0-----0---0-0-0--0--0000000010-
Kniphofia uvaria          0101--00001101--0--0-----0---0-0-0--0--0000000010-
Muscari comosum           0101--000011000000001----0---0-0-0--0--00001-0000-
Nivenia corymbosa         0101--000011000----1-----0-----0----0-----0--00-0-
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Nothoscordum bivalve      0101--00001101--0--0-----0---0-0-0--0--0000000010-
Rhadamanthus sp.          0101--000011000000000000000001000--0-000000000001
Schizobasis sp.           0101--00001100000000000000000--1----------------0-
Drimia intricata          0101--00001100000000000000000--1----------------0-
Thuranthos indicum        0101--000011000000000-0-100--00000--0-000000000001
Tulbaghia violacea        0101--000011001-00-00-0--00--00000--0-00000000001-
Whiteheadia bifolia       0101--000011000000001----0---0-0-0--0--00000000001
Witsenia maura            0101--00001100000000-----1-----------------------

Albuca sp.*               ------000-0-0-00--0--00-000000001--0000-100000001-
Albuca nelsonii           ------000-0-0-00--0--00-000000001--0000-100000001-
Albuca sp.                01----000-0-0-00--0--00-000000001--0000-100000001-
Albuca shawii             01----000-0-0-00--0--00-000000001--0000-100000001-
Bowiea volubilis*         0000000000000000001-00-000000000100001-000100001-
Bowiea volubilis          0000000000000000001-00-000000000100001-000100001-
Eriospermum cooperi*      ------000-0-0-00--0--00-000001001--000001000100001-
Eriospermum flagelliforme ------000-0-0-00--0--00-000001001--000001000100001-
Eucomis autumnalis*       0000000000000000000010000000000001--000001000100001-
Eucomis punctata          0000000000000000000010000000000001--000001000100001-
Gloriosa sp.              0o000000000000001------------------000001000100001-
Ledebouria revoluta*      00000000000000001-0--00-000000001--000001000100001-
Ledebouria revoluta       00000000000000001-0--00-000000001--000001000100001-
Ledebouria socialis       00000000000000001-0--00-000000001--000001000100001-
Ledebouria somalensis     00000000000000001-0--00-000000001--000001000100001-
Ledebouria cordifolia     00000000000000001-0--00-000000001--000001000100001-
Ledebouria urceolata      00000000000000001-0--00-000000001--000001000100001-
Ornithogalum amphibolum   -0-0-0000-0000000000-000000000001--0010-001-00001-
Ornithogalum angustif.    -0-0-0000-0000000000-000000000001--0010-001-00001-
Ornithogalum fimbriatum   -0-0-0000-0000000000-000000000001--0010-001-000001
Ornithogalum gussonei     -0-0-0000-0000000000-000000000001--0010-001-00001-
Ornithogalum longibr      -0-000000000000000001001000000001--0010-001-00001-
Ornithogalum montanum     -0-0-0000-0000000000-000000000001--0010-001-00001-
Ornithogalum pannonic.    -0-0-0000-0000000000-000000000001--0010-001-00001-
Ornithogalum paschean.    -0-0-0000-0000000000-000000000001--0010-001-00001-
Ornithogalum tenuifol.    -0-000000000000000001001000000001--0010-001-00001-
Ornithogalum umbellat.    -0-0-0000-0000000000-000000000001--0010-001-00001-
Ornithogalum wiedeman.    -0-0-0000-0000000000-000000000001--0010-001-00001-
Ornithoglossum viride     00000000000000000000100001---------00001000010-100
Asparagus laricin.        ------000-0-0-00--0--00-000000001--000001000100001-
Sansevieria aethiopic.    00000000000000000000001--00000001--000001000100001-
Scadoxus membranaceus     -------------------------------------------------
Schizocarphus nervosus*   00000000000000000000100000000001--000001000100001-
Schizocarphus nervosus    00000000000000000000100000000001--000001000000001-
Scilla peruviana          000010000-0000000000-000000000001--000001000100001-
Scilla lazulina           0000-1000-0000000000-000000000001--000001000100001-
Trachyandra sp.*          -0----000-000-000-00-000000100011--000001000100001-
Trachyandra sp.           1001--000-000-000-00-000000-1--01--000001000100001-
Drimia altissima*         0000000000000000001-00-000000001--000001000100001-
Urginea undulata          0000000000000000001-00-000000001--000001000100001-
Urginea sp.               0000000000000000001-00-000000001--000001000101001-
Veltheimia capensis*      00000000000000000000100000000001--000001000100001-
Veltheimia bracteata      00000000000000000000100000000001--000001000100001-
Aloe vera                 -000--100------0-----0---0--0-001--000001000100001-
Aloe bakeri               -000---10------0-----0---0------1--000001000100001-
Bulbine wiesei            0000----1------0-----0---0------1--000001000100001-
Bulbine semibarbata       -000----1------0-----0---0------1--000001000100001-
Bulbine succulenta        -000--100------0-----0---0--0-001--000001000100001-
Bulbinella cauda-felis    0000----1------0-----0---0------1--000001000100001-
Dipcadi viride            -0-0--000-000-000-00-000000000001--0000-100000001-
Dipcadi fulvum            -0-0--000-000-000-00-000000000001--0000-100000001-
Drimia elata              0000000000000000100-000000000001--000001000100001-
Drimia fugax              0000000000000000100-000000000001--000001000100001-
Drimia calcarata          00000000000000000000000100000001--000001000100001-
Drimia undata             0000000000000000100-000000000001--000001000100001-
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Drimiopsis botryoides      00000000000000000-1--00--00000001--00001000100001-
Drimiopsis maculata        00000000000000000-1--00--00000001--00001000100001-
Drimiopsis barteri         00000000000000000-1--00--00000001--00001000100001-
Galtonia princeps          -0-0--000-000-000-00-000000000001--0000-100000001-
Galtonia viridiflora       -0-0--000-000-000-00-000000000001--0000-100000001-
Galtonia candicans         -0-0--000-000-000-00-000000000001--0000-100000001-
Gasteria bicolorvar. lili.-00000000100000000000-000000-1--01--00001000100001-
Haworthia fasciata         -000--000-1-0-00-----00--00-1--01--00001000100001-
Kniphofia uvaria           -000--000-010-00--0--00-000-1--01--00001000100001-
Muscari comosum            00000000000000000-1--00--00000001--00001000100001-
Nivenia corymbosa          -0-0--000-000-000-00-000001-00001--00001000100001-
Nothoscordum bivalve       -000--000---1--0-----0---0--00001--00001000100001-
Rhadamanthus sp.           00000000000000000100-000000000001--00001000100001-
Schizobasis sp.            ------000---0-00-----00--00000001--00001000100001-
Drimia intricata           ------000---0-00-----00--00000001--00001000100001-
Thuranthos indicum         00000000000000000100-000000000001--00001000100001-
Tulbaghia violacea         ------000---0-00-----0---00000101--00001000100001-
Whiteheadia bifolia        00000000000000000-1--00--00000001--00001000100001-
Witsenia maura             -------00------0-----0---0-----01--00001000100001-

Albuca sp.*                00110010--010010--1010-000000000000000-10---0-00001
Albuca nelsonii            00110010--010010--1010-000000000000000-10---0-00001
Albuca sp.                 00110010--010010--1010-000000000000000-10---0-00001
Albuca shawii              00110010--010010--1010-000000000000000-10---0-00001
Bowiea volubilis*          00110010--010010--1010-000000010------00--00-00001
Bowiea volubilis           00110010--010010--1010-000000010------00--00-00001
Eriospermum cooperi*       00110010--010010--11-0-10--------------0---0-00001
Eriospermum flagelliforme  00110010--010010--1010-0000000-1-------0---0-00001
Eucomis autumnalis*        00110010--1-10-0--1010-000000000000000--1-----00001
Eucomis punctata           00110010--1-10-0--1010-000000000000000--1-----00001
Gloriosa sp.               00110010--010010--10001-1-------------------00000
Ledebouria revoluta*       00110010--010010--1010-000000000000000100--00-00001
Ledebouria revoluta        00110010--010010--1010-000000000000000100--00-00001
Ledebouria socialis        00110010--010010--1010-000000000000000100--00-00001
Ledebouria somalensis      001100001-010010--1010-000000000000000100--00-00001
Ledebouria cordifolia      00110010--010010--1010-000000000000000100--00-00001
Ledebouria urceolata       00110010--010011--1010-000000000000000100--00-00001
Ornithogalum amphibolum    00110010--010010--1010-000000000000000-10---0-00001
Ornithogalum angustif.     00110010--010010--1010-000000000000000-10---0-00001
Ornithogalum fimbriatum    00110010--010010--1010-000000000000000-10---0-00001
Ornithogalum gussonei      00110010--010010--1010-000000000000000-10---0-00001
Ornithogalum longibr       00110010--010010--1010-000000000000000-10---0-00001
Ornithogalum montanum      00110010--010010--1010-000000000000000-10---0-00001
Ornithogalum pannonic.     00110010--010010--1010-000000000000000-10---0-00001
Ornithogalum paschean.     00110010--010010--1010-000000000000000-10---0-00001
Ornithogalum tenuifol.     00110010--010010--1010-000000000000000-10---0-00001
Ornithogalum umbellat.     00110010--010010--1010-000000000000000-10---0-00001
Ornithogalum wiedeman.     00110010--010010--1010-000000000000000-10---0-00001
Ornithoglossum viride      00110010--010010--10001-1-------------------00000
Asparagus laricin.         00110010--010010--1010-000000010------00--00-00000
Sansevieria aethiopic.     00110010--010010--1010-000000000000000100--00-00000
Scadoxus membranaceus      0--10010--010010--1010-00000000010---000-000000000
Schizocarphus nervosus*    00110010--1-10-0--1010-000000000000000--1-----00001
Schizocarphus nervosus     00110010--010010--1010-000000000000000100--00-00001
Scilla peruviana           00110010--010010--10001000000000-1---000--00-00001
Scilla lazulina            00110010--010010--1010-000000000000000100--00-00001
Trachyandra sp.*           00110010--010010--1010-000000000-1---000--00-00001
Trachyandra sp.            0011000001010010--1010-00000000010---000-000000000
Drimia altissima*          00110010--010010--10-1-00--0--00-----000--00-00001
Urginea undulata           00110010--010010--1010-001-0--00-----000--00-10001
Urginea sp.                00110010--010010--10-1-00--0--00-----000--00-00001
Veltheimia capensis*       00110010--010010--1010-000000000000000-10---0-00001
Veltheimia bracteata       00110010--010010--1010-000000000000000001000000001
Aloe vera                  00110010--010010--1010-000000000001-00000000000001
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Aloe bakeri                00110010--010010--1010-00000000000010000000000001
Bulbine wiesei             00110010--010010--10001000100000000-000000000101--
Bulbine semibarbata        00110010--010000--1010-00000000010---000-0000101--
Bulbine succulenta         00110010--010010--1010-00000000000--100000000101--
Bulbinella cauda-felis     00110010--010010--1010-00000000000--10000000000001
Dipcadi viride             00110010--010010--1010-000000000000000-10---0-00001
Dipcadi fulvum             00110010--010010--1010-000000000000000-10---0-00001
Drimia elata               00110010--010010--10-1-00--0--00-----000--00-00001
Drimia fugax               00110010--010010--1010-001-0--00-----000--00-1001-
Drimia calcarata           00110010--010010--1010-00--1---0------00--00-00001
Drimia undata              00110010--010010--1010-001-0--00-----000--00-10001
Drimiopsis botryoides      00110010--010010--1010-0000000000000100--00-00001
Drimiopsis maculata        00110010--010010--1010-0000000000000100--00-00001
Drimiopsis barteri         00110010--010010--1010-0000000000000100--00-00001
Galtonia princeps          00110010--010010--1010-00000000000000000-100-10001
Galtonia viridiflora       00110010--010010--1010-00000000000000000-100-10001
Galtonia candicans         00110010--010010--1010-000000000000000-10---0-00001
Gasteria bicolorvar. lili.00110010--010010--1010-00000000000--100000000000001
Haworthia fasciata         00110010--010010--1010-000000000010---000-000000001
Kniphofia uvaria           00110010--010010--1010-000000000-1---000--00-00001
Muscari comosum            00110010--010010--1010-0000000000000100--00-00001
Nivenia corymbosa          1--10010--0--1-0--10001-1-------------------00001
Nothoscordum bivalve       00110010--010010--1010-00000000000000000-100-11---
Rhadamanthus sp.           00110010--010010100010-00--1---0------00--00-00001
Schizobasis sp.            00110010--010010--1010-00--1---0------00--00-10000
Drimia intricata           00110010--010010--1010-00--1---0------00--00-10000
Thuranthos indicum         00110010--010010--1010-000-0100000---000000001001-
Tulbaghia violacea         00010010--010010--1010-000-0-100-0---000-000000000
Whiteheadia bifolia        00110010--010010--1010-0000000000000100--00-00001
Witsenia maura             1--10010--010010--10001-1-------------------00001

Albuca sp.*                -0--00001--01-00000000000000000000000000001----0-1-
Albuca nelsonii            -0--00001--01-00000000000000000000000000001----0-1-
Albuca sp.                 -0--00001--01-00000000000000000000000100001----0-1-
Albuca shawii              -0--00001--01-000100000000000000000-10001----0-1-
Bowiea volubilis*          -0--00001--01-000000000000--1------0--0001----0-1-
Bowiea volubilis           -0--00001--01-000000000000--1------0--0001----0-1-
Eriospermum cooperi*       -0--00001--01-0000000000001-0-----00-00001----0-1-
Eriospermum flagelliforme  -0--00001--01-0000000000001-0-----00-00001----0-1-
Eucomis autumnalis*        -0--00101--00100000000000000000001000000001----0-00
Eucomis punctata           -0--00001--00100000000000000000001000000001----0-00
Gloriosa sp.               01----001--1--001000000000--1------0--0001----0-00
Ledebouria revoluta*       -0--00001--01-000000000000--1------0--000010--001-
Ledebouria revoluta        -0--00001--01-0000000000000001-00000000001----0-1-
Ledebouria socialis        -0--00001--01-0000000000001-0-----00-00001----0-1-
Ledebouria somalensis      -0--00001--01-0000000000000001-00000000001----0-00
Ledebouria cordifolia      -0--00001--01-0000000000001-0-----00-00001----0-1-
Ledebouria urceolata       -0--00001--01-0000000000000001-00000000001----0-00
Ornithogalum amphibolum    -0--00001--01-00000000000000000000100-0001-----0-1-
Ornithogalum angustif.     -0--00001--01-00000000000000000000100-0001-----0-1-
Ornithogalum fimbriatum    -0--00001--01-00000000000000000000100-0001-----0-1-
Ornithogalum gussonei      -0--00001--01-00000000000000000000100-0001-----0-1-
Ornithogalum longibr       -0--00001--01-00000000000000000000000000001----0-1-
Ornithogalum montanum      -0--00001--01-00000000000000000000100-0001-----0-1-
Ornithogalum pannonic.     -0--00001--01-00000000000000000000100-0001-----0-1-
Ornithogalum paschean.     -0--00001--01-00000000000000000000100-0001-----0-1-
Ornithogalum tenuifol.     -0--00001--01-00000000000000000000000000001----0-01
Ornithogalum umbellat.     -0--00001--01-00000000000000000000100-0001-----0-1-
Ornithogalum wiedeman.     -0--00001--01-00000000000000000000100-0001-----0-1-
Ornithoglossum viride      000100001--01-000000000000--1------0--0001----0-00
Asparagus laricin.         100000001--01-0000000000001-0-----00-00100-0--0001
Sansevieria aethiopic.     01----001--01-0000000000001-0-----00-00001----0-01
Scadoxus membranaceus      00001-001--01-0000000000001-0-----00-00001----0-1-
Schizocarphus nervosus*    -0--00001--00101000000000000000100100-00000-1--001-
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Schizocarphus nervosus    -0--00001--00000000000000000000100-00001----0-1-
Scilla peruviana          -0--00000100010000000000000000000000000000000001-
Scilla lazulina           -0--00001--0001000000001----0-----00-00001----0-1-
Trachyandra sp.*          -0--00001--01-0000000000001-0-----00-00001----0-00
Trachyandra sp.           01----001--01-0000000000001-0-----00-00001----0-00
Drimia altissima*         -0--00001--01-000000000000--1------0--0001----0-1-
Urginea undulata          -0--00001--01-00000000001-0-0----000000001----0-1-
Urginea sp.               -0--00001--01-0000000000001-0-----00-00001----0-1-
Veltheimia capensis*      -0--00001--01-00000000000000000100-00001----0-1-
Veltheimia bracteata      00--00001--01-00000000000000000100-00001----0-1-
Aloe vera                 -0--00001--01-000000100000000000000000001----0-00
Aloe bakeri               -0--00001--01-000111-11000000000000000001----0-00
Bulbine wiesei            -0--00001--01-0000000000010000-00100-0000000100000
Bulbine semibarbata       -0--00001--01-0000000000010000-00100-0000000100100
Bulbine succulenta        -0--00001--01-0000000000010000-00100-0000000100000
Bulbinella cauda-felis    -0--00001--01-0000000000010000-00100-0000000-10000
Dipcadi viride            -0--00001--01-00000000000000000100-00001----0-1-
Dipcadi fulvum            -0--00001--01-00000000000000000100-00001----0-1-
Drimia elata              -0--00001--01-000000000000000000-10--0001----0-1-
Drimia fugax              -0--00001--01-000000000000000000-10--0001----0-1-
Drimia calcarata          -0--00001--01-000000000000000000-10--0001----0-1-
Drimia undata             -0--00001--01-000000000000000000-10--0001----0-1-
Drimiopsis botryoides     -0--000000101-00000000000000000100-00001----0-1-
Drimiopsis maculata       -0--00001--01-00000000000000000100-00001----0-1-
Drimiopsis barteri        -0--00001--01-000000000000000000100-00001----0-1-
Galtonia princeps         -0--00001--01-00000000000000000100-00001----0-1-
Galtonia viridiflora      -0--00001--01-00000000000000000100-00001----0-1-
Galtonia candicans        -0--00001--01-00000000000000000100-00001----0-1-
Gasteria bicolorvar. lili.-0--00001--01-0000000000010000-00100-00001----0-00
Haworthia fasciata        -0--00001--01-0000000000010000-00100-00001----0-00
Kniphofia uvaria          -0--00001--01-0000000000010000-00100-00001----0-00
Muscari comosum           -0--00001--01-00000000000000000000000000-----1---
Nivenia corymbosa         -0--000100001-0000000000010000-00100-00001----0-00
Nothoscordum bivalve      -0--00001--01-0000000000010000-00100-00001----0-00
Rhadamanthus sp.          -0--00001--01-000000000000000000-10--0001----0-1-
Schizobasis sp.           001-00001--01-000000000000000000-10--0001----0-1-
Drimia intricata          001-00001--01-000000000000000000-10--0001----0-1-
Thuranthos indicum        -0--00001--01-00000000000000000000--1--0001----0-1-
Tulbaghia violacea        000001001--01-0000000000010000-00100-00001----0-00
Whiteheadia bifolia       -0--00001--01-00000000000000000100-00001----0-1-
Witsenia maura            -0--000001001-0000000000010000-00100-00001----0-00

Albuca sp.*               ---------000001---00001-0-----0-------000010-0001-
Albuca nelsonii           ---------000001---00001-0-----0-------000010-0001-
Albuca sp.                ---------000001---00000001----0-------000010-0001-
Albuca shawii             ---------000001---00000000001-0-------000010-0001-
Bowiea volubilis*         ---------001001---00001-0-----0-------000010-0001-
Bowiea volubilis          ---------001001---00001-0-----0-------000010-0001-
Eriospermum cooperi*      ---------000001---01----0-----0-------000010-0001-
Eriospermum flagelliforme ---------000001---0001--0-----0-------000010-0001-
Eucomis autumnalis*       0001-----000001---00000000001-0-------01--10-0001-
Eucomis punctata          0001-----000001---00000000001-0-------01--10-0001-
Gloriosa sp.              0000000010001-----00100-000-0-00-0--00000010-00001
Ledebouria revoluta*      ----------00000001-01----0-----0-------000110-0001
Ledebouria revoluta       ---------00000001-01----0-----0-------000110-0001-
Ledebouria socialis       ---------00000001-01----0-----0-------000110-0001-
Ledebouria somalensis     0000000001-000001-01----0-----0-------000110-0001-
Ledebouria cordifolia     ---------00000001-01----0-----0-------000110-0001-
Ledebouria urceolata      0001-----00000001-01----0-----0-------000110-0001-
Ornithogalum amphibolum   ---------000001---00001-0-----0-------000010-0001-
Ornithogalum angustif.    ---------000001---00001-0-----0-------000010-0001-
Ornithogalum fimbriatum   ---------000001---00001-0-----0-------000010-0001-
Ornithogalum gussonei     ---------000001---00001-0-----0-------000010-0001-
Ornithogalum longibr      ---------000001---00000001----0-------000010-0001-
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Ornithogalum montanum     ---------000001---00000001----0-------000010-0001-
Ornithogalum pannonic.    ---------000001---00001-0-----0-------000010-0001-
Ornithogalum paschean.    ---------000001---00001-0-----0-------000010-0001-
Ornithogalum tenuifol.    -000-0000000001---00001-0-----0-------000010-00000
Ornithogalum umbellat.    ---------000001---00001-0-----0-------000010-0001-
Ornithogalum wiedeman.    ---------000001---00001-0-----0-------000010-0001-
Ornithoglossum viride     00000001-000001---00000000001-0-------000010-00001
Asparagus laricin.        -000-0000000001---00000000001-0-------000010-0001-
Sansevieria aethiopic.    -000-0000000001---00000000001-0-------000010-0001-
Scadoxus membranaceus     ---------000001---01----0-----0-------000010-01---
Schizocarphus nervosus*   ---------000001---00000000001-0-------01--10-0001-
Schizocarphus nervosus    ---------000001---000000000000001------000110-0001-
Scilla peruviana          ---------000001---0001--0-----0-------000110-0001-
Scilla lazulina           ---------000001---00001-0-----0-------000110-0001-
Trachyandra sp.*          0001-----000001---00001-0-----0-------000010-0001-
Trachyandra sp.           0001-----000001---00000001----0-------000010-0001-
Drimia altissima*         ---------001001---0000000000000001----000010-000--
Urginea undulata          ---------001001---00000000001-0-------000010-000--
Urginea sp.               ---------001001---00000000001-0-------000010-000--
Veltheimia capensis*      ---------000001---000000000000001------000110-0001-
Veltheimia bracteata      ---------000001---00000000001-0-------000110-00000
Aloe vera                 0001-----000001---000000000000001------000010-00000
Aloe bakeri               0001-----000001---0001--0-----0-------000010-00000
Bulbine wiesei            01-------000001---00000000000000100100000010-00000
Bulbine semibarbata       0010-000-000001---00000000000100-01-00000010-00000
Bulbine succulenta        000000000000001---00000000000100-01-00100010-00000
Bulbinella cauda-felis    000010000000001---000001000-0-00-00000000010-00000
Dipcadi viride            ---------00001----00000001----0-------000010-0011-
Dipcadi fulvum            ---------00001----0000000000--1-------000010-0011-
Drimia elata              ---------00001----0000000000000001----000010-000--
Drimia fugax              ---------00001----00001-0-----0-------000010-000--
Drimia calcarata          ---------00001----00000001----0-------000010-000--
Drimia undata             ---------00001----000000001-0-00-0--00000010-000--
Drimiopsis botryoides     ---------00000001-01----0-----0-------000110-0001-
Drimiopsis maculata       ---------00000001-01----0-----0-------000110-0001-
Drimiopsis barteri        ---------0000000011-----0-----0-------000110-0001-
Galtonia princeps         ---------00001----00001-0-----0-------000010-0001-
Galtonia viridiflora      ---------00001----00001-0-----0-------000010-0001-
Galtonia candicans        ---------00001----00001-0-----0-------000010-0001-
Gasteria bicolorvar. lili.0001-----00001----00001-0-----0-------000010-00000
Haworthia fasciata        0001-----00001----00001-0-----0-------000010-00000
Kniphofia uvaria          0001-----00001----00000000010-00-0001-000010-00000
Muscari comosum           ----------------0001--0-----0-------000110-0001-
Nivenia corymbosa         0000001--00001----00000000000100-00001000010-0001-
Nothoscordum bivalve      1000000000000001---00000000000001------000010-0001-
Rhadamanthus sp.          ---------00001----00001-0-----0-------000010-000--
Schizobasis sp.           ---------00001----00000001----0-------000010-000--
Drimia intricata          ---------00001----00000001----0-------000010-000--
Thuranthos indicum        ---------00001----0001--0-----0-------000010-00000
Tulbaghia violacea        10000000001001----00000001----0-------000010-0001-
Whiteheadia bifolia       ---------000001---0000--1--------------000-1--0---
Witsenia maura            000001---00001----0000000000000000000001000010-0001-

Albuca sp.*               -0-0-010-0000101-1-0-0000101----10011-001-1-------
Albuca nelsonii           -0-0-010-0000101-1-0-0000101----10011-001-1-------
Albuca sp.                -0-0-010-0000101-1-0-0000101----10011-001-0010-011
Albuca shawii             -0-0-010-0000101-1-0-0000101----10011-001-0010-011
Bowiea volubilis*         -0-0-010-0000101-010-000010001--10011-001-0010-011
Bowiea volubilis          -0-0-010-0000101-1-0-000010001--10011-001-0010-011
Eriospermum cooperi*      -0-0-010-000011--00001000101----10011-001-0010-010
Eriospermum flagelliforme -0-0-010-000011--00001000101----10011-001-0010-010
Eucomis autumnalis*       -0-0-00001000101-1-0-0000101----10011-001-0010-011
Eucomis punctata          -0-0-00001000101-1-0-0000101----10011-001-0010-011
Gloriosa sp.              -0-00010-0000101-000101-0010-001100101011-0010-010
```

*Ledebouria revoluta** -0-0-00001000101-1-0-0000100100010011-001-0010-011
Ledebouria revoluta -0-0-00001000101-1-0-0000100100010011-001-0010-011
Ledebouria socialis -0-0-00001000101-1-0-0000100100010011-001-0010-011
Ledebouria somalensis -0-0-00001000101-1-0-0000100100010011-001-0010-011
Ledebouria cordifolia -0-0-00001000101-1-0-0000100100010011-001-0010-011
Ledebouria urceolata -0-0-00001000101-1-0-0000100100010011-00000010-011
Ornithogalum amphibolum -0-0-010-0000101-1-0-0000101----10011-001-0010-011
Ornithogalum angustif. -0-0-0-1-0000101-1-0-0000101----10011-001-0010-011
Ornithogalum fimbriatum -0-0-010-0000101-1-0-0000101----10011-001-0010-011
Ornithogalum gussonei -0-0-010-0000101-1-0-0000101----10011-001-00000011
Ornithogalum longibr -0-0-010-0000101-1-0-0000101----10011-001-0010-011
Ornithogalum montanum -0-0-010-0000101-1-0-0000101----10011-001-0010-011
Ornithogalum pannonic. -0-0-010-0000101-1-0-0000101----10011-001-0010-011
Ornithogalum paschean. -0-0-010-0000101-1-0-0000101----10011-001-0010-011
Ornithogalum tenuifol. 10000010-0000101-1-0-0000101----10011-001-0010-011
Ornithogalum umbellat. -0-0-010-0000101-1-0-0000101----10011-001-0010-011
Ornithogalum wiedeman. -0-0-010-0000101-1-0-0000101----10011-001-0010-011
Ornithoglossum viride -0-00010-0000001-0-1-0000010-010100101011-0010-011
Asparagus laricin. -0-0-0000100011--0000100010010000010011-001-0010-011
Sansevieria aethiopic. -0-0-010-000011--010-0000100100010010-1---0110-011
Scadoxus membranaceus ----------0-------
*Schizocarphus nervosus** -0-0-00001000101-1-0-0000101----10011-001-0010-011
Schizocarphus nervosus -0-0-00001000101-1-0-0000100100010011-001-0010-011
Scilla peruviana -0-0-00001000101-1-0-0000100100010011-001-0010-011
Scilla lazulina -0-0-00001000101-1-0-0000100100010011-001-0010-1--
*Trachyandra sp.** -0-0-00000000101-1-0-0000100100010011-001-0010-011
Trachyandra sp. -0-0-00000000101-1-0-0000100100010011-001-0010-011
*Drimia altissima** -1---00010000101-1-0-0000100100010011-001-0010-011
Urginea undulata -1---00010000101-1-0-0000100100010011-001-0010-011
Urginea sp. -1---00010000101-1-0-0000100100010011-001-0010-011
*Veltheimia capensis** -0-0-010-0000101-0000000010010010011-001-0010-011
Veltheimia bracteata 000011----000101-1-0-0000101----10011-001-0010-011
Aloe vera -0100010-0101-01-1-0-0000100100010011-001-0010-011
Aloe bakeri -0100010-0101-01-1-0-0000100100010011-001-0010-011
Bulbine wiesei -0100010-0000101-1-0-0000100100010011-001-0010-011
Bulbine semibarbata -0100010-0000101-1-0-0000100100010011-001-0010-010
Bulbine succulenta -0100010-0000101-1-0-0000100100010011-001-0010-010
Bulbinella cauda-felis -0100010-0000101-1-0-0000100100010011-001-0010-010
Dipcadi viride -0-0-010-0000101-1-0-0000101----10011-001-0010-010
Dipcadi fulvum -0-0-010-0000101-1-0-0000101----10011-001-0010-010
Drimia elata -0-1-010-0000101-1-0-0000100100010111-00010010-010
Drimia fugax -0-1-010-0000101-1-0-0000100100010011-001-0010-010
Drimia calcarata -0-1-010-0000101-1-0-0000100100010011-001-0010-010
Drimia undata -0-1-010-0000101-1-0-0000100100010011-001-0010-010
Drimiopsis botryoides -0-0-00001000101-1-0-0000100100010011-001-0010-010
Drimiopsis maculata -0-0-00001000101-1-0-0000100100010011-001-00-1-010
Drimiopsis barteri -0-0-00001000101-1-0-0000100100010011-001-00001010
Galtonia princeps -0-0-010-0000101-1-0-00001001000-1--1-001-0010-010
Galtonia viridiflora -0-0-010-0000101-1-0-00001001000-1--1-001-0010-010
Galtonia candicans -0-0-010-0000101-1-0-00001001000-1--1-001-0010-010
Gasteria bicolorvar. lili. -0100010-0000101-1-0-0000100100010011-001-0010-010
Haworthia fasciata -0100010-0000101-1-0-0000100100010011-001-0010-010
Kniphofia uvaria -010000001000101-010-0000100100010011-001-0010-010
Muscari comosum -0-0-00001000101-1-0-0000100100010011-001-0010-010
Nivenia corymbosa -0-0-00001000101-1-0-0000100100010011-001-0010-010
Nothoscordum bivalve -0-0-010-0000101-1-0-0010100100010011-001-0010-010
Rhadamanthus sp. -0-1-010-0000101-1-0-0000100100010011-001-0010-010
Schizobasis sp. -0-1-010-0000101-1-0-0000100100010011-001-0010-010
Drimia intricata -0-1-010-0000101-1-0-0000100100010011-001-0010-010
Thuranthos indicum 10000010-0000101-1-0-0000100100010011-001-0010-010
Tulbaghia violacea -0-0-00001000101-1-0-0001100100010011-001-0010-010
Whiteheadia bifolia ----------10011-001-0010-010
Witsenia maura -0-0-00001000101-1-0-0000100100010011-001-0010-010

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Albuca sp.*                ------------------------------------------------
Albuca nelsonii            ------------------------------------------------
Albuca sp.                 000100--0001010-00-0--00000010--0000010--00--00000
Albuca shawii              000100--0001010-00-0--00000010--0000010--00--00000
Bowiea volubilis*          000100--000100000001--00000010--0000010--00--00000
Bowiea volubilis           000100--000100000001--00000010--0000010--00--00000
Eriospermum cooperi*       0000000001-1010-00-0--00000010--0001--------------
Eriospermum flagelliforme  0000000001-1010-00-0--00000010--0000000100000000000
Eucomis autumnalis*        000100--00010-1-00----00000010--0000010--00--10000
Eucomis punctata           000100--00010-1-00----00000010--0000010--00--00000
Gloriosa sp.               1---0--------00000-0--000100-1----00010--00--00001
Ledebouria revoluta*       000100--0001010-00-0--00000010--0000010--00--00000
Ledebouria revoluta        000100--0001010-00-0--00000010--0000010--00--00000
Ledebouria socialis        000100--0001010-00-0--00000010--0000010--00--00000
Ledebouria somalensis      000100--0001010-00-0--00000010--0000010--00--00000
Ledebouria cordifolia      000100--0001010-00-0--00000010--000000000001-00000
Ledebouria urceolata       000100--0001010-00-0--00000010--0000010--00--00000
Ornithogalum amphibolum    000100--0001000100-0--00010010--0000010--00--00000
Ornithogalum angustif.     000100--0001000100-0--00010010--0000010--00--00000
Ornithogalum fimbriatum    000100--0001000100-0--00010010--0000010--00--00000
Ornithogalum gussonei      000100--0001000100-0--00010010--0000010--00--00000
Ornithogalum longibr       000100--0001010-00-0--00000010--0000010--00--00000
Ornithogalum montanum      000100--0001000100-0--00010010--0000010--00--00000
Ornithogalum pannonic.     000100--0001000100-0--00010010--0000010--00--00000
Ornithogalum paschean.     000100--0001000100-0--00010010--0000010--00--00000
Ornithogalum tenuifol.     000100--0001010-00-0--00000010--0000010--00--00000
Ornithogalum umbellat.     000100--0001000100-0--00010010--0000010--00--00000
Ornithogalum wiedeman.     000100--0001000100-0--00010010--0000010--00--00000
Ornithoglossum viride      000-1--------00-00-0--000100000000100010--00--0000-
Asparagus laricin.         000-01-----10---1-----00000010--0000010--00--00100
Sansevieria aethiopic.     0000001-0001010-00-0--00000010--0000100--000000000
Scadoxus membranaceus      0-0-0------1010-00-0--000000000001010010--00--00000
Schizocarphus nervosus*    000100--00010-1-00----00000010--0000010--00--00000
Schizocarphus nervosus     000100--0001010-00-0--00000010--0000010--00---1000
Scilla peruviana           000100--00010---01----00000010--0000010--00--00000
Scilla lazulina            0-0-00--0001010-00-0--00000010--0000010--00--00000
Trachyandra sp.*           000000010001000000000100000010--0000000-1000000000
Trachyandra sp.            000100--000100000000100000010--0000000-1000000000
Drimia altissima*          000100--000100000001--00000010--0000010--00--00000
Urginea undulata           000100--000100000001--00000010--0000010--00--00100
Urginea sp.                000100--000100000001--00000010--0000010--00--00000
Veltheimia capensis*       000100--0001010-00-0--00000010--0000000001-----000
Veltheimia bracteata       000100--0001010-00-0--00000010--00000000001--00000
Aloe vera                  000100--000100000000000100010--0000010--00--00000
Aloe bakeri                000100--000100000000001000010--0000010--00--00000
Bulbine wiesei             000100--000100000000000100000001-0000010--00--00000
Bulbine semibarbata        000000000011000000000000000010--0000010--00--00000
Bulbine succulenta         000000000001000000000000000010--0000010--00--00000
Bulbinella cauda-felis     000-00--10-1000000000001001--------0-----------00
Dipcadi viride             000-00--10-1010-00-0--00000010--0000010--00--00000
Dipcadi fulvum             000-00--10-10-1-00----00000010--0000010--00--00000
Drimia elata               000-00--10-100000001--00000010--0000010--00--00000
Drimia fugax               000-00--10-100000001--00000010--0000010--00--00000
Drimia calcarata           000-00--10-100000001--00000010--0000010--00--00000
Drimia undata              000-00--10-100000001--00000010--0000010--00--00000
Drimiopsis botryoides      000-00--10-1010-00-0--00000010--0000010--00--00000
Drimiopsis maculata        0-1-0------1010-00-0--00000010--0000010--00--00000
Drimiopsis barteri         000-00--10-1010-00-0--00000010--0000010--00--00000
Galtonia princeps          000-00--10-1010-00-0--00000010--0000010--00--00000
Galtonia viridiflora       000-00--10-1000100-0--00000010--0000010--00--00000
Galtonia candicans         000-00--10-1000100-0--00000010--0000010--00--00000
Gasteria bicolorvar. lili. 000-00--10-1000000000100000010--0000010--00--00010
Haworthia fasciata         000-00--10-1000000000100000010--0000010--00--00010
Kniphofia uvaria           000-00--10-1000000000100000010--0000010--00--00010
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Muscari comosum           000-00--10-1100000-0--00000010--0000010--00--00010
Nivenia corymbosa         000-00--10-1000000001000000000010000000000000100000
Nothoscordum bivalve      000-00--10-1010-00-0--000001-0--0000010--00--00000
Rhadamanthus sp.          000-00--10-100000001--00000010--0000010--00--00000
Schizobasis sp.           000-00--10-100000001--00000010--0000010--00--00000
Drimia intricata          000-00--10-100000001--00000010--0000010--00--00000
Thuranthos indicum        000-00--10-100000001--00000010--0000010--00--00000
Tulbaghia violacea        000-00--10-1010-00-0--00000010--0000010--00--00000
Whiteheadia bifolia       000-00--10-1010-00-0--00000010--0000010--00--00000
Witsenia maura            000-00--10-100000010--1-000010--0000000000000000000

Albuca sp.*               ----------------------------------------0-0-0001-
Albuca nelsonii           ----------------------------------------0-0-0001-
Albuca sp.                0001-------0----------0----0---000001-000000010001-
Albuca shawii             0001-------0----------0----0---000001-000000010001-
Bowiea volubilis*         0001-------0----------0----0---000001-000000010001-
Bowiea volubilis          0001-------0----------0----0---000001-000000010101-
Eriospermum cooperi*      ----------------------------------------0-0-0001-
Eriospermum flagelliforme 000000000001----------0----0---000001-00100-0-0001-
Eucomis autumnalis*       0001-------0----------0----0---001----000000010001-
Eucomis punctata          0001-------0----------0----0---001----000000010001-
Gloriosa sp.              00000000001010000000001--------0------0000000-1001-
Ledebouria revoluta*      0001-------0----------0----0---001----000000010001-
Ledebouria revoluta       0001-------0----------0----0---001----000000010001-
Ledebouria socialis       0001-------0----------0----0---001----000000010001-
Ledebouria somalensis     0001-------0----------0----0---001----000000010001-
Ledebouria cordifolia     0001-------0----------0----0---001----000000010001-
Ledebouria urceolata      0001-------0----------0----0---001----000000010001-
Ornithogalum amphibolum   0001-------0----------0----0---000001-000000010001-
Ornithogalum angustif.    0001-------0----------0----0---000001-000000010001-
Ornithogalum fimbriatum   0001-------0----------0----0---000001-000000010001-
Ornithogalum gussonei     0001-------0----------0----0---000001-000000010001-
Ornithogalum longibr      0001-------0----------0----0---000001-000000010001-
Ornithogalum montanum     0001-------0----------0----0---000001-000000010001-
Ornithogalum pannonic.    0001-------0----------0----0---000001-000000010001-
Ornithogalum paschean.    0001-------0----------0----0---000001-000000010001-
Ornithogalum tenuifol.    0001-------0----------0----0---000001-000000010001-
Ornithogalum umbellat.    0001-------0----------0----0---000001-000000010001-
Ornithogalum wiedeman.    0001-------0----------0----0---000001-000000010001-
Ornithoglossum viride     1--00-0-0--0-000101-100000100001----------0-0-0001-
Asparagus laricin.        00101---0--0-----0---000-0-0000000001-0000000-1001-
Sansevieria aethiopic.    0001-------0----------0----0---000100000010-0-0001-
Scadoxus membranaceus     0001-------0----------0----0---000000000010-0-0001-
Schizocarphus nervosus*   0001-------0----------0----0---001----000000010001-
Schizocarphus nervosus    0001-------0----------0----0---001----000000010001-
Scilla peruviana          0001-------0----------0----0---000-1--000000010001-
Scilla lazulina           0001-------0----------0----0---001----0000100001000
Trachyandra sp.*          01-0000000000000-1----0----0---000001-00001----001-
Trachyandra sp.           01-00000000000000000001---0---000001-00001----001-
Drimia altissima*         0001-------0----------0----0---000001-000000010001-
Urginea undulata          0001-------0----------0----0---000001-000000010001-
Urginea sp.               0001-------0----------0----0---000001-000000010001-
Veltheimia capensis*      0001-------0----------0----0---001----000000010001-
Veltheimia bracteata      0001-------0----------0----0---001----000000010001-
Aloe vera                 000000010-000100000000000100001-001----00001----001-
Aloe bakeri               000000010-0001000000000000000001-001----00001----001-
Bulbine wiesei            000000010-0000100000010----0---01-----00001----001-
Bulbine semibarbata       00000000010000100000100000001--001----00001----001-
Bulbine succulenta        000000010-00000000010000-1-0---000-1--00001----001-
Bulbinella cauda-felis    0000010-0-000000-1----0----0---001----00001----001-
Dipcadi viride            0001-------0----------0----0---000-1--000000010001-
Dipcadi fulvum            0001-------0----------0----0---000001-000000010001-
Drimia elata              0001-------0----------0----0---000001-000000010001-
Drimia fugax              0001-------0----------0----0---000001-000000010001-
```

Drimia calcarata	0001-------0----------0----0---000001-000000010001-
Drimia undata	0001-------0----------0----0---000001-000000010001-
Drimiopsis botryoides	0001-------0----------0----0---001----000000010001-
Drimiopsis maculata	0001-------0----------0----0---001----000000010001-
Drimiopsis barteri	0001-------0----------0----0---001----000000010001-
Galtonia princeps	0001-------0----------0----0---000001-0100010-0001-
Galtonia viridiflora	0001-------0----------0----0---000001-0100010-0001-
Galtonia candicans	0001-------0----------0----0---000001-0100010-0001-
Gasteria bicolorvar. lili.	0000000001000000000000000000000000000000001----001-
Haworthia fasciata	0000000001000000000000000000001001----00001----001-
Kniphofia uvaria	0000000001000001-0--0001---0---001----00001----001-
Muscari comosum	0000000-1--0----------0----0---000-1--000000010001-
Nivenia corymbosa	00000-1-0--0-----0--00000001---0------00000-1-0001-
Nothoscordum bivalve	0001-------0----------0----0---00000010000000-1001-
Rhadamanthus sp.	0001-------0----------0----0---000001-000000010001-
Schizobasis sp.	0001-------0----------0----0---000001-000000010001-
Drimia intricata	0001-------0----------0----0---000001-000000010001-
Thuranthos indicum	0001-------0----------0----0---000001-000000010001-
Tulbaghia violacea	0001-------0----------0----0---000000000000000-1001-
Whiteheadia bifolia	0001-------0----------0----0---001----000000010001-
Witsenia maura	00001---0--0-----0---000-0-0000000-1--0000000-1001-

*Albuca sp.**	000
Albuca nelsonii	100
Albuca sp.	010
Albuca shawii	000
*Bowiea volubilis**	000
Bowiea volubilis	000
*Eriospermum cooperi**	000
Eriospermum flagelliforme	000
*Eucomis autumnalis**	000
Eucomis punctata	000
Gloriosa sp.	000
*Ledebouria revoluta**	000
Ledebouria revoluta	000
Ledebouria socialis	000
Ledebouria somalensis	000
Ledebouria cordifolia	000
Ledebouria urceolata	000
Ornithogalum amphibolum	000
Ornithogalum angustif.	000
Ornithogalum fimbriatum	000
Ornithogalum gussonei	000
Ornithogalum longibr	000
Ornithogalum montanum	000
Ornithogalum pannonic.	000
Ornithogalum paschean.	000
Ornithogalum tenuifol.	000
Ornithogalum umbellat.	000
Ornithogalum wiedeman.	000
Ornithoglossum viride	000
Asparagus laricin.	000
Sansevieria aethiopic.	000
Scadoxus membranaceus	000
*Schizocarphus nervosus**	000
Schizocarphus nervosus	000
Scilla peruviana	000
Scilla lazulina	000
*Trachyandra sp.**	000
Trachyandra sp.	000
*Drimia altissima**	000
Urginea undulata	000
Urginea sp.	000
*Veltheimia capensis**	000

Veltheimia bracteata	000
Aloe vera	000
Aloe bakeri	000
Bulbine wiesei	000
Bulbine semibarbata	000
Bulbine succulenta	000
Bulbinella cauda-felis	000
Dipcadi viride	000
Dipcadi fulvum	000
Drimia elata	000
Drimia fugax	000
Drimia calcarata	000
Drimia undata	000
Drimiopsis botryoides	000
Drimiopsis maculata	000
Drimiopsis barteri	000
Galtonia princeps	000
Galtonia viridiflora	000
Galtonia candicans	000
Gasteria bicolorvar. lili.	000
Haworthia fasciata	000
Kniphofia uvaria	000
Muscari comosum	000
Nivenia corymbosa	000
Nothoscordum bivalve	000
Rhadamanthus sp.	000
Schizobasis sp.	000
Drimia intricata	000
Thuranthos indicum	000
Tulbaghia violacea	001
Whiteheadia bifolia	000
Witsenia maura	000

Appendix D: **Chromosome numbers from various authors for the species cytogenetically and molecularly examined in this study. Genera are grouped according to families and sorted alphabetically, firstly according to families and then to genera and species. Species studied cytogenetically are indicated by an asterix.**

Family/species	**Synonym**	**Ende-mic to SA?**	**n=**	**2n=**	**Basic no.**	**Author**
Family Alliaceae						
Nothoscordum bivalve (L.) Britton		No	9	18-22, 32, 34, 48	9	Palomino *et al.*, 1992
				18		Anderson, 1931; Beal, 1932; Smith, 1964; Crosa, 1972; Nunez *et al.*, 1972
Tulbaghia violaceae Harvey	*Omentaria cepacea* Salisb.; *T. cepacea* L.f.	Yes	6	12	6	Lakshmi, 1988; Vijayavalli & Mathew, 1990a
				12		Flory, 1955; Mookerjea, 1955; Whitaker & Flory, 1955; Sharma, 1956; Riley & Hoff, 1960; Dyer, 1963; Smith & Flory, 1965; Vosa, 1966; Vosa, 2000
Family Amaryllidaceae						
Scadoxus membranaceus (Bak.) Friis & Nordal	*Haemanthus membranaceus* Bak.	Yes				
Family Asparagaceae						
Asparagus laricinus Burchell	*Protasparagus laricinus* (Burch.) Oberm.	Yes		20	5/10	Nordenstam, 1982
Family Asphodelaceae						
Aloe bakeri Scott Elliot		No	7		7	Brandham, 1971
				14		Amano *et al.*, 1972; Adams *et al.*, 2000
A. vera (L.) Burm.f.		No	7	10, 14	7	Vig, 1968
			7	14		Vijayavalli & Mathew, 1990c
			7	14, 38		Vij *et al.*, 1980
				10		Vig, 1965
				14		Sutaria, 1932; Marshak, 1934; Resende, 1937; Resende & Rijo, 1948; Vij & Madhu, 1976; Adams *et al.*, 2000
Bulbine semibarbata Haw.		No	38		13	Keighery, 1984
				26		Straub, 1938; Jones & Smith, 1967; Watson, 1986; Watson, 1988
				26, 28, 52, 54, 78		Watson, 1987
B. succulenta Compton	*Bulbine hantamensis* Poelln.	Yes		14	7	Snoad, 1951
B. wiesei L.I. Hall		Yes				
Bulbinella cauda-felis (L.f.) Dur. & Schinz	*Anthericum cauda-felis* L.f.; *A. caudatum* Thunb.; *Bulbine cauda-felis* (L.f.) Schult. & Schult.f; *B. caudata* (Thunb.) Kunth.	Yes		12	6	Nordenstam, 1982

Gasteria bicolor Haw. var. *liliputana* (Poelln.) Van Jaarsv.	*Gasteria liliputiana* V. Poelln.	Yes	7		7	Brandham, 1971
				14		Snoad, 1951; Riley, 1959; Sharma & Mallick, 1966
Haworthia fasciata (Willd.) Haw.	*Aloe fasciata* (Willd.) Haw. var. *major* Salm-Dyck; *Aloe fasciata* (Willd.) Haw. var. *minor* Salm-Dyck; *Aloe subfasciata* Salm-Dyck; *Apicra fasciata* Willd.; *Haworthia browniana* Poelln.; *H. fasciata* (Willd.) Haw. var. *fasciata* Poelln.; *Haworthia subfasciata* (Salm-Dyck) Bak.	Yes		14	7	Chinnappa & Semple, 1976
				c. 28		Ferguson, 1927
				c. 28		Ferguson, 1927
Kniphofia uvaria (L.) Oken	*Aletris uvaria* (L.) L.; *Aloe longifolia* Lam.; *Aloe rigida* Salisb.; Aloe uvaria L.; *Kniphofia aloöides* Moench.; *Kniphofia bachmannii* Bak.; *Triclissa uvaria* (L.) Salisb.; *Tritoma burchellii* Lindl.; *T. uvaria* (L.) Ker Gawl; *Tritomanthe burchellii* (Lindl.) Steud.; *T. uvaria* (L.) Link; *Tritomium uvaria* (L.) Link; *Veltheimia uvaria* (L.) Willd.	Yes	6	12	6	Mehra & Sachdeva, 1976
				12		Moffett, 1932; De Wet, 1960; Mehra & Pandita, 1978; Pandita, 1979; Vijayavalli & Mathew, 1990a
				12, 13		Webber, 1932
Trachyandra sp.		Yes		14	7	Nordenstam, 1982
Family Colchicaceae						
Gloriosa superba L.	*G. virescens* Lindl.	Yes	11		11	Mitra & Datta, 1967; Koul *et al.*, 1976; Mehra & Sachdeva, 1976; Vosa & Bennett, 1990
				20, 21		Vishwakarma & Tarar, 1989
			11	22		Vijayavalli & Mathew, 1990b; Vijayavalli & Mathew, 1992
				22		Miller, 1930; Satô, 1942; Delay, 1947; Tjio, 1948; Khoshoo, 1956; Narain, 1981; Tarar *et al.*, 1985; Karihaloo, 1986
				22, 90		Sharma & Sharma, 1961
				88		La Cour, 1951
Ornithoglossum viride (L.f.) Ait.	*Melanthium viride* L.f.; *Ornithoglossum glaucum* Salisb.	Yes				
Family Dracaenaceae						
Sansevieria aethiopica Thunb.	*S. scabrifolia* Dinter	Yes		14	7	De Wet, 1957
Family Eriospermaceae						
Eriospermum cooperi Bak.	*Eriospermum hygrophilum* Bak.; *E. sprengerianum* Schinz	Yes		14	7	Vosa & Perry, 1999
E. flagelliforme	*Anthericum flagelliforme*	Yes		12	6	Vosa & Perry, 1999

(Bak.) J.C.Manning	Bak.; *Eriospermum abyssinicum* Bak.; *E. burchellii* Bak.; *E. elatum* Bak.; *E. Fleckii* Schinz; *E. luteorubrum* Bak. *E. schinzii* Engl. & K.Krause; *Schizobasis flagelliformis* (Bak.) Bak.			24		Jones & Smith, 1967
Family Hyacinthaceae						
Albuca nelsonii N.E. Br.		Yes		18	9	Satô, 1942; Jong, 1991
				20		De Wet, 1957
A. shawii Bak.	*A. elliotii* Bak.; *A. granulata* ; *A. minima* Bak.;*A. trichophylla* Bak.	Yes		18	9	Jong, 1991
Bowiea volubilis Harv. ex Hook.f.	*Bowiea gariepensis* Van Jaarsv.	Yes		20	5/10	D'Amato, 1949; De Wet, 1957; Horikawa, 1967; Jones & Smith, 1967
				21		Satô, 1942
Dipcadi fulvum (Cav.) Webb & Berthel.		No		34	?	Battaglia, 1954
D. viride (L.) Moench.	*D. elatum* Bak.; *D. palustre* Bak.; *D. umbonatum* (Bak.) Bak.	Yes		12	6	De Wet, 1957; Fernandes & Neves, 1962; Stedje & Nordal, 1987; Raimondo *et al*., 2000
Drimia altissima (L.f.) Ker. Gawl.	*Urginea altissima* (L.f.) Bak.; *Urginea epigea* R.A.Dyer	Yes		32	8	De Wet, 1957
D. calcarata		No				
D. elata Jacq.	*D. alta* R.A.Dyer; *D. scilliaris* Jacq. ex. Willd.; *D. robusta* Bak.	Yes		18	9	De Wet, 1957
D. fugax		No				
D. intricata (Bak.) J.C..Manning & Goldblatt	*Schizobasis intricata* (Bak.) Bak.; *S. cuscutoides* (Burch. ex Bak.) Benth. & Hook.; *S. flagelliformis* (Bak.) Bak.; *S. macowanii Bak.*	Yes	10		5/10	Watters & Ornduff, 1985
				18		Bruyns & Vosa, 1987
				20		Jones & Smith, 1967
D. undata Stearn		No		20	5/10	Valdes-Bermejo, 1980
Drimiopsis barteri		No				
D. botryoides Bak.		No		44	11	Stedje & Nordal, 1987
				55		Stedje & Nordal, 1987; Stedje, 1994
				66		Stedje, 1994
				80		Matsuura & Sutô, 1935
D. maculata		No	15			Jessop, 1972
				60		Fernandes & Neves, 1962
				64		Sato, 1942
Eucomis autumnalis (Mill.) Chitt. subsp. *autumnalis*	*E. undulata* Ait.	Yes		30	15	Koeperich, 1930
				60		Satô, 1942; Riley, 1962
						Reyneke & Liebenberg, 1980
Galtonia candicans (Bak.) Deche.		Yes		16	8	Schneiwind-Thies, 1901; Miyake, 1905; Strasburger, 1905; Grégoire, 1912; Müller, 1912; Newton, 1924; Satô, 1942
				c. 16		Baranova, 1965

G. princeps (Bak.) Decne.		Yes		16	8	Newton, 1924; De Wet, 1957
G. viridiflora Verdoorn		Yes		16	8	De Wet, 1957
Lachenalia alba W.F.Barker		Yes		18	10	Johnson & Brandham, 1997
				20		Johnson & Brandham, 1997
				40		Johnson & Brandham, 1997
L. algoensis Schonl.		Yes	7		7	Ornduff & Watters, 1978
				21		Coertze quoted by Hancke, 1991
L. aloides var. aloides (L.f.) Engl.	*L. tricolor* (L.) Thunb.	Yes	7		7	Hancke & Liebenberg, 1990
			7II			Hancke & Liebenberg, 1998
			14			Ornduff & Watters, 1978; Hancke & Liebenberg, 1990
				14		Crosby, 1986; Hancke, 1991; Johnson & Brandham, 1997; Kleynhans, 1997; Hamatani *et al.*, 1998
				14 (*L. tricolor*)		Moffett, 1936; Therman, 1956; De Wet, 1957; Speta, 1972
				21 (*L. tricolor*)		Moffett, 1936
				28		Hancke & Liebenberg, 1990; Hancke, 1991
**L. aloides* (L.f.) Engl. var. *aurea* (Lindl.) Engl.		Yes		14	7	De Wet, 1957; Coertze quoted by Hancke, 1991; Johnson & Brandham, 1997; Kleynhans, 1997
L. aloides var. *luteola*		Yes		14	7	Moffett, 1936
**L. aloides* var. *nelsonii*		Yes		14	7	Moffett, 1936; Coertze quoted by Hancke, 1991
**L. aloides* (L.f.) Engl. var. *quadricolor* (Jacq.) Engl.		Yes	7; 7 + 0-1B		7	Hancke & Liebenberg, 1990
			14 + 0-1B			Hancke, 1991
				7II		Hancke & Liebenberg, 1998
				14		De Wet, 1957; Hancke & Liebenberg, 1990; Coertze quoted by Hancke, 1991; Hancke, 1991; Johnson & Brandham, 1997; Kleynhans, 1997; Hamatani *et al.*, 1998
				21		Moffett, 1936
				28		Hancke & Liebenberg, 1990; Coertze quoted by Hancke, 1991; Hancke, 1991
**L. aloides* (L.f.) Engl. var. *vanzyliae* W.F.Barker		Yes		28	7	Crosby, 1986; Hancke, 1991; Hamatani *et al.*, 1998
				c. 28		Kleynhans, 1997
L. ameliae		Yes		18	9	Johnson & Brandham, 1997

W.F.Barker						
L. angelica W.F.Barker		Yes				
L. anguinea Sweet		Yes		30+2B	15	Johnson & Brandham, 1997
L. arbuthnotiae W.F.Barker		Yes	7		7	Minnaar, 2004
				14		Crosby, 1986; Johnson & Brandham, 1997; Hamatani *et al.*, 1998; Minnaar, 2004
L. attenuata W.F.Barker ex. G.D.Duncan		Yes				
L. aurioliae G.D.Duncan		Yes				
L. bachmanii Bak.		Yes		16	8	De Wet, 1957; Crosby, 1986; Coertze quoted by Hancke, 1991; Johnson & Brandham, 1997
L. barkeriana U.Müller-Doblies, B.Nord. & D.Müller-Doblies		Yes				
L. bolusii W.F.Barker		Yes				
L. bowkeri Bak.	*L. subspicata* Fourc.	Yes				
L. buchubergensis Dinter		Yes				
**L. bulbifera* (Cyr.) Engl.	*L. pendula* Ait.	Yes	14		7	Ornduff & Watters, 1978
				14		Crosby, 1986
				c. 26		Kleynhans, 1997
				28		Crosby, 1986; Coertze quoted by Hancke, 1991; Kleynhans, 1997; Kleynhans & Spies, 1999
				29		Kleynhans, 1997
				c. 39		Kleynhans, 1997
				c. 41		Kleynhans, 1997
				42 (*L. pendula*)		Moffett, 1936
				42		Crosby, 1986; Johnson & Brandham, 1997; Kleynhans, 1997; Hamatani *et al.*, 1998; Kleynhans & Spies, 1999
				c. 42		Kleynhans, 1997
				43		Kleynhans, 1997
				c. 43		Kleynhans, 1997
				c. 44		Kleynhans, 1997
				c. 45		Kleynhans, 1997
				c. 46		Kleynhans, 1997
				c. 47		Kleynhans, 1997
				c. 48		Kleynhans, 1997
				49		Kleynhans & Spies, 1999
				c. 49		Kleynhans, 1997
				c. 54		Kleynhans, 1997
				c. 56		Kleynhans, 1997

				56		Crosby, 1986; Coertze quoted by Hancke, 1991; Johnson & Brandham, 1997; Kleynhans, 1997; Kleynhans & Spies, 1999
				c. 57		Kleynhans, 1997
L. campanulata Bak.	*L. rhodantha* Bak.	Yes				
L. capensis W.F.Barker		Yes		16	8	Hamatani *et al.*, 1998
				c. 28		Johnson & Brandham, 1997
**L. carnosa* Bak.	*L. ovatifolia* Guth.	Yes	8		8	Du Preez, Unpublished
				16		Crosby, 1986; Johnson & Brandham 1997; Hamatani *et al.*, 1998; Du Preez *et al.*, 2002
**L. comptonii* W.F.Barker		Yes		20	10	Johnson & Brandham, 1997
				c. 20		Crosby, 1986
				c. 26		Crosby, 1986
L. concordiana Schltr. ex W.F.Barker		Yes				
L. congesta W.F.Barker		Yes		26	?	Johnson & Brandham, 1997
				28		Johnson & Brandham, 1997
L. contaminata Ait.		Yes	8		8	Ornduff & Watters, 1978
				14		Gouws, 1965
				16		De Wet, 1957; Gouws, 1965; Crosby, 1986; Coertze quoted by Hancke, 1991; Johnson & Brandham, 1997; Kleynhans, 1997
				c. 16		Kleynhans, 1997
				16 +0-1B		Johnson & Brandham, 1997
				32		Johnson & Brandham, 1997
L. convallarioides Bak.		Yes				
L. cooperi Bak.						
L. dasybotrya Diels		Yes				
L. dehoopensis W.F.Barker		Yes				
L. doleritica G.D.Duncan		Yes				
L. duncanii W.F.Barker		Yes		16	8	Reineke, personal comm.
L. elegans W.F.Barker var. *elegans*		Yes	14		7	Ornduff & Watters, 1978; Minnaar, 2004
			21			Minnaar, 2004
			28			Ornduff & Watters, 1978
				14		Johnson & Brandham, 1997
				28		Moffett, 1936; Crosby, 1986; Johnson & Brandham, 1997; Minnaar, 2004
				42		Johnson & Brandham, 1997; Minnaar, 2004
				56		De Wet, 1957
L. elegans		Yes		42	7	Johnson & Brandham, 1997

W.F.Barker var. *flava* W.F.Barker						
L. elegans W.F.Barker var. *membranacea* W.F.Barker		Yes				
L. elegans W.F.Barker var. *suaveolens* W.F.Barker		Yes		14	7	Johnson & Brandham, 1997
L. esterhuysenae W.F.Barker						
**L. fistulosa* Bak.	*L. convallariodora* Stapf.	Yes	7		7	Ornduff & Watters, 1978; Minnaar, 2004
				14		Johnson & Brandham, 1997; Kleynhans, 1997; Minnaar, 2004
				c. 14		Johnson & Brandham, 1997; Kleynhans, 1997
L. framesii W.F.Barker		Yes		16	8	Du Preez *et al.*, 2002; Reineke, personal comm.
L. giessii W.F.Barker		Yes				
L. gilettii W.F.Barker		Yes		16	8	Reineke, personal comm.
L. glaucophylla W.F.Barker						
L. haarlemensis Fourc.		Yes		18	9	Johnson & Brandham, 1997
**L. hirta* (Thunb.) Thunb.		Yes	9		?	Ornduff & Watters, 1978
			11			Ornduff & Watters, 1978
				18		Ornduff & Watters, 1978
				22		Ornduff & Watters, 1978; Johnson & Brandham, 1997; Van Rooyen *et al.*, 2002
				c. 22		Kleynhans, 1997
				24		De Wet, 1957; Coertze quoted by Hancke, 1991; Johnson & Brandham, 1997
L. hirta (Thunb.)Thunb. var. *hirta*						
L. inconspicua G.D.Duncan		Yes				
L. isopetala Jacq.		Yes		30	15	Johnson & Brandham, 1997
L. juncifolia Bak. var. *campanulata* W.F.Barker						
**L. juncifolia* Bak. var. *juncifolia*		Yes	11		11	Ornduff & Watters, 1978
				22		Crosby, 1986; Johnson & Brandham, 1997
				c. 22		Kleynhans, 1997
L. karooica W.F.Barker ex. G.D.Duncan		Yes				
L. klinghardtiana Dinter		Yes		14	7	Reineke, personal comm.
L. kliprandensis W.F.Barker						

L. lactosa G.D.Duncan		Yes		14	7	Reineke, personal comm.
L. latimerae W.F.Barker		Yes				
L. leipoldtii G.D.Duncan						
L. leomontana W.F.Barker		Yes				
**L. liliflora* Jacq.		Yes		16	8	Moffett, 1936; De Wet, 1957; Fernandes & Neves, 1962; Crosby, 1986; Coertze quoted by Hancke, 1991; Johnson & Brandham, 1997; Hamatani *et al.*, 1998
L. longibracteata Phillips		Yes	7		7	Ornduff & Watters, 1978
				14		Crosby, 1986
				16		Moffett, 1936
L. magregoriorum W.F.Barker		Yes		22	11	Reineke, personal comm.
L. margaretea W.F.Barker		Yes				
L. marginata W.F.Barker ssp. *marginata*		Yes		28	7	Johnson & Brandham, 1997
				29		Johnson & Brandham, 1997
L. marginata W.F.Barker ssp. *neglecta* Schltr. ex G.D.Duncan		Yes				
L. marlothii W.F.Barker ex G.D.Duncan		Yes		14	7	Reineke, personal comm.
L. martinae W.F.Barker		Yes		26	13	Reineke, personal comm.
**L. mathewsii* W.F.Barker		Yes		14	7	Johnson & Brandham, 1997; Hamatani *et al.*, 1998
L. maximiliani Schltr. ex W.F.Barker		Yes				
**L. mediana* Jacq. var. *mediana*		Yes		14	?	Johnson & Brandham, 1997
				26		Crosby, 1986
**L. mediana* Jacq. var. *rogersii* (Bak.) W.F.Barker		Yes				
L. minima W.F.Barker		Yes		16	8	Reineke, personal comm.
L. moniliformis W.F.Barker		Yes				
L. montana Schltr. ex. W.F.Barker						
L. muirrii W.F.Barker		Yes		14	7	Johnson & Brandham, 1997
L. multifolia W.F.Barker		Yes				
L. mutabilis Sweet.		Yes	5		5, 6, 7	Ornduff & Watters, 1978
			6			Spies *et al.*, 2000; Minnaar,

						2004
			7			Hancke & Liebenberg, 1990; Spies *et al.*, 2000; Minnaar, 2004
			7II			Hancke & Liebenberg, 1998
			12			Minnaar, 2004
			14			Hancke, 1991
				10		Johnson & Brandham, 1997
				12		Kleynhans, 1997; Spies *et al.*, 2000
				c. 12		Kleynhans, 1997
				14		De Wet, 1957; Hancke & Liebenberg, 1990; Coertze quoted by Hancke, 1991; Hancke, 1991; Johnson & Brandham, 1997; Kleynhans, 1997; Hamatani *et al.*, 1998; Spies *et al.*, 2000; Minnaar, 2004
				24		Kleynhans, 1997; Spies *et al.*, 2000; Minnaar, 2004
				56		De Wet, 1957
L. namaquensis Schltr. ex W.F.Barker		Yes	8		8	Du Preez, Unpublished
				16		Crosby, 1986; Johnson & Brandham, 1997; Du Preez *et al.*, 2002
L. namibiensis W.F.Barker		Yes				
L. neilii W.F.Barker ex G.D.Duncan		Yes				
L. nervosa Ker-Gawl.	*L. bowieana Baker; L. latifolia Tratt.*	Yes		16	8	Moffett, 1936
L. nordenstamii W.F.Barker		Yes				
L. nutans G.D.Duncan						
L. obscura W.F.Barker		Yes		18+0-1B	9	Johnson & Brandham, 1997
L. orchioides (L.) Ait. var. *glaucina* (Jacq.) W.F.Barker	*L. glaucina Jacq.*	Yes		14	7	Crosby, 1986
				24		Coertze quoted by Hancke, 1991
				28		Moffett, 1936; De Wet, 1957; Crosby, 1986; Johnson & Brandham, 1997
L. orchioides (L.) Ait. var. *orchioides*		Yes	7		7	Ornduff & Watters, 1978; Minnaar, 2004
			14			Ornduff & Watters, 1978
				14		Minnaar, 2004
				16		Moffett, 1936; De Wet, 1957; Coertze quoted by Hancke, 1991
				17		Moffett, 1936
				18 (*L. glaucina*)		Riley, 1962
				28 (*L. glaucina*)		Moffett, 1936; Therman, 1956; De Wet, 1957
				28		Johnson & Brandham, 1997

				29		Johnson & Brandham, 1997
L. orthopetala Jacq.		Yes		16	8	Zakharyeva & Makushenko, 1969; Crosby, 1986; Johnson & Brandham, 1997
**L. pallida* Ait.		Yes	8		8	Ornduff & Watters, 1978
				14		Kleynhans, 1997
				16		Moffett, 1936; Crosby, 1986; Johnson & Brandham, 1997; Hamatani *et al.*, 1998
L. patula Jacq.	*L. succulenta* Masson ex. Bak.	Yes		16	8	Johnson & Brandham, 1997
L. pearsonii (P.E.Glover) W.F.Barker	*Scilla pearsonii* P.E.Glover	Yes				
L. peersii Marloth ex. W.F.Barker		Yes		12	6/7	Kleynhans, 1997
				14		Johnson & Brandham, 1997
L. perryae G.D.Duncan		Yes				
L. physocaulos W.F.Barker		Yes		14	7	Reineke, personal comm.
L. polyphylla Bak.		Yes				
L. polypodantha Schltr. ex.W.F.Barker		Yes				
**L. purpureo-caerulea* Jacq.		Yes	8		8	Ornduff & Watters, 1978
				16		Moffett, 1936; Johnson & Brandham, 1997
L. pusilla Jacq.		Yes	8		7	Ornduff & Watters, 1978
				14		Crosby, 1986; Johnson & Brandham, 1997; Kleynhans, 1997; Hamatani *et al.*, 1998
				16		Nordenstam, 1982
				28		Coertze quoted by Hancke 1991
L. pustulata Jacq.		Yes	8		8	Ornduff & Watters, 1978
				16		Moffett, 1936; Crosby, 1986; Johnson & Brandham, 1997; Kleynhans, 1997
				32		Satô, 1942
						Spies *et al.*, 2000
**L. reflexa* Thunb.		Yes	7		7	Hancke & Liebenberg, 1990; Hancke, 1991
			7II			Hancke & Liebenberg, 1998
			14			Hancke, 1991
				14		Crosby, 1986; Hancke & Liebenberg, 1990; Hancke, 1991; Johnson & Brandham, 1997; Hamatani *et al.*, 1998
				14 + 0-2B		Hancke & Liebenberg, 1990; Hancke, 1991
				16		De Wet, 1957
L. rosea Andr.		Yes		14	7	Moffett, 1936; Crosby,

						1986; Coertze quoted by Hancke, 1991; Johnson & Brandham, 1997
L. rubida Jacq. var. *rubida*		Yes		c. 12	7	Kleynhans, 1997
				14		Moffett, 1936; Crosby, 1986; Kleynhans, 1997; Hamatani *et al.*, 1998
				28		Crosby, 1986
L. rubida Jacq. var. *punctata* (Jacq.) Bak.						
L. rubida Jacq. var. *tigrina* (Jacq.) Bak.	*L. trigina* (Jacq.) Bak.					
L. salteri W.F.Barker		Yes				
L. sargeantii W.F.Barker		Yes				
L. schelpei W.F.Barker		Yes				
L. splendida Diels	*L. roodieae* Phill.	Yes	8		8	Du Preez, Unpublished
			16			Hancke, 1991
				14		Hancke, 1991
				16		Crosby, 1986; Hancke, 1991; Johnson & Brandham, 1997; Kleynhans, 1997; Hamatani *et al.*, 1998; Du Preez *et al.*, 2002; Du Preez, Unpublished
				18		Crosby, 1986
L. stayneri W.F.Barker		Yes		24	6	Johnson & Brandham, 1997
L. thomasiae W.F.Barker ex G.D.Duncan		Yes				
L. trichophylla Bak.	*L. massonii* Bak.	Yes	7		7	Ornduff & Watters, 1978
				14		Johnson & Brandham, 1997
L. undulata Masson ex. Bak.						
L. unicolor Jacq.		Yes	8		8	Ornduff & Watters, 1978
				16		Moffett, 1936; Satô, 1942; De Wet, 1957; Gouws, 1965; Crosby, 1986; Coertze quoted by Hancke, 1991; Johnson & Brandham, 1997; Kleynhans, 1997; Hamatani *et al.*, 1998; Du Preez *et al.*, 2002
				32		Crosby, 1986
L. unifolia Jacq.		Yes	11		11	Ornduff & Watters, 1978
				16		Coertze quoted by Hancke, 1991
				21		De Wet, 1957
				22		Moffett, 1936; De Wet, 1957; Crosby, 1986; Johnson & Brandham, 1997; Van Rooyen *et al.*, 2002
				24		De Wet, 1957

				26		Moffett, 1936; De Wet, 1957
				44		Johnson & Brandham, 1997
L. unifolia Jacq. var. *schlechteri* (Bak.) W.F.Barker	*L. schlechteri* Bak.					
L. unifolia Jacq. var. *unifolia*		Yes		22	11	Johnson & Brandham, 1997
L. unifolia Jacq. var. *wrightii* Bak.						
L. valeriae G.D.Duncan		Yes		16	8	Reineke, personal comm.
**L. variegata* W.F.Barker		Yes		14	7	Reineke, personal comm.
L. ventricosa Schltr. ex W.F.Barker		Yes				
L. verticillata W.F.Barker		Yes		16	8	Crosby, 1986
**L. violacea* Jacq.		Yes	7		7	Ornduff & Watters, 1978
				14		Coertze quoted by Hancke, 1991; Johnson & Brandham, 1997; Kleynhans, 1997; Hamatani *et al.*, 1998
				15		Johnson & Brandham, 1997
				16		Crosby, 1986
L. violacea Jacq. var. *glauca* W.F.Barker						
L. violacea Jacq. var. *violacea*						
**L. viridiflora* W.F.Barker		Yes	7II		7	Hancke & Liebenberg, 1998
			7			Hancke & Liebenberg, 1990
			14			Hancke, 1991
				14		Nordenstam, 1982; Crosby, 1986; Hancke & Liebenberg, 1990; Hancke, 1991; Johnson & Brandham, 1997
L. whitehillensis W.F.Barker		Yes				
L. xerophila Schltr. ex. G.D.Duncan						
L. youngii Bak.		Yes		16	8	Reineke, personal comm.
L. zebrina W.F.Barker forma *densiflora*		Yes				
L. zebrina W.F.Barker forma *zebrina*		Yes		30	15	Johnson & Brandham, 1997
**L. zeyheri* Bak.		Yes		22	11	Johnson & Brandham, 1997
Ledebouria cordifolia		No				
L. revoluta (L.f.) Jessop	*Drimia revoluta* L.F.Kunth.; *Scilla albomarginata* V.d.	Yes	9-13		?	Jessop, 1972
			15-			Jessop, 1972

	Merwe; *S. asperifolia* V.d. Merwe; *S. carnosula* V.d. Merwe; *S. lanceaefolia* (Jacq.) Bak.		17			
			22			Jessop, 1972
			28			Stedje, 1996
L. socialis (Bak.) Jessop	*Scilla socialis* Bak.; *S. violacea* Hutch.	Yes	13		?	Jessop, 1972
			15			Jessop, 1972
L. somalensis		No		30	5/10	Stedje, 1996
L. urceolata		No		20	5/10	Stedje, 1996
Massonia depressa Houtt.	*M. grandiflora* Lindl.; *M. latifolia* L.f.	Yes		26	13	Johnson & Brandham, 1997
M. echinata L.f.	*Daubenya gustifolia* (L.f.) A.M.v.d. Merwe & J.C..Manning; *M. angustifolia* L.f.; *M. bolusiae* W.F.Barker; *Neobakeria angustifolia* (L.f.) Schltr.	Yes		18	9	Johnson & Brandham, 1997
M. jasminiflora Burch. ex. Bak.	*M. bowkeri* Bak.	Yes				
M. pustulata Jacq		Yes		22	11	Johnson & Brandham, 1997
Muscari comosum (L.) Miller		No	9		9	Delay, 1970; Ruíz Rejón, 1976; Ruíz Rejón, 1978; Galland, 1988
			9+1B			Ruíz Rejón *et al.*, 1986
				18		Guignard, 1889; Wunderlich, 1937; D'Amato, 1950; Pólya, 1950; Larsen, 1960; Gadella *et al.*, 1966; Garbari, 1966; Borgen, 1969; Stuart, 1970; Ruíz Rejón, 1976; Ruíz Rejón, 1978; Natarajan, 1979a; Natarajan, 1979b; Van Loon & Snelders, 1979; Ruíz Rejón *et al.*, 1981; Montmollin, 1986; Ruíz Rejón *et al.*, 1987; Galland, 1988; Ruíz Rejón *et al.*, 1990; Dalgiç, 1991; Javurková-Jarolímová, 1992; Steck-Blaser, 1992; Lovka, 1995; Özhatay & Johnson, 1996; Cuñado *et al.*, 2000
				18+B's		Ruíz Rejón *et al.*, 1987
				19		Ruíz Rejón *et al.*, 1986
				27/2		Ruíz Rejón *et al.*, 1981
				28		Sharma, 1970; Sharma & Sarkar, 1967-1968
				36		Ruíz Rejón *et al.*, 1986
Ornithogalum amphibolum Zahar.		No		18	9	Lungeanu, 1971; Lungeanu, 1972
				20		Agapova, 1980
O. angustifolium Bor.		No		18	9	Van Raamsdonk, 1985a; Van Raamsdonk, 1986
				27		Van Raamsdonk, 1982; Van Raamsdonk, 1985a; Van Raamsdonk, 1986
				36		Van Raamsdonk, 1985a; Van Raamsdonk, 1986
O. fimbriatum		No	6		6	Agapova, 1980

Willd.				12		Neves, 1956b; Cullen & Ratter, 1967; Zhukova, 1967; Markova *et al.*, 1972; Markova *et al.*, 1974; Van Loon & Oudemans, 1976; Agapova, 1980; Dalgiç & Özhatay, 1997; Johnson & Brandham, 1997
				12+0-3B		Agapova, 1976a
				12+1-3B		Agapova, 1980
				13		Johnson *et al.*, 1991
				20+1B		Johnson *et al.*, 1991
				35		Cullen & Ratter, 1967
				36		Cullen & Ratter, 1967; Couderc *et al.*, 1984a
				37		Cullen & Ratter, 1967
				38		Couderc *et al.*, 1984a
				84		Couderc *et al.*, 1984a
O. gussonei Ten.		No		14	9	Pogosian, 1997; Moret & Couderc, 1986; Phitos *et al.*, 1989; Speta, 1990
				14+2B		Speta, 1990
				14+0-5B		Tornadore & Garbari, 1979
				15, 30		Moret & Couderc, 1986
				16		Agapova, 1976a; Agapova, 1976b; Šopova & Sekovski, 1981
				18		Pólya, 1949; Czapik, 1965; Markova *et al.*, 1972; Zabinska, 1972; Agapova, 1976b; Šopova & Sekovski, 1989
				18+1B		Tornadore & Garbari, 1979
				19		Czapik, 1965
				20		Czapik, 1965; Zabinska, 1972; Agapova, 1976b
				20+2-3B, 32		Agapova, 1976b
				20+f		Czapik, 1965
				27		Czapik, 1965
				28		Czapik, 1965; Phitos *et al.*, 1989
				29		Czapik, 1965
				36		Markova *et al.*, 1972
				72		Van Raamsdonk, 1985a; Van Raamsdonk, 1985b; Van Raamsdonk, 1986
				90		Van Raamsdonk, 1985a; Van Raamsdonk, 1985b; Van Raamsdonk, 1986
O. longibracteatum Jacq.	*O. caudatum* Ait.	Yes	27		9	Vijayavalli & Mathew, 1990a
				51-56		Heitz, 1926
				52		Vijayavalli & Mathew, 1988; Vijayavalli & Mathew, 1990a
				54 (*O. caudatum*)		Vijayavalli & Mathew, 1988; Vijayavalli & Mathew, 1990a
				54		Therman, 1951; Neves,

						1959
O. montanum Cirillo ex. Ten.		No	16	32	9	Cullen & Ratter, 1967
				14		Markova *et al*., 1972; Markova *et al*., 1974
				16		Markova *et al*., 1974; Kushnir & Galil, 1977; Van Loon & Oudemans, 1982
				16-(18)		Heitz, 1926
				18		Garbari & Tornadore, 1971; Lungeanu, 1971; Lungeanu, 1972; Phitos, 1980; Van Loon & Oudemans, 1982; Johnson & Brandham, 1997
				18+0-2 B		Özhatay & Johnson, 1996
				18+0-6 B		Tornadore & Garbari, 1979
				18+2B		Bolkhovskich & Alexandrova, 1988; Barbujani & Pigliucci, 1989
				20		Kushnir & Galil, 1977; Johnson & Brandham, 1997; Pogosian, 1997
				36+4B		Bolkhovskich & Alexandrova, 1988
O. pannonicum		No		18	9	Speta, 2000
O. pascheanum Speta		No		14	7	Speta, 1991a
O. tenuifolium Delaroche	*O. breviscapum* F.M.Leight; *O. chloranthum* Bak.; *O. ecklonii* Schlechtd.; *O. inconspicuum* Bak.; *O. pretoriense* Bak.; *O. virens* Lindl.	Yes	9+1B		?	Ruíz Rejón, 1978
				4		Stedje, 1988; Stedje, 1989; Nordal & Stedje, 1993
				6		Stedje, 1989
				8		Stedje, 1989
				10		Stedje, 1989
				12		Stedje, 1989; Nordal & Stedje, 1993
				12 (*O. pretoriense*)		Pienaar unp.
				12 (*O. ecklonii*)		De Wet, 1957
				16		Cullen & Ratter, 1967; Van Loon & Oudemans, 1976; Stedje, 1989
				18		Moret & Couderc, 1986; Azzioui *et al*., 1990
				18+2B		Ruíz Rejón, 1978
				20 (*O. inconspicuum*)		De Wet, 1957
				24		Nordal & Stedje, 1993
				26		Stedje, 1989
				50 (*O. pretoriense*)		De Wet, 1957
				52		Moret & Couderc, 1986
O. umbellatum L.		No	9		9	Galland, 1988
			9+B			Ruíz Rejón, 1976
			26			Galland, 1988
			27			Ruíz Rejón, 1978; Galland, 1988
				16		Özhatay & Johnson, 1996; Johnson & Brandham, 1997

				18		Neves, 1952; Neves, 1956a; Czapik, 1965; Tornadore & Garbari, 1979; Gadella & van Raamsdonk, 1981; Mezev-Krischfalushi *et al.*, 1989; Moret & Galland, 1992; Baltisberger, 1999
				18-30		Czapik, 1965
				18+0-8B (19-23)		Ruíz Rejón *et al.*, 1987
				18+2B		Ruíz Rejón, 1976
				19		Czapik, 1965
				24		Delay, 1947
				24-28		Heitz, 1926
				27		Sprumont, 1928; Nakajima, 1936; Satô, 1942; Pólya, 1950; Czapik (Skalinska *et. al.*, 1961); Neves, 1952; Gadella & Kliphuis, 1963; Czapik, 1965; Czapik, 1968; Gadella, 1970; Gadella, 1972a; Gadella, 1972b; Gadella, 1976; Mehra & Pandita, 1979; Gadella & van Raamsdonk, 1981; Moret & Galland, 1992; Marcucci & Tornadore, 1997
				28		Tischler, 1934; Delay, 1947; Czapik, 1965; Czapik, 1968
				32-36		Czapik, 1965
				35		Cullen & Ratter, 1967
				36		Neves, 1952; Czapik, 1965; Cullen & Ratter, 1967; Markova *et al.*, 1972; Markova *et al.*, 1974; Gadella & van Raamsdonk, 1981; Van Raamsdonk, 1985a; Van Raamsdonk, 1985b; Van Raamsdonk, 1986; Moret & Galland, 1992; Hill, 1995; Dalgiç & Özhatay, 1997
				42		Uhrikova, 1976
				43		Neves, 1952; Dietrich, 1958
				44		Cullen & Ratter, 1967; Markova *et al.*, 1972; Moret & Couderc, 1986
				45		Sprumont, 1928; Neves, 1952; Agapova, 1976a; Tornadore & Garbari, 1979; Agapova, 1980; Gadella & van Raamsdonk, 1981; Van Raamsdonk, 1982; Moret & Couderc, 1986; Van Raamsdonk, 1985a; Raamsdonk, 1985b; Raamsdonk, 1986; Mezev-Krischfalushi *et al.*, 1989; Moret & Galland, 1992; Dalgiç & Özhatay, 1997; Johnson & Brandham, 1997

				45+0-1 B		Krichphalushi, 1989
				45+1-4 B		Mezev-Krischfalushi *et al.*, 1989
				46		Dietrich, 1958; Markova *et al.*, 1974; Sveshnikova & Krichfalushij, 1985
				47		Moret & Couderc, 1986
				51		Moret & Couderc, 1986
				52		Neves, 1952; Favarger *et al.*, 1979; Moret & Couderc, 1986; Moret, 1987
				53		Moret & Couderc, 1986
				54		Tischler, 1934; Mat suura & Sutô, 1935; Holzer, 1952; Neves, 1952; Czapik, 1968; Marchi, 1971; Markova *et al.*, 1972; Markova *et al.*, 1974; Gadella, 1976; Ruíz Rejón, 1978; Tornadore & Garbari, 1979; Gadella & van Raamsdonk, 1981; Van Raamsdonk, 1982; Van Raamsdonk, 1985a; Van Raamsdonk, 1985b; Moret & Couderc, 1986; Van Raamsdonk, 1986; Dalgiç & Özhatay, 1997
				55		Moret & Galland, 1992
				72		Neves, 1952; Tornadore & Garbari, 1979; Van Raamsdonk, 1982
				90		Tischler, 1934; Tornadore & Garbari, 1979; Van Raamsdonk, 1982
				104		Moret & Couderc, 1986
				108		Tornadore & Garbari, 1979
O. wiedemannii Boiss.		No		12	?	Speta, 1991b
				12+0-1 B		Johnson *et al.*, 1991; Johnson & Brandham, 1997
				12+4B		Johnson *et al.*, 1991
				14		Johnson *et al.*, 1991
				14+1B		Couderc *et al.*, 1984a; Couderc *et al.*, 1984b
				18		Özhatay & Johnson, 1996; Johnson & Brandham, 1997
				21		Johnson & Brandham, 1997
				22		Johnson & Brandham, 1997
Polyxena calcicola U. &. D. Müll-Doblies		Yes				
P. corymbosa (L.) Jessop	*Hyacinthus corymbosus* L.; *H. paucifolius* W.F.Barker; *Periboea corymbosa* (L.) Kunth	Yes				
P. ensifolia (L.f.) Schonl.	*P. odorata* (Hook.f) Bak.; *P. pygmaea* (Jacq.) Kunth.	Yes		24	?	Johnson & Brandham, 1997
				26		Johnson & Brandham, 1997
P. longituba A.M. van der Merwe		Yes				

P. maughanii W.F.Barker		Yes				
P. pauciflora (W.F.Barker) A.M.van der Merwe & J.C.Manning		Yes				
Rhadamanthus sp.				20	5/10	Bruyns & Vosa, 1987
Schizocarphus nervosus (Burch.) V.d. Merwe	*Ornithogalum nervosum* Burch.; *Schizocarpus acerosus* V.d. Merwe; *S. gerrardii* (Bak.) V.d. Merwe*; S. rigidifolius* (Kunth) V.d. Merwe*; Scilla gerrardii* Bak.; *S. hispidula* Bak.*; S. rigidifolia* Bak.; *S. rigidifolia* Bak. var. *acerosa* V.d. Merwe; *S. rigidifolia* Bak. var. *nervosa* Bak.	Yes				
Scilla lazulina		No				
S. peruviana L.		No		14	8	Battaglia, 1950; Battaglia & Guanti, 1968
				15		Battaglia, 1949b; Battaglia, 1950
				16		Heitz, 1926; Satô, 1935; Battaglia, 1949a, b; Battaglia, 1955; Giménez-Martin, 1959a, b; De Dominicis *et al*, 1981; Pastor, 1985; Luque *et al.*, 1988; Almeida da Silva *et al.*, 1998
				22		Battaglia, 1950
				28		Battaglia, 1950; Battaglia & Guanti, 1968; De Dominicis *et al.*, 1981
				29		Battaglia & Guanti, 1968
				32		Battaglia, 1949a; Battaglia & Guanti, 1968
Thuranthos indicum		No				
Urginea undulata (Desf.) Steinh.		No		20	5/10	Martinoli, 1949; Battaglia, 1957; Bartolo *et al.*, 1984
Veltheimia bracteata Harv. ex. Bak.	*V. undulata* Moench; *V. viridifolia* Jacq.	Yes		40	5/10	Taylor, 1925; Coleman, 1940; Delay, 1947
V. capensis (L.) DC.	*V. deasii* Bernes; *V. glauca* (Ait.) Jacq.; *V. roodeae* E.Phillips	Yes		40	5/10	Satô, 1942
Whiteheadia bifolia (Jacq.) Bak.		Yes				
Family Iridaceae						
Nivenia corymbosa (Ker-Gawl.) Bak.		Yes		32	8	Goldblatt, 1971
Witsenia maura (L.) Thunberg		Yes		32	8	Goldblatt, 1971; Goldblatt, 1993