The phylogenetic relationship in the *Lachenalia pusilla* group

✲✲

Sizani Bulelani Londoloza

Dissertation submitted in fulfillment of the requirements for the degree ***Magister Scientiae*** *in the Faculty of Natural and Agricultural Sciences (Department of Genetics) at the University of the Free State.*

02 July 2014

Supervisor: Dr P. Spies

Co- supervisor: Prof J.J. Spies

✲✲

****

"I declare that the dissertation hereby submitted by me for the Magister Scientiae degree at the University of the Free State is my own independent work and has not previously been submitted by me at another university/faculty. I further more cede copy of the dissertation in favour of the University of the Free State"

****

Table of content:

List of Abbreviation:

%	Percentage
˚C	Degrees centigrade
µl	Microliter
2n	Somatic chromosome number
ABI	Applied Biosystems
ARC	Agriculture Research Council
bp	base pair
CO_2	Carbon dioxide
CTAB	Hexadecyltrimethyl Ammonium Bromide
DAPI	4',6-Diamidino-2-Phenylindole, Dihydrochloride
DNA	Deoxyribonucleic Acid
dH_2O	Distilled water
dNTP	Deoxynucleotide triphosphate
DMSO	Dimethyl Sulfoxide
e.g.	for example
EDTA	Ethylene Diaminetetra Acetic Acid
Ethanol	Ethyl alcohol
Fig.	Figure
FISH	Fluorescent *In Situ* Hybridization
G	Gram
g.	Gravitational Force
GISH	Genomic *In Situ* Hybridization
HCl	Hydrochloric acid
i.e.	Id est (that is)
INDELS	Insertions/deletions
ITS	Internal Transcribed Spacer Region
M	Molar
$MgCl_2$	Magnesium chloride
Min	Minute
Ml	Milliliter
mM	Millimolar
N	Gametic chromosome number
NaCl	Sodium chloride
PCR	Polymerase Chain Reaction
psbA-trnH	Intergenic spacer locus
rbcL	Ribulose-1, 5-biphosphate carboxylase large subunit
RNA	Ribonucleic acid
SANBI	South African National Biodiversity Institution
subsp.	Subspecies
TAE	Tris; Acetic acid; EDTA
TE	Tris; EDTA
trnF	Transfer RNA gene for Phenylalanine
trnL	Transfer RNA gene for Leucine
x	Basic chromosome number

****

I would like to give gratitude to my supervisor Dr. P. Spies and to my co-supervisor Prof. J. Spies for their time, patience and guidance. I would like to give a special appreciation Dr. P. Spies (my supervisor) for motivation and great opportunities given to me throughout the duration of this study.

Special gratitude to ARC Roodeplaat (Riana Kleynhans), for the plant material provided for this study and to the University of the Free State (Department of Genetics) for the use of their facilities.

I would like to thank Prof Van Wyk P.W. (Center for Microscopy) for his valuable time on front of a microscopy for GISH chromosome capturing of this study. I sincerely thank Susan Reinecke for taking me through her lifetime cytogenetic experience and for sharing her chromosome preparation slides.

To my family, my mother and my sister who stood side to side throughout this journey and who held my hand at times when I was falling thank you.

Finally I would like to thank the Department of Genetics personnel and co-students for their support and great times we shared.

****

1. General introduction

Lachenalia Jacq.f.ex Murray is a geophytic genus endemic to the western areas of Southern Africa (Manning *et al.* 2004; Duncan & Edwards 2006).

Common names for *Lachenalia* are Wild Hyacinth, Cape Cowslip (superficial resemblance to genus *Primula*), Leopard Lily (Bryan 1989) (perhaps due to its beautiful black spots and stripes) or in Afrikaans: "viooltjies" or "kalossies" (Crosby 1986). The genus *Lachenalia* is named after Werner de Lachenal (1736–1800), a Swiss professor of botany (Bryan 1989).

The genus consists of about 133 species (Duncan 2012) and comprises approximately 139 taxa (thus subspecies included). More than 80% of the 133 species are found in the Western and Northern Cape (former Cape Province) of South Africa. Duncan (1996, 1999, 2012) recorded that *Lachenalia* species have a geographical distribution from the south-western parts of Namibia, down the western parts of Northern Cape, Western Cape and Eastern Cape Provinces of South Africa; and reaches as far inland as the south-western part of the Free State Province (South Africa). The only limiting factor to the distribution of this genus is its sensitivity to frost (Kapczńska 2009), but even then, some lachenalias survive in extremely cold or high temperatures.

Lachenalia inhabits a very wide variety of habitats, including pure sand on sea level to loam soils at altitudes exceeding 2000 meters or seasonal pools in clay soils (Duncan 2012). The *Lachenalia* specimens can be solitary or found among other vegetation. The flowering season begins in late March or early April and last until mid-December with the exception of a summer growing species, *L. pearsonii* (Glover) W.F. Barker from Namibia (Duncan 1999).

The centre of origin of *Lachenalia* is the 3319 grid (Worcester) in the Western Cape Province of South Africa with species diversity decreasing towards the margins of its range (Duncan 2005, 2012). Even though *Lachenalia* species are widely distributed, a significant number of species are listed as endangered (10%), vulnerable (17%), considered to be near threatened (2%), critically rare (6%), rare (9%) and declining (2%) (http://www.sanbi.org/index.php?option=com_docman&task=documentdetails&id=43) and the list is increasing dramatically every year (Duncan 2003). In 2012, the number of vulnerable species significantly increased by more than 100%, endangered species showed an increase of 4% and 50% for critically endangered species (Duncan 2012). *Lachenalia moniliformis* and *L. mathewsii* for example, have a restricted distribution contributing to their vulnerability (Duncan 1998). These species, like other endangered species, grows in the area under development for human inhabitants (for example Cape-flats). Critically endangered *L. viridiflora* is threatened by coastal housing development on the Cape west coast (Duncan 2012). Endangered and vulnerable species are threatened by coastal housing development and alien plant infestation respectively (Duncan 2012).

1.1. Medicinal application

Lachenalias are known for their natural biochemical compounds and scents (Duncan 2012). Most of those natural scents are to facilitate and promote pollination and seed dispersal vectors. Even though there's a lot of natural scents and medical importance, phytochemical characterisation of Hyacinthaceae*, Lachenalia* has not been investigated much (Arnold *et al.* 2002). Only *L. flava* (*syn. L. tricolor* Jacq.f.) has been investigated pharmacologically (Watt & Breyer-Brandwijk 1962). Based on chemotaxonomic trends reported on the subfamilies of the African Hyacinthaceae*, Lachenalia* in the Hyacinthoideae is expected to produce homoisoflavanone (Pohl *et al.* 2000). In South Africa, indigenous bulbous plants, mainly belonging to the Amaryllidaceae and Hyacinthaceae families are normally used (by natives) as disinfectants and anti-inflammatory agents, suggesting some degree of antimicrobial activity (Louw *et al*. 2002). Few authors investigated chemical compositions of *Lachenalia,* chelidonic acid (Ramstad 1953) and flavone sulphates, tricetin, diosmetin and luteolin sulphate (Williams *et al.,* 1976). Recently Langois *et al.* (2005) identified 3-benzylchromone from *L. punctata.*

The other importance of this geophytic genus beside its potential medicinal value is the commercial flora value. *Lachenalia* specimens can be cultivated and, a complete collection of all the species is maintained at South African National Biodiversity Institution (SANBI).

1.2. South African and Global floriculture industry

The global floriculture industry is worth more than US$33 billion (Boshoff 2010) and is constantly growing. The floriculture export revenue for South Africa amounted to more than R524 million in 2008 (Boshoff 2010). The flower-bulbs market is estimated to be worth more than US$1 billion (Kamenetsky & Miller 2010). Kleynhans & Spies (2011) described the floriculture industry as a market on the move. It is closely linked to fashion and life style resulting in ever changing demands and requires new floral products. New innovations and adapting to market changes are vital as failure will have catastrophic results for plant growers and breeders. New innovations include, among other, the development of new cultivars and different uses for existing crops (Kleynhans & Spies 2011).

South Africa has an extremely rich plant diversity which consists of approximately 10% of the world's plant species. Five plant species native to South Africa (*Gerbera* L.*, Freesia, Zantedeschia, Gladiolus* and *Ornithogalum*) generated a turn-over revenue of more than €218 million on Dutch auctions in 2009 (Anon 2010 as quoted by Kleynhans & Spies 2011). None of these cultivars have been developed in South Africa (Kleynhans & Spies 2011). The popular crops sold in South Africa are mainly roses (±30%), *Chrysanthemum* (15%), Lilies (10%) and carnations (6%) all of which are mainly produced in greenhouses (Kleynhans & Spies 2011). The rest consists of summer flowers and proteas, which are mainly shade net or field produced (Kleynhans & Spies 2011). Like Dutch auctions, the South African market is dominated by Multiflora auction structures located in Johannesburg and supermarkets (Kleynhans & Spies 2011).

In 1985 The Indigenous Bulb Growers Association of South Africa, marked the genus *Lachenalia* as the second most popular plant in the world following the genus Gladiolus (Duncan 1988).

1.3. *Lachenalia* breeding and new cultivars

Lachenalia has been used in a breeding program at the Agricultural Research Council's Vegetable and Ornamental Plant Institute (ARC-VOPI) with the aims to increase commercialized production of *Lachenalia* plants (Du Preez *et al*. 2002) and to develop new cultivars for the international market. Early attempts of commercializing *Lachenalia* cultivars were unsuccessful due to inadequate cultivation procedures (Kleynhans & Hancke 2002), as well as the political isolation of the country until late 1990's (Kapczńska 2009). In 1992 the breeding programme and production of *Lachenalia* increased significantly and in 1998 and 1999 ARC developed a production system to satisfy the commercial growers' requirement internationally (Kleynhans 2006; Kapczńska 2009). The intense labour work, technology and breeding management applied by ARC resulted in a revolution of *Lachenalia* hybrids. In 1999 a *Lachenalia* hybrid 'Rupert' was honoured as the best bulbous pot plant (Sochacki 2003). The first inter-species crosses were made in 1968 at ARC-VOPI breeding programme (Kleynhans 2006). Even though this plant has been used in a breeding programme since 1968, it has not really gained much exposure or popularly in the horticultural industry. Bester *et al*. (2009) mentioned obstacles faced by this plant in floriculture industry and the authors further discussed methods that can be used to improve a market for this plant. Hundreds of crossing combinations have been made and more than 25 cultivars have been released (Kleynhans *et al.* 2009b). However, there are external and internal crossing barriers in the genus (Kleynhans 2006) limiting new cultivars development. Kleynhans & Hancke 2002) discussed most of external barrier that exists in *Lachenalia* breeding. Amongst them, the morphological variation in the genus cause a number of isolation barriers (Lubbinge 1980). Variation in the flowering time of species (April to November) makes crossing difficult (Kleynhans & Hancke 2002).

Kleynhans (2006) described a way to overcome external barriers by growing the plants in controlled conditions and by storing of pollen in -4°C or in liquid nitrogen or by storing dry pollen for a 24 months period in a refrigerator. Stored pollen is used to overcome different flowering periods (April to November). Dry pollen stored in a refrigerator retained 80% of its germination ability when stored for up to 24 months (Kleynhans *et al.* 1995). Kleynhans (2006) observed similar results with pollen storage in liquid nitrogen. *Lachenalia reflexa* seed have high initial viability but do not persist in the soil seed bank for more than three years (Kate & Grazyna 2011).

Internal barriers have not been studied in detail (Kleynhans *et al.* 2009b) and in general a study on internal crossing barriers is necessary to assist breeders to understand low cross-ability. Chromosome variation in the genus is linked to external barriers. The study of Kleynhans *et al.* (2012) indicates a correlation between the cross-ability of *Lachenalia* species and their basic chromosome numbers, as well as their phylogenetic relationships.

Incompatibility between species is another isolation barrier among *Lachenalia* accessions (Kleynhans & Hancke 2002). Kleynhans (2002) reported, intra-species crosses between different accessions sometimes overcome accession incompatibility, and recommended combining accessions collected from different areas to improve cross-ability. Incompatibility is associated with flora incompatibility: (1) flower length (and short style) restrict pollen to grow down the style of a longer flower (Lubblinge 1980) which leads to (2) failure of the pollen tube to reach the ovary, (3) abnormal penetration of the pollen tube in ovule, and (4) embryo abortion and non-viable seeds (Kleynhans & Hancke 2002). The *Lachenalia* breeding program is still relatively young as compared to those on other large bulbous crops; therefore it's not surprising that there are still no developed mechanisms to overcome existing crossing barriers.

1.4. Division of genus *Lachenalia*

Lachenalia makes beautiful ornamental plants and is therefore an important genus of the family Hyacinthaceae (Manning *et al*. 2004; Hamatani *et al*. 2007) or *Asparagaceae* Juss, according to the reclassification in 2009 (APG III group 2009).

Lachenalia species are morphologically extremely variable (Duncan 1996, 1998; Duncan & Edwards 2006; Kleynhans 2006) and presents taxonomic difficulties (i.e. due to its high degree of variation, the *Lachenalia* species are easily confused and wrongly identified by inexperienced identifiers). The number of species in the genus increased as new taxa were added, i.e. the former genus *Polyxena* has been included in the genus *Lachenalia* (Manning *et al.* 2004).

Based on chromosome number and cross-ability, Crosby (1986) divided the genus *Lachenalia* into five provisional groups: (1) *Lachenalia aloides* group, (2) *Lachenalia orchioides* group, (3) *Lachenalia unicolor* group, (4), *Lachenalia unifolia* group and (5) *Lachenalia pusilla* group. *Lachenalia pusilla* group is the smallest of the five groups with only one species, *L. pusilla* Jacq. (*x = 7*). Baker (1897) placed the *Lachenalia pusilla* group into the subgenus *Brachyscypha*. In the Duncan (1988) and Manning *et al*. (2002) classification, *Lachenalia* was divided into five groups and *L. pusilla* species (the only member of *Lachenalia pusilla* group) was placed in group 1 and subgroup 2c.

Recently, Duncan (2012) re-divided subgenus *Lachenalia* into five sections namely, *Lachenalia*, *Urceolatae*, *Oblongae*, *Augustae* and *Latae*. Duncan (2012) grouped *L. pusilla*, the only species belonging to *Lachenalia pusilla* group (Crosby 1986) into subgenus *Lachenalia*, section *Lachenalia* which consists mainly species with *x = 7* except for only two species *L. unifolia* (*x = 11*) and *L. isopetala* (*x = 10*). Remarkably this dwarf geophyte species (*L. pusilla*) possess homologous morphological characters with the subgenus *Polyxena* species (*x = 12*, *13* and 1*4*) and one subgenus *Lachenalia*, section *Lachenalia* species (*L. barkeriana*, *x = 7*). Additionally, *L. pusilla* and *L. barkeriana* look different from other section *Lachenalia* species, but similar to members of subgenus *Polyxena*.

There is also high morphological resemblance between the sections of subgenus *Lachenalia*. For example, the prostrate leaves of the *Lachenalia pusilla* group are also found in other sections, *Lachenalia: L. trichophylla* (*x = 7*); *Oblongae: L. stayneri* (*x = 11*), *L. nardousbergensis* and section *Latae: L. nervosa* (*x = 8*).

In this study, *Lachenalia pusilla* group (Crosby 1986) refers to all the species within genus *Lachenalia* with basic chromosome number of *x = 9, 10* and *13*, plus *x = 7* and *x = 8* species that group with these on a phylogenetic tree. These species are believed to have originated from natural hybridization-polyploidization among species with relative basic chromosome numbers.

1.5. Aim

The aim of this study is to determine the phylogenetic relationship within the *Lachenalia pusilla* group (*x = 9, 10, 13*) plus *x = 7* and *8* species clustering with *x = 9, 10*, and *13* species. To determine whether this group is a hybrid swarm through a combination of cytogenetic (GISH) and molecular systematics *(ITS, trnL-F, rbcL, psbA-trnH*) techniques. Finally, to determine if multiple gene region analysis (*ITS, trnL-F, rbcL, psbA-trnH*) are sufficient for species level phylogeny in the genus.

1.6. Dessertation outline

This derssertation consists of two sections. The first section is a literature review (chapters 1, 2 and 3) and the last section (chapters 4 and 5) is research work. **Chapter 1** gives a general history of the genus *Lachenalia*, its medical application, new cultivar production and *Lachenalia* in the floriculture industry.

Species within the same group (cladogram clade) are closely related. The high number of successful artificial inter-species crosses (ARC *Lachenalia* breeding programme) among the species within the groups support that they are sister species. Therefore, an accurate

Lachenalia classification is a fundamental knowledge for breeders and taxonomists. **Chapter 2** elucidates *Lachenalia*'s classification based on morphological, chromosome number and karyotyping and finally based on molecular systematics.

Phenological, ecology and geographic distribution can provide guidance understanding genus *Lachenalia* phylogenetic relationship and can be used as a giudence to predict the model of species evolution and population establishment. **Chapter 3** briefly gives a general overview of the factors promoting the survival of the genus *Lachenalia,* and recommendation for growing *Lachenalia* species. Phenotypic plasticity, pollination syndrome and polyploidization interactions are beyond the scope of this study, but may have a significant role in *Lachenalia* evolution.

Chapter 4 is a research work chapter. This chapter is designed to map genome origin of taxa with basic chromosome number of $x = 9, 10, 11$ and 13. The genome of putative parental taxa with $x = 7$ and $x = 8$ is also analysed to determine their genetic constitution. Lastly, briefly troubleshooting suggestion for GISH analysis of the genus *Lachenalia* were given.

Chapter 5 is a research work chapter. Combined molecular analyses of a nucleus-plastid dataset were used to reconstruct the phylogenetic relationship of *Lachenalia* species. To validate the hypothesis that the *Lachenalia pusilla* group is a hybrid swarm, network and dendroscope analyses were incorporate.

The last two chapters **Chapter 6** and **Chapter 7** are general discussion and references respectively.

2. Review of *Lachenalia* classification based on morphological, cytogenetic and molecular data

2.1. Abstract

Recent progress in identification and classification of the genus *Lachenalia* Jacq. *f.* ex Murray was briefly review in this chapter. Great taxonomic confusion exists in the genus due to high level of diversity of the leaves, inflorescence and flowering time. Polyploidy and aneuploidy, which occur in abundance, may form more morphological variation that may lead to miss identification and classification of the species in this genus. In some cases, the occurrence of B-chromosomes may lead wrong chromosome count that may lead to miss identification. In some cases, accessions with similar ploidy levels differ morphologically in different geographic areas. Additionally, very similar accessions may possess different somatic chromosomes numbers (*2n*) or very different species may have the same somatic chromosome number and similar ploidy level.

Species with basic chromosome numbers of $x = 7$ and *8* are at the bottom of the phylogenetic tree and represent primary chromosomes and other groups scattered around group $x = 7$ and $x = 8$. Interestingly, cytogenetic studies and molecular systematics indicates that there are two separate clades within the $x = 7$ group.

This review emphasises on the classification of the genus *Lachenalia* based on morphological characters, cytogenetical data and molecular data. Secondly, discuss phylogeny relationships unfeasibility within the genus and lastly, discuss the correlation between monophyletic species, basic chromosome number and their cross ability.

Keywords: basic chromosome number, *Lachenalia*, molecular data, morphological data, variation

2.2. Introduction

The dwarf *Lachenalia pusilla* Jacq. geophyte (10- 20 mm) (Nordenstam 1982; Müller-Doblies *et. al*. 1987), is a diploid ($n = 7$). The high morphological variation of *Lachenalia* species might be the by-product of speciation on the species level. For example, *Lachenalia* *hirta* (*x = 11*) and *L. unifolia* (*2n = 11*) differ mainly in the presence of hairiness. Van Rooyen *et al*. (2002) suggested that these two species represent two subspecies of the same species. However, morphological dataset placed these species in two distinct groups (Duncan *et al*. 2005). The former *Polyxena* species and some other *Lachenalia* species had been moved within the genus or to the sister genera based on morphological data, and were reclassified or repositioned into a better resolution on phylogenetic tree using molecular data (Pfosser & Speta 1999; Pfosser *et al*. 2003; Spies 2004).

There is a correlation between the cross-ability of *Lachenalia* species and their basic chromosome number (Kleynhans *et al*. 2009b). Similar to Spies (2004), the authors also found a strong correlation between species within a provisional group in their phylogenetic relationship and crossing ability. Thus basic chromosome numbers of *Lachenalia* species can be used to construct their phylogenetic relationship.

In the integrated study presented here, the classification of the genus *Lachenalia* based on (1) morphological data, (2) cytogenetic and karyological data and (3) molecular data was re-evaluate, and where possible suggest few techniques or evolutional algorithms to improve the phylogenetic modeling of the relationships in *Lachenalia*.

2.3. *Lachenalia* classification

2.3.1. Classification of *Lachenalia* based on morphological data

It is very difficult to study phylogenetic relationships, classification, speciation and other evolutional biology in *Lachenalia* (Hamatani *et al*. 2008). This unfeasibility of evolutional determination is due to (but not limited to) high phenotypic variation. There is taxonomic confusion due to high level of morphological variation with overemphasis of minor morphological difference in *Lachenalia* (Duncan 1992). In contrast, a recent study of Duncan (2012) emphasized that the majority of *Lachenalia* species have clear-cut morphological differences leading to straight forward identification. A broad array of data collection (e.g. morphology, palynology, cytogenetics, anatomy, ecology, biogeography and DNA techniques) may results in an improved classification of *Lachenalia*.

Variation within species occurs in several macro-morphological characters. Plants belonging to the same species display constant features such as bulb shape and size, flower shapes and seed morphologies (Duncan 2005), inflorescences and flora make-up. Resemblance complexes can be differentiated by a combination of morphological features that constitute unique species characters (Duncan 2012) rather than treating each character individual. Species like *L. bifolia, L. contaminata, L. elegans, L. mutabilis, L. orchioides, L. punctata* and *L. violacea* are highly variable (Duncan 2005), and can be used as a guide for classification based on their morphological characters (i.e. species sharing unique morphological characters similar to those of seven species ('clades') mentioned above can be assumed to be phylogenetically related and falls under the same clade on the cladistics).

Based on morphological data, Baker (1897) classified *Lachenalia* into five subgenera. Crosby (1986) and Manning *et al.* (2002) dividing *Lachenalia* into five groups. Ten subgroups were rearranged based on morphological similarities into five groups by Duncan (1988). However, cladistic analysis based on 73 characters that included flowers, bulbs and seeds indicated that all these morphological data could be inadequate to clarify and justify the species phylogenetic relationships (Duncan 1998; Duncan *et al.* 2005).

Duncan (1988) described a high degree of *Lachenalia* leaf variation based on leaf shape, length, width and leaf number. The leaves vary from short-prostrated and spreading to long-erected and cylindrical shapes (i.e. *Lachenalia contaminata* produces grass-like leaves, whereas *L. latifolia* produces leaves lying horizontally on the ground surface) (Fig. 2.1). Furthermore, leaves can be spotted, banded, smooth or hairy (Kapczńska 2009) (Fig. 2.1). The variation is further extended into inflorescences as they vary from geoflorous raceme to long-pedicelled raceme, or from corymbose recame to widely campanulate perianth shapes (Duncan 1988) (Fig. 2.1). The variation in inflorescences resulted in formation of three main types of inflorescences: the spike, the subspicate inflorescences and the raceme (Duncan 2012) (Fig. 2.1). The other factor which might have promoted the popularity of this genus is the spectrum of different flower colours (Duncan 1988). Flower colours range from yellow, red, purple and green to white with different spot patterns (Fig. 2.1). Furthermore, the production of new cultivars (Fig. 2.1) push the colour range of this genus to levels never imagined. Some species have fragrant flowers, for example *L. convallarioides* (Kapczńska 2009).

Figure 2.1. Examples of the morphological diversity of the leaves and inflorescences/flowers and different somatic chromosome numbers (*2n*) in *Lachenalia*. **A**-**J**, leaf variation: **A**, long and thick erect leaves, *L. namaquensis*; **B**, prostrated rough leaves, *L. unicolor*; **C**, green grass-like immaculated leaves, *L. zeyheri*; **D**, grass-like with strips from above the ground to the middle *L. unifolia* var. *unifolia*; **E**, solitary edge folded-like leaf with simple trichomes, *L. hirta*; **F**, thin erect, twisted-lanceolate leaves, *L. mediana*; **G**, spotted semi-erected leaves, *L. aloides*; **H**, red

circular cubic postulated leave, *L. patula*; **I**, suberect spotted leave, always occur in two, *L. cernua;* **J**, leaves heavily covered with stellate trichomes, *L. trichophylla*. **K-T**, inflorescences and flower variation: **K**, deep-blue spike inflorescence with tubular perianth, *L. viridiflora*; **L**, the geoflorous, subcapitate raceme, *L. violaceae*; **M**, corymbose raceme *L. corymbosa*; **N**, maculated widely campanulate perianth with short-pedicelled raceme, *L. xerophila*; **O**, immaculated white widely campanulate perianth, *L. orthopetala;* **P**, short-pedicelled raceme with urceolate perianth, *L. congesta*; **Q**, unique flower shape of ex genus *Polyxena*; **R**, maroon spike, *L. isopetala*; **S**; long-pedicelled raceme, *L. flava*; **T**, short-pedicelled raceme with postulate urceolate perianth. **U**-**Y**, Somatic chromosomes number: **U**, *2n = 2x = 20*, *L. undulata*; **V**, *2n = 2x = 28*, *L. cernua*; **W**, *2n = 2x = 16*, *L. capensis*; **X**, *2n = 2x = 18*, *L. mediana*; **Y**, *2n = 2x = 14*, *L. mathewsii*. Photographer: **A**, **B**, **D**, **E**-**I**, **L**-**U**: P. Spies; **C:** R. Kleynhans; **V**-**Y**: slides prepared by S. Reinecke. Google images: **J**: https://www.strangewonderfulthings.com; **K**: https//www.flickriver.com

2.3.2. Classification of *Lachenalia* based on cytogenetics

The other factor resulting into an unconvincing *Lachenalia* phylogenetical relationship is the variation of chromosome numbers. Chromosome numbers of approximately 89 taxa have been determined (Spies *et al.* 2011). The variation in chromosome number is due to different somatic chromosome numbers, which range from *2n = 10* to *2n = 56* (Moffett 1936; Sato 1942; Therman 1956; De Wet 1957; Fernandes & Neves 1962; Riley 1962; Mogford 1978; Ornduff & Watters 1978; Nordenstam 1982; Crosby 1986; Hancke & Liebenberg 1990; Johnson & Brandham 1997; Kleynhans 1997; Hamatani *et al.* 1998, 2004, 2009, 2010, 2012; Hancke & Liebenberg 1998; Kleynhans & Spies 1999; Spies *et al.* 2000, 2002; Du Preez *et al.* 2002; Van Rooyen *et al.* 2002).

The taxa with basic chromosome numbers of of *x = 7* and x = *8* are more common within the genus, but *x = 5*, *6*, *9*, *10*, *11*, *12*, *13*, *14* and *15* have also been found (Moffett 1936; Ornduff & Watters 1978; Crosby 1986; Johnson & Brandham 1997; Hancke *et al.* 2001; Hamatani *et al.* 2007, 2010, 2012; Spies *et al*. 2008, 2009;). Polyploidy is also frequent in the genus (Johnson & Brandham 1997; Kleynhans & Spies 1999; Spies *et al.* 2000, 2002) and B-chromosomes have been reported in eight species, namely *L. aloides, L. anguinea, L. bifolia, L.*

carnosa, L. contaminata, L. obscura, L. reflexa and *L. splendida* (Crosby 1986; Hancke & Liebenberg 1990; Johnson & Brandham 1997; Kleynhans & Spies 1999; Spies *et al.* 2009, 2011). A chromosome count of *2n = 23* in an accession of *L. zeyheri* Baker is probably due to the occurrence of a B-chromosome (Hamatani *et al.* 1998). Species with basic chromosome numbers of *x = 7* have high occurrences of polyploidy (Spies *et al.* 2002).

Chromosome damage occurring during slides preparation might result in chromosome misidentification and B-chromosome identification (Kleynhans *et al.* 2012). And often only one specimen is studied (Spies *et al*. 2011). The small size of the chromosomes within the genus can lead to miss-identification of B chromosomes and unfeasible cytology studies (Hancke & Liebenberg 1990; Spies *et al.* 2000). Therefore, it is important to analyse and determine the chromosome number of several specimen belonging to specific species to have accurate chromosome counts and correctly identify of the presence of B-chromosomes as well as somatic chromosome numbers.

The occurrence of B-chromosomes reported can also lead to taxa and taxonomic confusions based on chromosomal classification. Hancke & Liebenberg (1990) identified and described the properties of B chromosomes in *Lachenalia* for the first time. According to Hancke & Liebenberg (1990) B-chromosomes in *Lachenalia* do not have a specific staining pattern and are similar in size to the smallest chromosome in the normal complement. Due to this behaviour, it is difficult to identify B-chromosomes in the genus *Lachenalia* and results in some erroneous counts reported in literature. Moreover B-chromosomes in *Lachenalia* do not occur in all cells of a specific individual and also not in all accessions of a species (Hancke & Liebenberg 1990).

2.3.2.1. Basic chromosome numbers in the genus

x = 7

The basic chromosome number of $x = 7$ is the most common in the genus *Lachenalia*. About 46.5% of *Lachenalia* specimens studied forms an $x = 7$ complex, with 60.8% of those species being diploid (Fig. 2.2) (Johnson & Brandham 1997; Spies *et al.* 2011). Polyploidy in the $x = 7$ complex is easily identified. However, hexaploids or octoploids of $x = 7$ may be confused with uneven polyploids of taxa with $x = 6$ and $x = 8$ (Spies *et al.* 2011), and can also be confused with diploids with $2n = 30$ ($x = 15$) (Johnson & Brandham 1997). These ploidy levels (hexaploids and octoploids) could actually be allotetraploids derived from taxa with $x = 7$ and $x = 8$ following hybridisation and doubling of the chromosome number (Johnson & Brandham 1997). All other varieties of this group other than hexaploids, octoploids and diploids with $2n = 30$ ($x = 15$) are multiples of $x = 7$ making it clear that they must have a basic number of $x = 7$ (Johnson & Brandham 1997; Spies *et al.* 2011). Polyploidy is more frequent in the $x = 7$ group (Fig. 2.2) (Johnson & Brandham 1997; Kleynhans & Spies 1999) and 17.8% of the specimens studied represents polyploids (Spies *et al.* 2011).

Only 3 out of the 273 cytogenetic reports on $x = 7$ taxa represent specimens at uneven ploidy levels, $2n = 3x = 21$ (*L. aloides* and *L. rosea* Andrews) (Crosby 1986) and $2n = 7x = 49$ (*L. bifolia)* (Kleynhans & Spies, 1999). Uneven ploidy levels are extremely rare making up to 1% of the chromosome numbers reported (Spies *et al.* 2011).

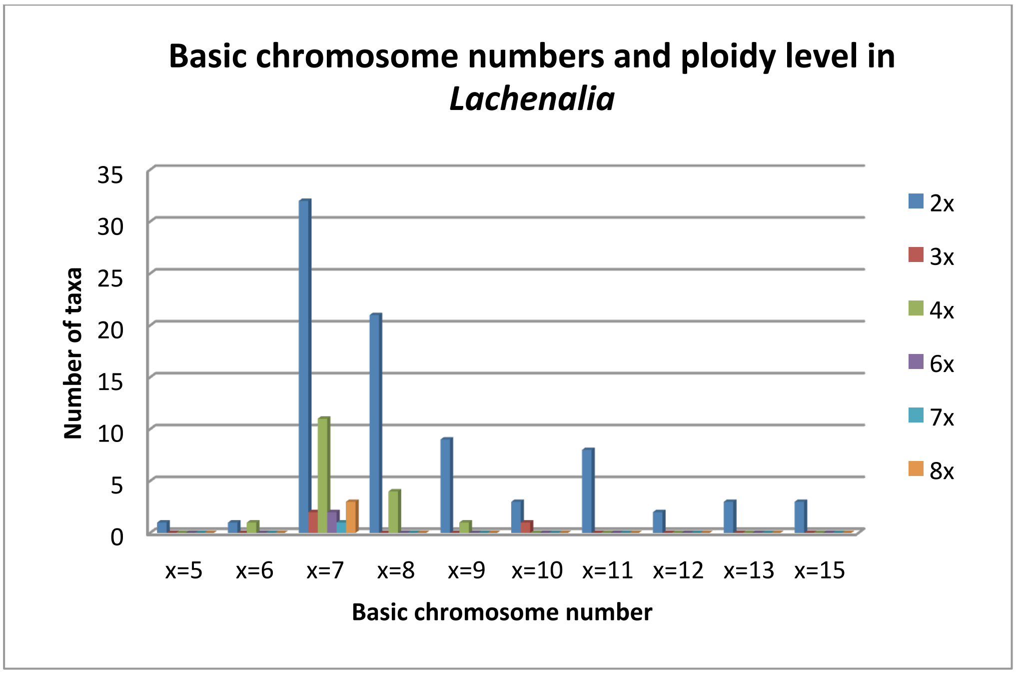

Figure 2.2: Basic chromosome numbers in the genus *Lachenalia* indicating the number of taxa for each basic number and the ploidy levels reported for these basic numbers. Taxa with *2n = 24* were excluded. (Figure copied from Kleynhans *et al*. 2012 with permission of the authors).

However, the *x = 7* group has been divided into four taxa due to at least four different karyotypes described in Hamatani *et al.* (2007). Hamatani *et al.* (2007) grouped together *L. longibracteata* E. Phillips, *L. orchioides, L. orchioides subsp. orchioides*, *L. orchioides subsp. glaucina* (Jacq.) W.F. Barker and *L. pusilla* Jacq. as taxa containing chromosomes that gradually decrease in size. *Lachenalia aloides* have two long, four medium and eight short chromosomes. Hamatani *et al.* (2007) further groups *L. algoensis* Schönland*, L. rosea* and*. L. viridiflora* in group 2 as they contain karyotypes with six long and eight small chromosomes. Eight short chromosomes were observed in *L. sessiliflora* W. F. Barker and two long and 12 short chromosomes (Hamatani *et al*. 2007). Therefore it seems as if taxa with basic chromosome number *x = 7* are under chromosomal evolution.

There is a possibility of some *x = 7* species resulting from hybridization. Hamatani *et al*. (2007) reported *L. longituba* (A.M. van der Merwe) J.C. Manning and Goldblatt with three long and 25 short chromosomes. Spies *et al.* (2011) concluded that the chromosomes from these are not homologous and this taxon originates through hybridization of taxa with respectively two and four long chromosomes. Spies *et al.* (2011) hypothesised that *L. longituba* originated from an aneuploidy event following hybridization or separate hybridization events involving taxa with different chromosome numbers.

x = 8

Basic chromosome number of *x = 8* is the second most significant group of lachenalias with 19.5% of the taxa having this number (Fig. 2.2) (Spies *et al.* 2011). The *x = 8* taxa are predominantly diploid with only 9.6% of the taxa at tetraploid level (Du Preez *et al*. 2002; Spies *et al.* 2011). Specimens with *2n = 24* were excluded from this group (Spies *et al.* 2011). This is because the taxa of *2n = 24* have only *2n = 24* with no lower or higher ploidy levels and the probability of so many different taxa being triploid based on *x = 8* (3.8%) seem improbable (Spies *et al.* 2011). Thus *2n = 24* taxa is associated with *x = 6* group rather than a triploid within *x = 8* taxa. Even though, triploid of some true *x = 8* species have been recorded in the literature, Spies *et al.* (2011) proposed proper meiotic analyses to provide the answer in this instance.

x = 9

This is the third most prominent group in *Lachenalia* with the majority of the specimens being diploids (Spies *et al*. 2011; Kleynhans *et al*. 2012). About 10.7% specimens represent these taxa (Fig. 2.2) (Spies *et al*. 2011). Yet, meiotic studies are required to solve problems regard the possibility of the presences of other basic chromosome numbers such as *x = 6* or *x = 12*, or is it really a tetraploid (Spies *et al*. 2011). The karyotype of *L. latimerae* W.F.

Barker revealed three long and 15 short chromosomes (Hamatani *et al.* 2007). This indicates again a possible hybrid origin for a non-homologous karyotype (Spies *et al.* 2011).

x = 11

This chromosome number exists in 7 members of the genus and only a single tetraploid specimen (Fig. 2.2) was observed with the somatic chromosome number of $2n = 44$. The karyotypes of *L. juncifolia* Baker (Hamatani *et al.* 2007) and *L. zeyheri* (Hamatani *et al.* 2010) showed a gradual decrease in chromosome size. This karyotype has one very small chromosome that may be a B-chromosome thus explaining why somatic chromosome number for *L. zeyheri* is written as $2n = 23$ in Hamatani *et al*. (1998).

Lachenalia latimerae ($2n = 18$), *L. juncifolia* ($2n = 22$), and *L. zeyheri* ($2n = 22$) share common 5S rDNA signals and 18S rDNA near the centromeres, suggesting that these three species are related to each other although they have different chromosome numbers (Hamatani *et al.* 2010). Hamatani e*t al.* (2010) observed that *L. latimerae* ($x = 9$), *L. juncifolia* and *L. zeyheri* ($x = 11$) have similar characters in the DAPI and FISH signals than that of *L. pusilla* ($x = 7$) and hypothesized that the speciation of these three species and *L. pusilla* may have occurred from a common ancestor.

Lachenalia hirta (thumb.) Thunb. and *L. unifolia* are closely related (Duncan 1988) based on their morphological similarities. The only predominant feature differing within this two species is that *L. hirta* has hairy leaves whereas *L. unifolia* has smooth leaves (Van Rooyen *et al*. 2002). *Lachenalia unifolia* ($2n = 22$) (Moffet 1936; De Wet 1957; Ornduff & Watters 1978; Crosby 1986; Johnson and Brandham 1997) and *L hirta* ($2n = 22$) (De Wet 1957; Ornduff & Watters 1978) represents two subspecies of the same species rather than two separate species even though they are highly variable (van Rooyen *et al*. 2002, Duncan 1988).

x* = *5, 6, 10, 12,* 13 and *14

There are very few species reported with these chromosome numbers (Table 2.1) and further cytogenetic studies especially meiotic studies of these taxa should be done to resolve the actual chromosome numbers controversy. The majority of these species are endangered (SANBI 2009). There are only few species reported in literature with basic chromosome number of $x = 5$, e.g. *L. mutabilis* and *L. marginata* subsp. *neglecta* Schltr. ex G.D. Duncan. *Lachenalia zebrina* W.F. Barker ($2n = 30$) further supports the presence of an $x = 5$ group making *L. zebrina* a hexaploid with a basic number of $x = 5$, rather than a triploid species of $x = 10$. Johnson & Brandham (1997) suggested an alternative origin of $2n = 30$, where a dibasic origin of $x = 7$ crossed with $x = 8$ resulted in a secondary basic chromosome number of 15. Doubling of this chromosome number would results in $2n = 30$ specimens (Spies *et al.* 2011). There are only two species *L. alba* and *L. isopetala* with $2n = 40$. There is no doubt that the $x = 5$ group forms part of a very old polyploidy complex where the diploids are almost extinct (Spies *et al.* 2011). There are no karyotype information available for $x = 5$ taxa.

Table 2.1: List of chromosome numbers and number of diploid versus other ploidy levels reported for *Lachenalia* in literature. (Table copied from Spies *et al*. 2011 with permission of the authors).

x =	*No. of all taxa*	*No. of diploid taxa*	*% of diploid taxa*	*No. of ploidy taxa*	*% of ploidy taxa*
5	1	1	0.75	-	-
6	2	1	0.75	1	0.75
7	51	32	24	19	14.3
8	25	21	15.8	4	3
9	10	9	6.77	1	0.75
10	4	3	2.26	1	0.75
11	8	8	6	-	-
12	2	2	1.5	-	-
13	3	3	2.26	-	-
15	3	3	2.26	-	-
Total	***133***	***83***	***62.4***	***26***	***19.6***

According to Spies *et al*. (2011), "*x = 6* group is also represented by the same diploid taxon that may form part of an aneuploid series, *L. mutabilis*. Although either aneuploidy or dysploidy may be present, the tetraploid specimens observed may represent a tribasic chromosome number (*x = 7 + 8 + 9*) or a triploid (*2n = 3x = 24*). However, *L. stayneri* W.F. Barker behaves as a diploid based on *x = 12* or an allotetraploid with *x = 6*". However there is no karyotype information available for this species to support this hypothesis.

There are uncertainties regarding the correct chromosome numbers of *L. mediana* subsp. *mediana* and *L. mediana* subsp. *rogersii* (Bak) W.F. Barker*.* These species have three different basic chromosome numbers observed for the two varieties, i.e. *x = 7*, 9 and 13 and *x = 13* for *L. mediana* subsp. *mediana* and *L. mediana* subsp. *rogersii* (Bak) W.F. Barker respectively (Spies *et al.* 2011). The other *x = 13* species reported are *Lachenalia ensifolia* (Thunb.) J. C. Manning & Goldblatt and *L. paucifolia* (W.F. Barker) J. C. Manning & Goldblatt have three long chromosomes and 23 short chromosomes (Hamatani *et al.* 2007). This is an indication of a possible hybrid origin from *Massonia depressa* Houtt. (*2n = 26*) with a karyotype consisting of four long and 22 short chromosomes (Hamatani *et al.* 2007).

The presence of binding sites for 5S rDNA and 18S rDNA on one chromosome pair, indicate that polyploidy did not contribute to the formation of the higher chromosome numbers observed in *L. paucifolia* (*2n = 26*) and in *L. longituba* (*2n = 28*) (Hamatani *et al.* 2010). However, in *L. vanzyliae* (*2n = 4x = 28*) the polyploids based on *x = 7* clearly show multiple binding sites with two chromosome pairs providing binding sites for each probe and in *L. orchioides* (*2n = 2x = 28*), two chromosome pairs provide binding sites for each probe plus an additional pair with a binding site for 18S rDNA suggesting a segmental alloploid to alloploid origin for this species (Hamatani *et al.* 2010).

There is only two species with a basic chromosome number of *x = 14*, *Lachenalia congesta,* karyomorphological analysed for the first time by Hamatani *et al.* (2012), and *L. longituba* reclassified by Manning *et al*. (2004) from *Polyxena longituba* to *Lachenalia*. *Lachenalia longituba* and *L. congesta* both do not have clear DAPI positive bands (Hamatani *et al.* 2011; 2012) compared to other species. In addition to this characteristic *L. longituba* and *L. congesta* have two FISH signals of 5S rDNA sites on distal position of the long arms of the small chromosomes (Hamatani *et al.* 2010). Even though FISH data suggested that *L. congesta* and *L. longituba* had common chromosome feature (*2n = 28, x = 14*) and this is unique character among *Lachenalia*, they are separate groups as *ITS* clearly segregate *L. congesta* from *L. longituba* (Hamatani *et al.* 2012).

2.3.3. Classification of *Lachenalia* based on molecular systematic

Molecular data is more reliable in determining phylogenetic relationships than morphological, physiological data (Li 1997) and cytogenetic analysis. Even so, molecular analyses have not yet produced a well-resolved *Lachenalia* evolutional relationship. Duncan (2012) reported that molecular phylogeny results do not agree with the morphological phylogenetic results.

Spies (2004) determined from a molecular study using the *trnL-F* region that *Lachenalia* species with *x = 7* and *x = 8* are very closely related. This was supported by authors such as Hamatani *et al*. (2008) using the *ITS* region. Hamatani *et al*. (2008) found that species with basic chromosome numbers of *x = 7* and *x = 8* are genetic homologous and form a distinct clade. However, both Hamatani *et al*. (2008) and Spies (2004) hypothesized that taxa with basic chromosome number of *x = 8* originates from *x = 7* or might have evolved from a common ancestor. This is further supported by phylogenetic overlapping of few species such as *L. sessiliflora* between taxa with basic chromosome number of *x = 7* or *x = 8* (Hamatani *et al*. 2008). The other chromosome numbers are not monophyletic (Spies 2004). The *x = 7* taxa is divided into two distinct clades indicating multiple phylogenetic origin or divergence of *x = 7* soon after origin, whereas *x = 8* has a single clade indicating a single point of origin followed by continuous speciation (Spies 2004; Hamatani *et al*. 2008). Most of these findings are supported by florescence *In Situ* hybridization studies on *Lachenalia* (Hamatani *et al*. 2007; 2009). Other molecular markers beside *ITS* region such as *atpB* (Pfosser *et al*. 2003), *matK, psbA-trnH*, *atpH-I* (Spies *et al*. 2011), *rbcL* (Chapter 5) are also having similar conclusion of *Lachenalia* evolutional relationships. Multiple gene analysis seem not to improve species phylogenetic resolution significance and there is incongruence within plastid dataset separated, combined and *ITS* dataset (Chapter 5). There basic chromosome number *x = 7*, *8* and *11* and the former *Polyxena* species appear to form monophyletic group. Taxa with other basic chromosome numbers were spread between the *x = 7* and *x = 8*.

2.4. Conclusion

Diversity of lachenalias with the same basic chromosome numbers (*x*) but different ploidy levels can be linked to environmental factors and to geographic distribution. Although there is high morphological confusion in the classification of the genus, inflorescences, leaves filament, perianth structures and *etc* variation can be integrated with molecular and cytogenetic phylogenetic observations for much robust phylogeny. Evolutional divergent characters like trichomes and maculation can answer evolutional models, genetic drift and natural selection concepts.

Molecular systematics of nuclear or chloroplast gene regions may provide a better understanding of the phylogenetic relationships of the species than that of morphological or cytogenetic approaches. However both analyses have not yet produced well resolved phylogenies and may have to be used in conjunction with each other for betther phylogeny analysis.

3. Review of factors influencing the survival of the genus *Lachenalia*

3.1. Abstract

The genus *Lachenalia* consists of approximately 133 species. These species vary at phenotypic level (i.e. morphology, size of inflorescences, flower colour, *etc.*) and cytogenetic composition (dysploidy, aneuploidy, polyploidy, chromosome number, *etc.*). The diversity of *Lachenalia* flower and floral signals (i.e. flower colour and scent) displayed by members of this genus suggest pollination syndromes such as melittophily and ornithophily. Furthermore, the variation is increased by increased ploidy level and or geographic distribution (i.e. *L. bifolia*). Another survival mechanism of *Lachenalia* is the annual bulb regaining and propagation reproduction acquired by all the members of the genus *Lachenalia*. The ability of this genus to grow in foreign habitats (invasion of *L. reflexa* in Australia as a hazardous weed), feed on low fertile soils and disease tolerance may contribute to its survival. This study reviews most of the factors influencing the performance of this genus and gives a comprehensive summary on growing lachenalias as a garden or a pot plant.

Keywords: bulb, dwarfism character, florescence, Hyacinthaceae, inflorescence, *Lachenalia,* morphology, nutrients, Ornithogalum mosaic virus, pollination, seed, syndrome temperature regime, variation.

3.2. Introduction

South African endemic plants, especially bulbous plants such as *Lachenalia*, are well adaptive and has the potential to become an invasion alien plant (*L. reflexa*). Lachenalias have been cultivated in Britain for more than two centuries (Duncan 2012). In almost all of the northern countries, *Lachenalia* is not hardy enough for outdoor cultivation and must be kept frost-free to survive (Duncan 2012). Nonetheless, *Lachenalia* seems to possess traits for survival in harsh conditions. The survival of *Lachenalia* species might be, but not limited to factors like: (1) annual bulb character, (2) propagated vegetative by means of adventitious bud formation (Coertze *et al.* 1992), (3) rapid and profuse seedling germination in some species, (4) tolerance to diseases, viruses or pathogens attacking the family *Hyacinthaceae*, and (5) symbiosis with infectious bacteria (Pearson *et al*. 2009).

Some species have unusual dormant characteristics, for instance, *L. lutzeyeri, L. montana*, *L. mathewsii* and some other species remain completely dormant for years (Duncan 2012). Floral radiations within the genus promote selective pollinators inducing pollination syndromes (Duncan 2012). Seed production by sexual recombination and vegetative propagation enhance species survival. However, there is strong correlation between *Lachenalia* seed dispersal mechanisms and its restricted geographic distribution.

3.3. Climate and latitude

Lachenalia grows best at cold or moderate temperatures (du Toit 2002), but bulbs grown at low temperatures develop slightly slower than those at moderate and high temperatures (du Toit *et al.* 2002). *Lachenalia* follows a winter growth cycle similar to the Cape floristic region where the group originated (Grace & Van Staden 2003; Duncan 1992). *Lachenalia pearsonii* (Glover) W.F. Barker which inhabits Namibia is an exception and follows a summer rainfall growth cycle (Grace & Van Staden 2003). Another unique feature for this species is its dwarfish character. *Lachenalia pearsonii* might have acquired these characteristics to survive conditions worse than the point of origin (namely hot and dry summer conditions with little rain and cold dry winter).

In spite of the slower development of bulbs subjected to lower temperatures (under commercial cultivation), the quality of these bulbs are actually better than bulbs grown in moderate or high temperatures (du Toit *et al.* 2002). Louw (1991) reported that a drop in storage temperature before planting improves scape elongation and faster growth in cultivar 'Romelia'. Furthermore, bulbs initially exposed to a low temperature have high soluble sugar levels (du Toit *et al.* 2004a). Du Toit e*t al.* (2004a) observed that leaves produce copious photosynthates during the growing season. This might be one of the reasons for this genus being well adapted in winter regions, as they utilise stored carbohydrates for growth and development. The starch remains unchanged until the next growing season then it is rapidly burned to support the new plant growth. Thus the bulb serve as a storehouse for the essential growth nutrients and it might be the most fundamental survival trait. Therefore, it can be assumed (based on commercial *Lachenalia* cultivation data) that cold winter temperatures initiate growth and promote best quality inflorescence development (for review, see Louw 1991; du Toit *et al.* 2002; du Toit *et al.* 2004a, 2004b).

The effect of temperature on *Lachenalias'* physiological growth is species specific (genotypic specific). For example, *L. punctata* plants do not have a low temperature requirement for elongation of scape and flowering (Kodaira & Fukai 2005). Further studies are required to find an optimum bulb storage temperature and duration to maximize the number of florets for cultivation purpose.

Under commercial production, it should be noted that failure to flower, low flowering percentage, a lack of uniformity and periodicity of flowering in many geophytes (i.e. *Lachenalia*) depend on many factors, including bulb size and periodicity of inflorescence initiation (Roh 2005). Failure of scape elongation due to death of florets (inflorescence blast) is caused by unfavourable external factors, such as temperature during bulb production, storage, and forcing (Roh *et al.* 1998) as well as the internal source-sink relationship between inflorescence and other organs (Theron & Jacobs 1996).

3.4. Ecology and adaptative strategies

The distribution area of *Lachenalia* almost covers the western half of South Africa and southern Namibia (Duncan 1988, 1999) (Fig. 3.1). *Lachenalia* occurs in all the nine biomes and in 162 vegetation types of Southern Africa (Mucina & Rutherford 2006). One hundred and twenty-five species are endemic to the nine biomes recorded in South Africa, with some inhabiting more than one biome (Duncan 2012). Van Wyk & Smith (2001) documented the presence of lachenalias in all three primal floristic regions.

Species are morphological highly variable in the winter rainfall zone of the Western Cape, and there is a remarkable decrease in species diversity towards the summer rainfall zone of the Eastern Cape (Duncan 2012). Few species, mostly in the summer rainfall region, have a wider distribution range (Duncan 2012) and can inhabit higher attitudes and feed in different soil types (Duncan 1996, 1999). There are no records of *Lachenalia* species surviving in frost zone areas (Kapczńska 2009). Nevertheless, Duncan (2012) documented *L. attenuata*, *L. canaliculata*, *L. congesta*, *L. isopetala* and *L. longituba* as cold tolerant species, as they can survive temperatures below -15°C for short periods.

Lachenalia patula (a xerophytic species) has small bulbs and leaves. This species is endemic to the bare Karoo desert in the Knersvlakte. It has evolved “lush” semiterete leaves and small bulbs surrounded by extremely tough cartilaginous outer scales (Duncan 2012) as adaptive features. *Lachenalia namibiensis* from south-western Namibia shares almost xero-

Figure 3.1. Geographical distribution of genus *Lachenalia*. **A**: contains high number of species per grid (≥ 20 species per grid), **B**: contains low number of species per grid (≤ 10 species per grid) (Dancan 2012).

phytic lachenalias (Duncan 2012). All the species in this genus, except *L. pearsonii,* has tough bulbs in order to survive hot and dry summer months when in a dormant state (Duncan 2012). Lachenalias growing in areas with prolonged droughts and erratic rainfalls are adapted to remain dormant for years until favourable conditions return (Duncan 2012). Xerophytic species reduce water usage during growth (Duncan 2012), have shallow-seated bulbs and has horizontal spreading roots system ensuring easy access to shallow rainfalls (Duncan 2012). About 2.3% of lachenalias are pyrophytic (*L. lutzeyeri, L. montana and L. sargeantii*) and have deep-seated bulbs, i.e. can be buried up to 100 mm deep (Duncan 2012). Pyrophytic, proteranthous, synanthous and hysteranthous are other survival traits possessed. Deep seated bulbs assure that they survive wild fires. After reproduction all *Lachenalia* species lose leaves (deciduous) which prevent the bulb from overheating underground and loss of water in hot summer temperatures.

3.5. Disease tolerance

Lachenalia is frequently infected with *Ornithogalum* mosaic virus (OMV): a filamentous of virus which causes severe mosaic symptoms and flower deformation (Burger & Von Wechmar 1988; Duncan 2012). OMV in *Lachenalia* does not result in significant deterioration of plant quality like in other members of the family *Hyacinthaceae*. Pearson *et al.* (2009) describe *Ornithogalum* virus as a harmless virus which has no physiological effects in *Lachenalia*, therefore *Lachenalia* act as a host of both this virus as well as the *Veltheimia* mosaic virus. Conversely, Duncan (2012) describes deformed or stunted leaves and florescence, discolouration patterns on the leaves and flowers in the form of mosaics, mottling or streaks of light yellow or dull red as well as necrotic spots as variety symptoms caused by *Ornithogalum* mosaic virus (OMV). Ornithogalum virus is mostly concentrated in bulb growth points during the post dominancy period (Burger & Wechmar 1988). Like in potato tubers and in lily bulbs, *Ornithogalum* mosaic virus cannot be easily detected until the flowering phase, as it is a symptomless virus (Burger & Von Wechmar 1988). Burger & Von Wechmar (1988) described two serological assays (DAS-ELISA and DOT-ELISA) to detect OMV viral infections in *Lachenalia* and *Ornithogalum*. Horst (1988) and Veclar *et al*. (1992) described several techniques to eliminate viruses from plants including OMV.

Lachenalia is often attacked by several pathogenic insects: (1) aphids are usually found on developing flower buds and cause flower deformation and premature yellowing of the leaves (Duncan 2012). Furthermore, hemipteran secretes a sugar rich honeydew deposit on the plants' surface which affects photosynthesis (Halder *et al*. 2013). (2) *rhizoglyphus* *echinopus* (transparent bulb mites) commonly feed on plant bulbs (Fan & Zhang 2003), which cause lesions and craters to develop in *Lachenalia* bulbs (Journet 2003). It also causes chlorotic deformed leaves (Duncan 2012). (3) mealy bugs are insects mostly found between the bulb scales and around the leaf bases (Duncan 2012; Halder *et al*. 2013). They produce oily white deposits and excrete honeydew that coats the plant surface and these extract is responsible for distortion (Duncan 2012; Halder *et al*. 2013). (4) caterpillars, and (5) molluscs (slugs and snails) destroy the plant by feeding on the leaves and developing flowers, in lachenalias causing a massive damage and contamination by their faeces or slime (Duncan 2012). Lachenalias might not fully recover for that season if the plants are largely destroyed.

All of these pests are transmitters of fungal or viral disease. *Lachenalia* is frequently attacked by damping-off fungi that are caused by insufficient ventilated areas during autumn and winter. Damping-off fungi attack the leaves, resulting in a total collapse and disintegration of the whole plant; rust fungi are prevalent in winter under poor ventilation and insufficient light (Duncan 2012). Its symptoms are clusters of bright orange spores that can rapidly destroy entire leaves and fungal rotting of *Lachenalia* bulbs. Most species are affected by the fungi *Botrytis cinerea* and *Fusarium oxysporum*. These fungi are most common in poor drainage soils, excessive moisture and warm climate. Symptoms of *B. cinerea* and *F. oxysporum* infection are mostly slow development of leaves, turning leaves prematurely yellow or becoming distorted.

3.6. Pollination biology and seed dispersal

Lachenalia species might prevent inbreeding depression by self incompatibility. Duncan (2012) observed that flowers of most *Lachenalia* species are self incompatible. Some of the *Lachenalia* species appear to possess heterostylous flowers (flower morphs) i.e. long stamens with a short style or short stamens with a long style. There is no studies done on the self incompatibility of *Lachenalia* species and it is suspected that gametophytic self incompatibility might be common. Nonetheless, two species were able to breakdown self incompatibility, and various other species produced quite a number of seeds in cultivation without possible evidence of cross-pollination (Duncan 2012).

Some species are adapted for myrmecochory. These species flower closely to the ground which produce many elaiosome seeds (Duncan 2012), botanically known as diaspora. Ants are attracted to the elaiosomes: a rich proteins-lipid appendage on the *Lachenalia* seeds, which they use for feeding their larvae (Duncan 1988; Bryan 1989; Vittoz & Engler 2007; Garrido *et al*. 2009; Lengyel *et al.* 2010). The diaspora are later disposed in an area where it can germinate (Van der Pijl 1982; Vittoz & Engler 2007). Elaiosomes are therefore used as a method for seed transportation (Beattie 1985).

Dispersal of most *Lachenalia* seeds is local by means of anemochory (Duncan 2012). The scape is strongly attached to the bulb after drying of the infructescence and the seeds remain adhered to the open capsules, until strong winds blow them off (Duncan 2012). However, the wind merely blows the seeds a few millimetres from the bulbs. The infructescence of some xerophytic species, such as *L. patula* and *L. xerophila*, detach from the bulb, and seeds are scattered as the wind blows (Duncan 2012), resulting in colonial *Lachenalia* populations. A limited number of species have broadly winged capsules and the fracture is strongly blown off by wind. This results in wide range spread of these species. Seeds are also dislodged from the dry capsule by raindrops and projected up to 140 mm, but Duncan (2012) documented that *Lachenalia* seeds are non-buoyant.

The discrete nature of most populations suggests that seeds are not naturally spread easily over long distances (Bettink 2009). Therefore, in areas where new plants have established 50 m to 100 m beyond main infestations, mammals or birds are thought to be dispersers of the seed.

The diversity of floral structure within *Lachenalia* species correlates to the different dispersal strategies as well as pollination (species selection by a vector) as Schiestl & Jhonstone (2013) illustrated in some other species. Duncan (2012) recorded two pollination syndromes within the genus: melittophily and ornithophily. Certain *Lachenalia* species may have acquired favourable traits (for example flower shape, size, odour and nectar composition) that may have gradually become dormant due to natural selection enforced by different pollen vectors (Faegri & Van der Pijl 1979).

Most *Lachenalia* species are pollinated by different species of solitary bees. Some tubular and especially orange-flowering species are pollinated by sunbirds (Manning *et al*. 2004; Duncan 2012); different types of beetles; by an exotic beewolf; nectar-feeding insects; hoverflies; three types of butterflies; and moth (Duncan 2012). In addition ants frequently visit *lachenalias* but play no part in pollination (Duncan 2012). However, due to convergence evolution within *Lachenalia* species, some pollinators constantly revisit lachenalias specific for certain pollination syndromes. Geoflorous species may possibly be pollinated by rodents but it is not certain (Duncan 2012).

Lachenalia nervosa has a scent like a mixture of cloves and carnations (Duncan & Smith 1999) as a specialized pollination feature. Strong leaves, adequate landing facilities, a tepal surface that provide adequate foothold (Faegri & Van der Pijl 1979) and bright coloured anthers which emits a distinctive scent (Duncan 2012) are melittophilic features of bee-pollinated species. Several *Lachenalia* species are selected for bird pollination (Faegri & Van der Pijl 1979). *Lachenalia aloides*, *L. patentissima* and *L. quadricolor* have brightly coloured tubular flowers and are usually unscented and have abundant nectar and strong scapes to allow sunbirds to cling to them. All these features may attract the sunbirds for feeding, thus resulting in cross-pollination (Faegri & Van der Pijl 1979; Proctor & Yeo 1972; Duncan 2012). Nonetheless some species are also pollinated by honey bees and/or any other possible pollinators even though they are primary ornithophily (Duncan 2012), as they might possess other floral signals not specific only to sunbirds.

3.7. Vegetation propagation

Lachenalia can be propagated through offsets, bulblets (also known as bulbils), stolons, leaf cuttings, seeds and tissue culture methods (Duncan 1988; Duncan 2012). Small underground bulbs are called bulblets but if they develop at the periphery of the mother-bulb, they are called offsets (Kapczńska 2009). Some bulbous species may occasionally produce aerial bulblets (bulbils - small bulb or bulb-shaped growth arising from the leaf axil or in the place of flowers on the floral parts or on the edge of the leaf) (De Hertogh & Le Nard 1993). *Lachenalia bifolia* can produce bulblets aboveground level, and others (i.e. *L. namaquensis*) reproduce by stolons which push the bulblets away from mother-bulb (Duncan 1988; Duncan 2012). In some species, the mother bulb divides into two or more large bulblets of similar size that would flower the following season (Duncan 2012). These methods are too slow for commercial production and are species specific (Kleynhans & Hancke 2002). Propagation through leave cutting is the best method for commercial production (Duncan 1988). Young explant tissue produce the highest number of buds and the old tissue produced the least (Niederwieser & Vcelar 1990). Similar, leaves (leaf cutting) propagate least when the donor plant is in full flowering stage (Ndou, *et al*. 2002; Niederwieser & Ndou 2002). The proximal region of the active growing leaf should be cut before flowering begins, placed in a slightly moist medium of vermiculite and river sand or grit, with about 1 cm of the base of the material inserted into the medium (Duncan 2012). The formed bulblets should be stored in a dry place and can be planted in the next season (Du Plessis & Duncan 1989), and can flower in one year under optimum conditions (Duncan 2012).

However, vegetative propagation reduces species integrity as it prevents gene flow within the species but preserve morphological traits. Seeds collected from the wild are more likely to have species integrity of 100% (Duncan 2012). Under natural conditions, seed of most species flowers from their third season (Duncan 1988). *Lachenalia juncifolia* and *L. reflexa* can produce florescence in their second year (Duncan 2010), *L. congesta* (and perhaps some other xerophytic species) can take up to 4 to 5 years (Duncan 2012).

3.8. Recommendation for growing *Lachenalia*

Lachenalia is a strong plant adapted to harsh South-Western African conditions. Despite its hardiness, good care should be applied in commercial production or for good plant and florescence production. Kapczńska (2009) and Duncan (2012) recommended a sunny environment for good production and Kapczńska (2009) emphasised the importance of placing the plant under the shade on the hottest part of the day. Duncan (2012) documented some species that require full morning sun and afternoon shade. *Lachenalia viridiflora* tepals become insipid under insufficient light and the prostate leaf suberect or spread in numerous species such as *L. kliprandensis* and *L. congesta* (Duncan 2012). The best time to plant *Lachenalia* bulbs is early to late autumn in the southern hemisphere. The optimal growing temperature for lachenalias is 15 to 20°C at daytime and 8 to 10°C at night (Duncan 2012). During active growth plants requires moderate moisture and good drainage (Kapczńska 2009). Duncan (2012) recommends a very low humid and well ventilated enviroment. Watering should be decreased after flowering and stopped when the leaves become yellow (Bryan 1989). Prevention of excess water when the leaves turn yellow or when the plant start losing leaves might prevent the bulb from decaying. Not all *Lachenalia* species are suitable to be grown in the garden. During the summer dormant period, summer rains or garden irrigation cause lachenalias to decay as they are subjected to fungal attacks (Duncan 2012). *Lachenalia aloides, L. bifolia, L. flava, L. pallida* and *L. purpureo-caerulea* are examples of very few *Lachenalia* species that withstand summer rainfalls and are therefore suitable for garden cultivation.

The nutrients required by this genus depend mostly on the genotype or species as they occur in different soil habitats, and show different rates of achieving optimal nutritional status (Roodbol *et al*. 2002; Duncan 2012). Roodbol *et al*. (2002) discussed a standard nutrient regime that will benefit most *Lachenalia* genotypes. However lachenalias adapt readily to any soil types that differ from their natural habitats (Duncan 1988; Duncan 2012). In general, *Lachenalia* flourish in any soil with a good soil drainage system (Duncan 2012), mixtures containing loam, clay loam and sand beds (Perrignon 1992), or sand and bark (Duncan 2012). Duncan (2012) provided a comprehensive description on how to plant this genus in different soil types to genotypes suitable for a particular soil type. For example, species with larger bulbs must be planted up to 4 cm deep. Species with small bulbs like *Lachenalia namibiensis* should be planted not deeper than 1 cm. For most species, a depth of 2 to 3 cm is recommended (Duncan 2012).

If seeds are grown, they should be sown 3 mm to 5 mm deep depending on particular species and should be kept in moist soil in the full sun. Seeds sown in deeper pots reach maturity faster than the one sown in shallow pots (Duncan 2012). Seeds of *L. patula* take 11 days to germinate, 58 days for *L. argillicola* and 18 days for most species (Duncan 2012). Seeds must first undergo a summer dormant phase before they can germinate in the following autumn (Duncan 2012). *Lachenalia corymbosa* and *L. campanulata* are the only species known to be ready to sown directly after harvesting.

Lachenalia has low phosphorus and magnesium requirements (Roodbol & Niederwieser, 2002) but nitrogen applied in the nursery and pot plant phases positively affects the number of florets formed per inflorescence (Engelbrecht *et al.* 2008). Nevertheless fertilization has a significant effect on the growth and flowering of the plant. Fertilisers higher in potassium but low in nitrogen content can be applied once the plant has begun active growing (Duncan 2012). High nitrogen supply cause excessive soft leaf growth, reduce florescence and cause additional leaf growth (Duncan 2012). Interaction between nutrients required by plants play an important role in sustainable crop production. Neither nitrogen nor phosphorus level substantially influenced the leaf of *Lachenalia* plants (Engelbrecht *et al*. 2010). Phosphorus substantially influence bulb firmness, however firmness of 'Ronina' bulbs decreases with an increase in phosphorus (Engelbrecht *et al*. 2010). Duncan (2012) found that species grown in slightly acidic to neutral pH grows the best. Only *Lachenalia karooica* prefers moderately alkaline medium (Duncan 2012).

3.9. Conclusion

Lachenalia has been cultivated almost all around the world. Europe and East Asia make up to 75% world production South African flower heritage. In prolonged cold climates (i.e. northern hemisphere) lachenalias must be cultivated indoor as they cannot withstand temperatures below 0°C for very long periods. All lachenalias can be successfully grown in a container (dwarfs species requires shallow containers) but only certain species are suitable to be grown in the garden (Duncan 2012). In countries with a climate similar to the south-western parts of South Africa, *Lachenalia* has the potential to flourish and replace native plants (i.e. invasion of *Lachenalia reflexa* in Australia (Kate & Grazyna 2011)).

Factors that may insure the survival of *Lachenalia* are the annual bulb production, propagated vegetation (adventitious bud) and the rapid, profuse seeding germination of some species. Other fascinating features of this genus are ecological interactions and symbiosis with animals and vegetation respectively. Even though this genus is endemic only to a fraction of Southern Africa, it possesses adaptation plasticity over biomes, soils, soil nutrients and latitude.

Chapter 4:

4. The use of GISH techniques in phylogenetic studies of *Lachenalia pusilla* group (*x = 7, 8, 9, 10,* 11 and *13*).

4.1. Abstract

Lachenalia species with basic chromosome numbers of *x = 7* and *x = 8* are abundant and considered to be the primitive chromosome complement of the genus *Lachenalia*. Molecular systematic and cytogenetic studies provided compelling evidence that taxa with basic chromosome numbers of *x = 9*, *10* and *13* are descendant from taxa with *x = 7* and *x = 8*.

The aim of this study was to map and determine the chromosomal origin of taxa with *x = 9*, *10* and *13* and sort out genome constitutions of their putative parents (presumably *x = 7* and *x = 8* taxa) using the genomic *in situ* hybridization (GISH) technique.

Several GISH protocols were used but failed to provide results. Therefore possible reasons for this failure were discussed. Furthermore, few suggestions for optimizing the GISH protocol for further studies on the genus *Lachenalia* were provided.

Keywords: denaturation, genomic *in situ* hybridization, optimizing, preparations, probe, troubleshoot

4.2. Introduction

The application of the genomic *in situ* hybridization (GISH) technique led to chromosome mapping of parental genomic DNA, analysing of chromosome organization in interphase nuclei, detection of chromosomal aberrations and alien chromatin in plants (Devi *et al*. 2004; Chester *et al*. 2010). In plant systematics, GISH has a virtual potential of solving phylogenetic relationship between species, thus the rise of new species due to ancient hybridization, polyploidy and allopolyploid speciation events can be clarified (Dive *et al*. 2004). For example, Kono *et al.* (2012) confirmed *Begonia x chungii* (*2n = 22*) originated from *B. longifolia* and *B. palmate*. The authors sorted out the genome constitutions of its putative parents using GISH. Kono *et al*. (2012) used the entire genomic DNAs of both parental species as probes for the *B. x chungii* GISH analysis (thus, *B. longifolia* and *B. palmate* gDNA were labelled with different probes and hybridised simultaneously). *Begonia x chungii* has 22 chromosomes consisting of six chromosomes that hybridize with a probe derived from the *B. palmate* genome, six with a probe derived from the *B. longifolia* genome and the remaining ten with genomes overlapping genomes (Kono *et al.* 2012).

Another similar example of the use of GISH as a tool for analysing phylogenetic relationship is in *Lolium* x *Festuca* hybrids (Pasanskiene *et al*. 1998). Pasanskiene *et al*. (1998) compared GISH bands in hybrids between *Lolium multiflorum*, *L. perenne*, *Festuca glaucescens* and *F. pratensis*, and the authors found much closer homology between *L. multiflorum* and *F. pratensis* genomes than *L. multiflorum* and *F. glaucescens*. Consequently, indicating the presence of genomic exchange events between the intergeneric species *L. multiflorum* and *F. pratensis.*

Liu & Gu (2011) used GISH to study the genome organization and evolution of *Camellia reticulata* (*Theaceae* genus *Camellia*). *Camellia reticulata* has a polyploidy series varying from $2n = 2x = 30$, $2n = 4x = 60$ to $2n = 6x = 90$, with a basic chromosome number of $x = 15$ (Liu & Gu 2011). This genus also has allopolyploidy (Parks & Griffiths 1963). Liu & Gu (2011) demonstrated that, (1) the diploid species *C. reticulata, C. pitardii* and *C. saluenensis* are the progenitors of polyploid *C. reticulata*, (2) hybridization between diploid *C. reticulata* and diploid *C. pitardii* resulted in the allotetraploid *C. reticulata*, and (3) subsequent hybridization between allotetraploid *C. reticulata* and diploid *C. saluenensis* formed the allohexaploid *C. reticulata.*

Certainly GISH technique seems to be a perfect approach to determine phylogenetic relationships among species with bizarre numerical and structural chromosomes as in the case of *Lachenalia Jacq*. ex Murray.

This study summerises difficulties encountered in an attempt to determine genomic phylogenetic relationship and progenitor of *Lachenalia pusilla* and *Lachenalia* species using GISH technique. Secondly, gives suggestions (wherever possible) for further GISH inverstigation on the genus *Lachenalia*.

The aim of this study was (1) to analyse genome origin of *Lachenalia pusilla* group, (2) to determine the evolutional relationship of the *Lachenalia pusilla* group with taxa with basic chromosome numbers of *x = 7, 8* and *11* by using a GISH approach and lastly (3) to give suggestions on possible modification on improving GISH application on genus *Lachenalia*.

4.3. Materials and Methods

4.3.1. Plant material

Information on specimens used in this study is given in Appendix A. Plant materials were obtained from ARC-VOPI, Summerfield's Indigenous Bulbs and Seed and SANBI (Kirstenbosch Botanical Garden). Selected accessions were used for DNA extractions and chromosome preparation. All bulbs and seeds were grown in a greenhouse.

4.3.2. Chromosome preparation, staining and screening

4.3.2.1. Pre-treating and fixation

Multiple protocols were tested to obtain good chromosome spreads (Table 4.1). At the beginning (common step for all assays), actively growing root-tip meristems were harvested.

The facilitating medium (Deco swell gel) was rinsed off twice by tap water. Then the following two pre-treatment techniques were performed:

(1) Ice cold dH_2O for 24 hour (Ma *et al*. 1996; Mirzaghaderi 2010, Protocol for GISH, 2012, www.ksu.edu/wgrc). (2) ABN (1-bromonapthalene) for 24 to 27 hours (Mirzaghaderi 2010). In some cases roots were pre-treated for a longer time.

The roots were fixed in fresh Carnoy's fixative (EtOH: chloroform: glacial acetic acid 6:3:1) for 48 hours at 4^oC and stored in 70% ethanol at 4^o C until ready for use. As in the case of the pre-treatment step, root tips were macerated using 3 different techniques (Table 4.1) in the attempt to improve quality of the chromosomal spreads. At first, root tips were placed at room temperature for 15 min, thereafter macerated with:

(1). Acid hydrolysis in 1N HCl: 70% EtOH was rinsed off in dH_2O, and then roots were macerated in 1N HCI for 8 min at 60^oC (HCl must be at 60^o C before suspending roots). HCI was then washed twice with dH_2O before softened further in dH_2O at 4^oC for 24 hours.

(2). Enzymatic digestion: After thoroughly rinsing of the roots, root tips were cut and treated with a mixture of 5% (w/v) Cellulose and 1% liquid pectolyase in 0.01 M sodium citrate buffer, pH 4.6. The enzymatic digestions were run for 4 hours at 37^o C.

(3). Distilled water incubation: After fixation the root tips were soaked in dH_2O for 24 to 48 hours. However, to prevent the water becoming isotonic, dH_2O was changed after every 12 hours.

4.3.2.2. Staining and chromosome spread

Meristem tissues were stained by placing the roots in an eppendorf tube containing 1% aceto-carmine for 48 to 72 hours at room temperature. To enhance the intensity of the aceto-carmine stain, a drop of Ferric ions (Fe^+) was added to the eppendorf tubes before incubation (Table. 4.1). In a few cases 2% aceto-orcein or Leuco-basic fuchsin stains were used in attempt to improve chromosome visibility. Roots were placed in an eppendorf tube with orcein at room temperature until the tips became deep dark. In the case of the fuchsin, roots were stained for 2 hours at 4^{0} C in the dark, or until the root tip turned dark red.

Table 4.1. Summary of the materials and methods used to optimize chromosome preparations for GISH. Other minor adjustments and modifications are not discussed.

Technique	Method	General discussion
Pre-treatment	Ice cold dH_2o	• Very difficult to stain • No mitotic chromosomes were observed • Nucleus is visible after staining with carmine + Fe^+
	3 to 4 drops of 1-bromonapthalene	• Interphase nucleic were visible after carmine + Fe^+ stain • Poor prophase chromosomes (few)
Macerate	Enzymatic digestion • (5% cellulose + 1% pectolyase) • DAPI stain	• All slides were negative • Enzyme at their optimal activity can improve results
	Acid hydrolysis • Carmine, orcein & Fuchsin	• Carmine + Fe^+ produced better stained chromosomes or interphase nuclei • Ice cold dH_2O roots had solid nucleus • Fuchsin stained very poorly • Chromosomes cannot be identified/ differentiated
	dH_2O incubation • Carmine, orcein & Fuchsin	• Carmine + Fe^+ produced better stained chromosomes or interphase nuclei • Ice cold dH_2O roots had solid nucleus • Fuchsin stained very poorly • Chromosomes cannot be identified/ differentiated
Staining	Carmine	• Stain was intense when Ferric ions (Fe^+) were added
	Orcein	• Low signal • Fe^+ doesn't increase the intensity of the stain
	Fuchsin	• Very poor staining property
	DAPI (enzymatic maceration)	• No genomic material present to bind to
Chromosome spread	squeezing of meristem cells	• *Lachenalia* has very small chromosomes making this technique impossible
	Suspending enzymatic digested cells	• Slides were negative • Enzyme at their optimal activity can improve results
	Squashing plant tissue	• Better than any chromosome spreading technique tried in this study • Excess pressure might break the chromosomes

Root tips were squashed in either 1% aceto-carmine or in 2% aceto-orcein. To reduce over staining of cytoplasm, root tissues were placed in 45% acetic acid at 65^{o}C for 10 min before they were squashed in 45% acetic acid. Preparations were screened to determine the presence of metaphase and prophase chromosomes and interphase nuclei using epo-fluorescence microscopy (Nikon, Germany). Cover slides were removed by freeze drying in CO_2 or in liquid nitrogen. Few drops of ice cold alcohol: acetic acid fixative (3:1) was added immediately after removal of the cover slip to reduce too much presence of cytoplasm in the cell.

4.3.2.3. Genomic DNA extraction, probe labeling and blocking DNA

Total genomic DNA (gDNA) was extracted from fresh leaves using the CTAB method by Doyle & Doyle (1987) with the CTAB modification (Doyle & Doyle 1990). DNA was then diluted in 50 µl TE buffer (10 mM Tris-HCl, 1 mM EDTA, pH 8.0) and purified with phenol/chloroform. The DNA pellet was dried and resuspended in a maximum of 50 µl TE buffer. The genomic DNA was then sheared by boiling in TE buffer for 10 min to yield 300 to 600bp fragments, and labeled by nick translation with ChromaTide Fluorescein-12-dUTP (Molecular Probes C-7604) followed by the use of 0.1 M β-mercaptoethanol (Lysak *et al*. 2006).

4.3.2.4. Genomic *in situ* hybridization and detection

The GISH procedure of Bie *et al*. (2007) was followed with some modifications: The best preparations were incubated in 100% EtOH for 5 min at room temperature after removal of the coverslip. Slides were dehydrated in an EtOH series, 70%, 90% and 100% for 2 min respecticely, and air dried for 48 to 72 hours. Before probe hybridization, the slides were treated with RNase A (Sigma-Aldrich) (100 ng/µl in 2x SSC) for 60 min at 37^{o}C. The slides were then washed 3x for 5 min in 2x SSC (20x SSC: 1.3 M NaCl, 0.015M sodium citrate) at room temperature without proteinase K digestion, and rinsed in 1x PBS (PBS: 10mM sodium phosphate, pH 7.0, 143 mM NaCl). Preparations were fixed for 10 min in 4% paraformaldehyde (prepared in 1x PBS) at room temperature, raised in 2x SSC for 5 min and 1x PBS for 2 min at room temperature and dehydrated in 70%, 95% and 100% EtOH series for 3 min each at room temperature.

Labelled DNA probes were denatured at 95°C for 10 min. The hybridization mix (50% formamide, 10% dextran sulfate, 10 ng/µl probes DNA) were heated at 75°C for 5 min, and chilled on ice for 5 min. Total gDNA of *Lachenalia isopetala* (a diploid of x = 7) was used as a blocking DNA. Blocking DNA was prepared by boiling 400 mg *L. isopetala* DNA (1 mg/ml) in 0.4 mol/L NaOH for 45 min and then combined in the hybridization mixture at a ratio of 1:60 (probe:blocker). Pre-treated slides were denatured on a hot plate at 80° C for 2 min in 100 µl of 70% FA/2x SSC and dehydrated in ice cold 70%, 95% and 100% EtOH series for 5 min respectively. About 5 µl of hybridization mix was added immediately onto the preparations and immediately covered with approximately 20 x 20 mm parafilm plastic and incubated overnight at 37°C in a wet chamber.

4.3.2.5. Washing and counterstain

After overnight hybridization, slides were given a stringent wash in 1x SSC. The stringency conditions allowed the target sequences of approximately 56% homology to remain hybridized (Schwarzacher & Heslop-Harrison 2000). Post-hybridization was done by washing slides in 2x SSC at 42° C for 5 min, 50% formamide in 2x SSC for 10 min at 42° C, followed by 2 x washing in 2x SSC for 5 min at 42° C and 37° C respectively. The spreads were then counterstained for 10 min with DAPI staining in glycerol solution, containing 1 µl/ml of

4', 6-diamidino-2-phenylindole (DAPI, Sigma-Aldrich) and glycerol and immediately proceeded before glycerol damaged the probe-florescence intensity.

4.3.2.6. Image capturing and processing

Chromosome preparations were analysed using a Nikon Optiphot-2 epifluorescence microscope Fuji 800 digital camera. Photographs were taken using Fuji 800 digital camera. The images were saved, trimmed and presented in a collage (Figs. 4.1).

4.4. Results and discussion

Genomes of three *Lachenalia* accessions with each of the following basic chromosome numbers of *x = 9*, and *x = 10* were used, as well as two accessions of each of the following groups with *x = 11*, *x = 13*, *x = 7* and *x = 8* were compared. All the accessions studied were diploids. For each species, no chromosome numbers from the metaphases were scored. However, genomic *in situ* hybridization requires well preserved and dispersed chromosomes with no or little cell debris for effective genomic study (Ryan & Vasu 2013). Moreover, there are limited reports dedicated to elucidate the chromosome spreading dynamics for improving plant chromosome preparation (Kirov *et al*. 2014).

Modifications of previously similar protocols on *Lachenali*a, i.e. FISH protocol (Hamatani *et al*. 2009) and karyotyping protocols (Kleynhans & Spies 1999; Hamatani *et al*. 1998, 2004, 2007, 2012, Spies *et al.* 2000; Hancke *et al.* 2001) were unsuccessful for GISH analysis for this study.

In trying to solve these problems, troubleshooting and optimizing suggestions suggested by Schwarzacher & Heslop-Harrison (2000) were followed. However, due to time constrains GISH analysis was abort for this study.

In a few accessions, poor chromosome spread was observed and better genomic stain was observed with the addition of Fe^{+} (Fig. 4.1). In most cases cells observed were in a non-division phase (interphase). However, preparations prepared by pre-treating root tips in 1-bromonapthalene showed much more mitotic chromosome at metaphase (Fig. 4.1).

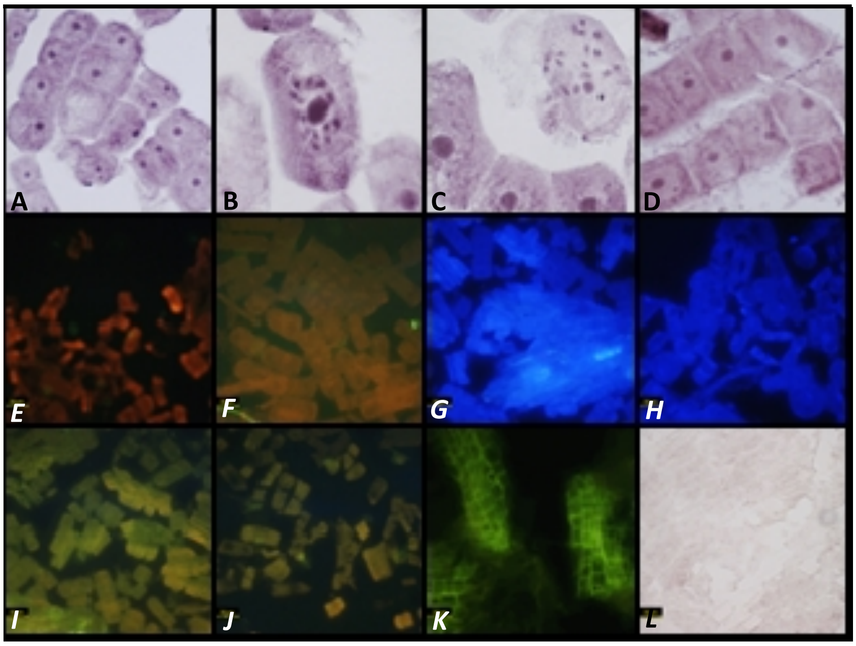

Figure 4.1: Stained genomic material of some *Lachenalia* accessions. **A-D**: For genomic screening, roots were stained in 1% Aceto-carmine + Fe^{+} for 24 hours at room temperature. A, D: prophase nucleic of *L. mediana* and *L. perryae*, respectively. B, C: metaphase nuclei of *L. alba* and *L. unifolia* respectively. **E**, **F**: Aceto-carmine stain appears on the prophase nucleic cells of *L. unifolia* and *L. undulata.* **G**, **H**: *L. comptonii* and *L. alba* cells counterstained using DAPI. **I**-**K**: green *L. mediana*, *L. comptonii* and *L. undulata* gDNA probe appear fixed on on the cell walls of *L. unifolia*, *L. obscura* and *L. perryae* respectively. **L**: *L. punctata* cells not reacting to DAPI or gDNA probes of any species.

Genomic DNA probes were unable to penetrate and identify shared genomes due to the presences of the cell wall (Fig. 4.1). Cytoplasm, cell wall and other material present on the surface of preparations mask chromosomes and nuclei (Schwarzacher & Heslop-Harrison

2000). Treating preparations with protease increased penetration of the probe slightly (Kumar 2010). However, the presence of the cell wall and cytoplasm prevented effective chromosome denaturation; reduced penetration and effective denaturation by chemical to prevent re-annealing the chromosome DNA. Moreover, the DNA probe could not penetrate into desirable locations resulting in none probe-chromosome hybridization (Schwarzacher & Heslop-Harrison 2000). Stain present within the cells (Fig. 4.1) indicated the presence of cytoplasm and cell walls. In addition, labelled gDNA probes appeared green on the cells wall.

A high quality chromosome preparation is the most fundamental factor in obtaining good results (Schwarzacher & Heslop-Harrison 2000). Therefore, it should be acknowledged that preparations for this study were not of the best quality. Furthermore, incorrect denaturation of preparations and poor probe labelling are also common course for failure in *in situ* hybridization.

Successful labelling and fragmentation of the gDNA probe (Nick translation) was routinely checked using gel electrophoresis. However this cannot be a certain proof that the probe will bind to its complementary targets. Secondly, the direct fluorophore (fluorescein ChromaTide dUTP) method of labelled probe was selected to reduce several steps to detect the probe. Thus, minimizing the washing steps (antibody or avidin treatment) that can result in material lost. In a few preparations the probe DNA appeared to be trapped within the cells cytoplasm or cell wall. The effect of probe concentration, stringency, chromosome denaturation and blocking DNA could not be optimised for *Lachenalia* genomic *in situ* hybridization. Nonetheless, they do not have great effect on the unfeasibility of future GISH studies.

Other aspects leading to the effectiveness of target specificity were pH, salt concentration and formamide concentration in the hybridization buffer (Kumar 2010). Even though these aspects were optimized, there is however not certainty of their optimization and effect on poor probe penetration. Microscope setup, mountant and immersion oil for microscopy are also possible factors resulting in negative *in situ* hybridization (Schwarzacher & Heslop-Harrison 2000). Some slides had no or only a low mitotic index. Plant material may have consecutively washed away during the dehydration steps following slide removal (Kirov 2014). This selective loss may have been due to non-treatment of glass slides with acid (acid cleaning slides) or coating slides with poly-lysine or silane. Too high denaturation or poor preparation methods may have promoted specimen material lost (Schwarzacher & Heslop-Harrison 2000). Interestingly, no noticed differentiated plant material lost between slides denatured at 75^{o}C to 85^{o}C, indicating that denaturation temperature had no effect on plant material lost. Preparations were carefully handled to prevent scratches on the slides and therefore loss of material.

4.5. Conclusion

Chromosome variation exists within the genus *Lachenalia* and chromosomal evolution is evident in this unique, beautiful South African flowering genus. The success of GISH in resolving chromosome relationship of e.g. origin of triploid *Allium* × *cornutum* (Fredotovic *et al*. 2014) assures that an optimized GISH protocol may resolve phylogenetic chromosomal relationship in the genus *Lachenalia*. Due to sensitive nature of this technique, great precision is needed, as well as delicate treatment during the preparation of specimens. Combined cytogenetics, molecular systematics, morphological and flow cytometry should result in an improved *Lachenalia* phylogeny.

5. Evolutionary relationships between *Lachenalia* species with basic chromosome number of *x = 7, 8, 9, 10, 11* and *13* (*Lachenalia pusilla* group) and its closest relatives.

5.1. Abstract

Lachenalia is one of the larger genera of the tribe Massonieae. The taxonomy of the genus has been studied by several authors based on basic chromosome number, morphology and systematics. In most cases, *Lachenalia* phylogeny construction included only a limited number of species from the genus, or only limited to certain taxa within the genus (i.e. *x = 7* and *x = 8*). Species with basic chromosome number *x = 7*, *8*, *11* including the subgenus *Polyxena* (the former genus *Polyxena*) are better resolved at molecular level, while other basic chromosome number species are not always resolved.

Combined molecular analysis (nucleus-plastid dataset) was used to investigated the phylogenetic relationship of *Lachenalia pusilla* group (*x = 9, 10, 11* and *13*) and *Lachenalia* species with basic chromosome number x = *7*, *8* and the subgenus *Polyxena*. Phylogenetic and hybridization networks were performed to identify possible hybridization events.

Separate dataset analysis provided far less resolution than combined dataset with general low level of statistical support and with some incongruence. The results are largely similar to those of previous studies, conforming monophyly of *x = 7*, *8, 11* and the subgenus *Polyxena*. *Lachenalia pusilla* group and few species with *x = 7*, *8* and *11* formed paraphyletic clades in between monophyletic groups of *x = 7*, *8* and *11.* Phylogenetic networks suggested that, closely related *Massonia* species may have hybridized with *Lachenalia* species, thus introducing other chromosome numbers and the subgenus *Polyxena* may be the result of *Massonia-Lachenalia* hybridization.

Keywords: *Lachenalia, Massonia, Polyxena*, chromosome number, *x = 7, x = 8, taxa*, group, hybridization

5.2. Introduction

The tribe Massonieae Baker (Box 5.1) comprise of very advanced and highly diverse genera within the subfamily Hyacinthoideae. Numerous phylogenetic techniques have been used to solve the phylogenetic relationship of tribe Massonieae. However, there is still not enough phylogenetic analysis done to infer relationships among genera of the Massonieae. In addition, inventory of the species and species delimitation within tribe Massonieae and subfamily Hyacinthoideae is not yet complete. There is frequently disputes regarding the delimitation of genera in the subfamily Hyacinthoideae resulting in species from different genera being treated under the same species name. Also, taxa belonging to the same species can be treated as different species belonging to different genera (Pfosser *et al*. 2003).

These errors result in a highly polymorphic and heterogeneous genera (Pfosser *et al*. 2003) (i.e. genus *Lachenalia*). There is some taxonomic confusion within the genus *Lachenalia* due to high morphological and chromosome variation. Molecular systematic analysis based on DNA sequences suggested that the taxa with basic chromosome number of $x = 7$ and the taxa with $x = 8$ are closely related (Spies 2004; Hamatani *et al.* 2008). Groups with basic chromosome numbers of $x = 7$ and $x = 8$ are the major groups within *Lachenalia* genus. The high chromosome variation ($x = 5, 6, 7, 8, 9, 10, 11, 12, 13, 14$ and 15, thus subgenus *Polyxena* included) within the genus and within species (i.e. *L. mutabilis*, $x = 5, 6$ and 7) indicates the possibility of speciation due to hybridization (Johnson & Brandham 1997).

Hamatani *et al.* (2008) found a high correlation between *Lachenalia* taxa with basic chromosome numbers of $x = 7$ and $x = 8$ in comparison to those with other basic chromosome numbers, based on molecular analysis of the internal transcribed spacer (*ITS*) region. In

Box 5.1: Delimitation of the tribe Massoniese Baker

Introduction

The tribe Massonieae (230 species, 19 genera) belongs to the subfamily Hyacinthoideae (Pfosser *et al*. 2003). The families Hyacinthaceae and Amaryllidaceae share very rich flora diversity.

Phylogeny in the tribe Massonieae and its chromosome evolution

Massonieae belongs to the monophyletic family Hyacinthaceae within the order Asparagales. Its close relatives are the family Themidaceae and *Aphyllanthes monspeliensis* (Pfosser and Speta 1999, Chase *et al*. 2000). Based on molecular, morphological, karyological and chemotaxonomical data the Hyacinthaeceae is divided into four subfamilies, Oziroeoideae, Urigineoideae, Ornithogaloideae and Hyacinthoideae (Pfosser & Speta 1999, 2001). Massonieae is further divided into subtribe Massoniinae and Lachenaliinae (Müller-Doblies & Müller-Doblies 1997). Molecular phylogenetic analysis (Pfosser *et al.* 2003), suggested monophyletic groupings of all the genera of the subfamily Hyacinthoideae (only when the genus *Pseudoprospero* is excluded), which are divided into the tribes Massonieae and Hyacintheae (Speta 1998). Hyacintheae is a sister tribe to Massonieae (Pfosser *et al.* 2003; Wetschnig & Pfosser 2003). Similar, seed morphology permit discrimination of most genera within the tribe Massonieae (Pfosser *et al*. 2003).

However, there is a taxonomic confusion within the subfamily Hyacinthoideae as species belonging to different genera are treated under the same species name (Pfosser *et al.* 2003). For example, this error resulted in a heterogeneous genus like the genus *Scilla*, a highly polymorphic genus (Pfosser *et al*. 2003).

The genus *Massonia* is sister to the genus *Lachenalia* and *Veltheimia* is a sister genus to the *Lachenalia* and *Massonia* clade (Pfosser *et al.* 2003). The *Lachenalia* subgenus *Polyxena* may have evolved through hybridization speciation.

According to Goldblatt *et al*. (2012) the ancestral basic chromosome number for Hyacinthoideae is $x = 10$. The ancestral basic chromosome number of the tribe Massonieae is $x = 10$ (Goldbatt *et al*. 2012). The basal tribe Pseudoprospereae have $x = 9$ (Goldblatt *et al*. 2012). The tribe Massonieae appears to have evolved due to polyploidization events. *Merwilla, Schizocarphus, Veltheimia* have $x = 20$ (Goldblatt *et al*. 2012). The highest polypoidy genus is *Eucomis*, $x = 15$ and the genus *Lachenalia*, the most advanced species have an ancestral basic chromosome number of $x = 9$ and 10 (Golbatt *et al*. 2012).

Distribution and adaptation

Massonieae is distributed south of the sub-Sahara Africa, Arabian Peninsula, Madagascar and India (Pfosser *et al.* 2003). According biogeographical analysis sub-Saharan Africa (place of origin) is the primary centre of diversity and radiation, followed by dispersal to the Mediterranean region (Ali *et al*. 2012). Advanced Massonieae genera are distributed in the winter rainfall area of western South Africa (Pfosser *et al.* 2003). Basal genera are better adapted to the tropical summer growing areas (Pfosser *et al*. 2003). Various species within the tribe Massonieae occur in the winter rainfall regions (*i.e.* taxa from the genus Neobakeria) (Muller-Dublies & Muller-Dublies 1997). *Lachenalia lutzeyeri, L. montana* and *L. sargeantii* are pyrophytic species (Duncan 2012).

Pollination/flower structure

There are several pollination syndromes within the family Hyacinthaceae. *Massonia depressa* (Johnson *et al*. 2001) and *Whiteheadia bifolia* (Wester 2011) show nonflying mammals floral syndrome. Mellitophily, ornithophily and phalaenophily pollination syndromes have been observed in the genus *Lachenalia* (Duncan 2012) and in *Dipcadi* (Manning *et al*. 2012) respectively. .

addition, Spies (2004) used the *trnL-F* region and observed correlations among species with similar basic chromosome numbers. Additionally, there is a significant correlation between the cross-ability of *Lachenalia* species, their basic chromosome numbers (Kleynhans *et al*. 2012) and their phylogenetic relationship (Kleynhans *et al*. 2009b).

It was suggested that the *Lachenalia* species with basic chromosome number of *x = 7* and *x = 8* evolved from a common ancestor, while the other species of the genus with basic chromosome numbers other than *x = 7* or *x = 8* had evolved from a different ancestral origin (Spies 2004; Hamatani *et al.* 2008). Moreover, molecular phylogenetic studies of the *trnL-F* region (Spies 2004), *ITS* region (Hamatani *et al.* 2008) and molecular karyotyping analysis (Hamatani *et al.* 2009) placed the taxa with basic chromosome number of *x = 7* or *x = 8* in basal distinct clades from taxa with other basic chromosome numbers. Spies (2004) and Hamatani *et al.* (2008) found that taxa with a basic chromosome number of *x = 8* form a small distinct clade from taxa of *x = 7*. Hamatani (2009) found similar conclusions to those of molecular phylogenetic conclusions using cytogenetics and DAPI-staining.

The relationships of *x = 9, 10, 11* and *13* with the *x = 7* and *= 8* groups and with *Massonia* (outgroup) have not been established up to date. Therefore, the aim of this study is to determine the phylogenetic relationship of *Lachenalia pusilla* group (*x = 9, 10, 11* and *13*) with *x = 7* and *8 Lachenalia* species. To determine if the outgroup genera are involved in *Lachenalia* speciation.

5.3. Materials and methods

5.3.1. *Plant material*

Plants that were used in this study were collected at different locations and were supplied by ARC-VOPI (by Mrs Riana Kleynhans), Summerfield's Indigenous Bulbs and Seed (by

Mr G. Summerfield) and SANBI, Kirstenbosch Botanical Garden (by Mr G. Duncan) (Appendix A). All seeds and bulbs were grown in a greenhouse.

5.3.2. ***DNA extraction and PCR amplification***

Total genomic DNA were extracted from young leaves of *Lachenalia* specimens using the CTAB method by Doyle & Doyle (1987), because of high amount of polysaccharides present, the CTAB concentration was adapted to 3% (Doyle & Doyle 1990). The DNA pellet was then diluted into 50 µl TE buffer (10 mM Tris-HCl, 1 mM EDTA, pH 8.0). An additional phenol/chloroform purification step was performed to remove proteins and potentially interfering secondary metabolites as follows: 150 µl of TE was added to bring the initial volume to 200 µl. Equal volume of phenol was then added, vortex gently and spin for 2 min at 13 000 rpm at room temperature. It was followed by addition of 100 µl of Sevag (chloroform-isoamyl alcohol 96:4), centrifugation at 13 000 rpm at room temperature of the collected aqueous steps (repeated twice). DNA was precipitated by incubating with 2/3 100% EtOH-3M NaOAc (25:1) at -20°C for 24 hours, then centrifuged for 2 min at 13 000 rpm at 4°C. The DNA pellet was washed with 70% EtOH, centrifuged at 13 000 rpm for 5 min, air dried in the dark and finally re-suspend in 50 µl TE.

Three chloroplast regions, *psbA-trnH*, *trnL-F*, *rbcL* and one nuclear region *ITS* (Table 5.1) were amplified using either direct PCR (Finnzymes Direct PCR kit) or iProof^{TM} High-Fidelity DNA Polymerase (Bio-Rad Laboratories, CA) according to the manufacturer's protocol. iProof GC buffer (Bio-Rad) was used when nuclear phylogenetic gene (*ITS*) amplification with HF buffer (Bio-Rad) did not provide satisfactory results. A final concentration of 5% DMSO was added in 20 µl PCR reaction (except for the *rbcL* region). For the direct PCR, DNA amplicons were amplified immediately after harvesting of leaves or receiving of the seeds. In few cases direct PCR was done on dry leaves or on fresh leaves stored at -20°C.

The PCR amplifications were performed using a G storm PCR system 9700 (Perkin-Elmer) with the following thermal cycle conditions unless stated otherwise: DNA was initially denatured at 98°C for 5 min followed by 35 cycles at 98°C for 10 seconds, primer annealing at 55°C for 10 seconds excluding the nuclear region (*ITS*), and elongation at 72°C for 30 seconds with a final 1 min elongation at 72°C. Reaction conditions for the whole *ITS* region (*ITS*1, 5.8S rDNA, *ITS*2), were as follows, one cycle at 98°C for 5 min; 35 cycles at 98°C for 10 seconds, 52°C for 30 seconds; 72°C for 30 min, and one cycle at 72°C for 7 min. The PCR fragment lengths were determined on a 1% agarose gel (see Fig. 5.1)

5.3.3. *DNA sequencing*

PCR products were sequenced directly after 1:5 diluting with dH_2O. Amplified regions were sequenced in both directions with an automated sequencer 3730 Genetic Analyser Applied Biosystems v1.1/3.1 Cycle Sequencing Kit, according to the protocol provided with few modifications. Briefly: the component and volumes for the sequencing PCR reactions were: 1 µl of 5x sequencing buffer, 0.5 µl premix (Applied Biosystems, Life technologies), 3 µl of 10 µM primer, 3 µl dH_2O, 5% DMSO and 2 µl PCR product were used. For the internal transcribed spacer (*ITS*1, 5.8S rDNA, *IT*S2) the premix was adjusted to 1 µl due to high GC content. The final PCR reaction was set up to 10 µl. The same primers where used for sequencing except for *trnL-F,* where nested *trnL-F* primers (Table 5.1) were used. Cycle sequencing steps were as follows: initial denaturation at 96°C for 1 min, following by 25x cycles of 96°C for 10 seconds (with a ramp seed of $3°Cs^{-1}$), 48°C for 15 seconds, 60°C for 4 min; 72°C for 1 min.

Table 5.1: Nucleotide sequence data of the universal primers used for the amplification of *ITS2, rbcL* and *psbA-trnH* and the *trnL-F* regions.

Region	primer name	Primer sequence 5'– 3'	Taxonomic group	References
ITS	*ITS* 5	TCGTAACAAGGTTTCCGTAGGTG	Fungi	White *et al*. 1990
	ITS 4	TCCTCCGCTTATTGATATGC	Fungi	White *et al*. 1990
psbA-trnH	*psbA3_f*	GTTATGCATGAACGTAATGCTC	Vascular plants	Tate & Simpson 2003
	trnHf_05	CGCGCATGGTGGATTCACAATCC	Vascular plants	Sang *et al*. 1997
trnL-F	*trnL-F* c	CGAAATCGGTAGACGCTACG	Vascular plants	Pfosser & Speta 1999
	trnL-F f	ATTTGAACTGGTGACACGAG	Vascular plants	Pfosser & Speta 1999
Sequencing primers	PS1	CTACGGACTTAATTGGATTGAGC	Vascular plants	Pfosser & Speta 1999[#]
	PS4	AGGATTTTCAGTCCTCTGCTC	Vascular plants	Pfosser & Speta 1999[#]
rbcL	*rbcLa*-F	ATGTCACCACAAACAGAGACTAAAGC	Vascular plants	Levin 2003
	rbcLa-R	GTAAAATCAAGTCCACCRCG	Vascular plants	Kress & Erickson 2007

[#] *trnL-F nested primers*

Cleanup

Extension products were adjusted to 20 µl by adding 10 µl of dH_2O, precipitated with 5 µl of 125 mM EDTA, and 60 µl of absolute EtOH for 15 min and centrifuged for 15 min at 20 000 g. For pellet purification, 60 µl of 70% EtOH was added after removal of supernatant, centrifuged for 5 min at 20 000 g at 4^oC. Tubes were then dried at 55^oC for 5 min.

5.3.4. *Sequence alignment and data analysis*

The data sequences of *rbcL*, *trnL-F*, *psbA-trnH* and the *ITS* region were aligned using Molecular Evolutionary Genetics Analysis (MEGA) 6.0.1 (www.megasoftware.net), followed by manual adjustment and trimming at the ambiguous ends using Geneious 6.1.5 (Biomatters, Ltd., ttp://www.geneious.com) using the default alignment parameters. The post-trimmed lengths were at least 80% of the original read length. Sequences which covered more than 70% overlap between the forward and reverse sequences were considered. No data sequence was submitted online (NCBI).

Additional sequence data of *trnL-F, rbcL*, *ITS*2 and *psbA-trnH* were obtained from Spies (2004), and from Genbank (http://www.ncbi.nlm.nih.gov/Genbank) (Table 5.2). Firstly, they were converted into Nexus format, then into Mega format using MEGA 6.0.1. After readjusting and editing the data was aligned and assembled in Geneious 6.1.5. Finally all the datasets were aligned and adjusted by eye on Geneious 6.1.5.

Table 5.2: List of additional accession retrieved directly from GenBank with their GenBank ID numbers.

Species	**Accession Name**
ITS	
Lachenalia algoensis	AB304971.1
Lachenalia flava	AB304975.1
Lachenalia arbuthnotiae	AB304978.1
Lachenalia bachmannii	AB304979.1
Lachenalia carnosa	AB439269.1
Lachenalia congesta	AB625560.1
Lachenalia hirta	AB439272.1
Lachenalia unicolor	AB439277.1
Lachenalia juncifolia	AB304983.1
Lachenalia latifolia	AB304984.1
Lachenalia latimerae	AB304985.1
Lachenalia liliflora	AB304986.1
Lachenalia longituba	AB305011.1
Lachenalia orchioides var. orchioides	AB304992.1
Lachenalia paucifolia	AB305012.1
Lachenalia peersii	AB304994.1
Lachenalia pusilla	AB3044996.1
Lachenalia zeyheri	AB305004.1
Lachenalia variegata	AB305005.1

Lachenalia viridiflora	AB305006.1
Massonia depressa	AB305007.1
rbcL	
Lachenalia orchioides	AM234989.1
trnL-F	
Lachenalia sp	AJ507984.1
Massonia depressa	AJ507980.1
Veltheimia bracteata	JX090593.1
Gloriosa superba	EU044686.1
psbA-trnH	
Gloriosa superba	DQ088321.1

5.3.5. *Phylogenetic analysis*

Phylogenetic analyses were performed using three character-based methods: maximum parsimony (MP), maximum likelihood (ML) and Bayesian Inference (BI) and one distance method: Neighbour Joining (NJ). BI analysis was performed using MrBayes v.3.1.2 (Ronquist & Huelsenbeck 2003) plugin for Geneious. ML and MP were carried out using MEGA 6.0.1 (Tamura *et al*. 2013). NJ analyses were perfumed using Geneious Builder. All the characters were equally weighed and unordered. A sequence of *Gloriosa superba* was included as outgroup.

Phylogenetic reconstructions were done on the combined and separate datasets of the *psbA-trnH*, *trnL-F*, *rbcL* and *ITS* gene regions. Indels were coded using DnaSP 5.10.1 (Rozas 2009). The indel option was selected to be model 3: tetra-allelic. Sites with overlapping indels were excluded as well as site with missing data was excluded. Non-tree evolutionary relationships (phylogenetic networks) were determined using SplitsTree 4.13.1, NJ tree and

NeighbortNet networks (Huson & Bryant 2006). Incongruence was determined by eye comparison and by Dendroscope 3.2.9.

5.4. Results

DNA was extracted from 125 specimens representing 97 ingroup species and 10 outgroup species for all the multiple phylogenetic gene markers. All the taxa were represented by one specimen except for *L. unifolia*, *L. mediana*, *L. mutabilis, L. bifolia, L. punctata, L. undulata, L. isopetala,* and *L. juncifolia*. One hundred and eleven specimens were successfully amplified for the *rbcL* gene marker, 109 for *trnL-F*, 105 for *ITS* and 97 for *psbA-trnH* gene marker. All the successful amplified gene regions were sequenced and about 101 for *rbcL*, 99 for *trnL-F*, 97 for *ITS* and 93 for *psbA-trnH* provided good results for phylogenetic analysis.

Estimated lengths for all the phylogenetic markers included in this study (*trnL-F, ITS, psbA-trnH and rbcL*) are shown in Figure 5.3. Although multiple attempts were made not all accessions were sequenced successful within the genus *Lachenalia*. Attempts to obtain sequences from difficult accessions were unsuccessful due to (1) poor amplification of older samples (direct PCR), (2) poor DNA quality and or (3) complexity of the species DNA composition. Appendix B lists all the accessions and genes where sequencing was unsuccessful. Due to time constraint DNA from the accessions listed in Appendix B was not cloned inorder to increase chances of obtaining their DNA sequences. Few sequences where obtained from NCBI gene bank and were included in this study (Table 5.2). Data characteristic of the single sequences plastid analysis, combined dataset of plastid (*rbcL* + *psbA-trnH* + *trnL-F*), nucleus analysis (*ITS*) and total combined dataset (nucleus-plastid) are summarized in Table 5.3.

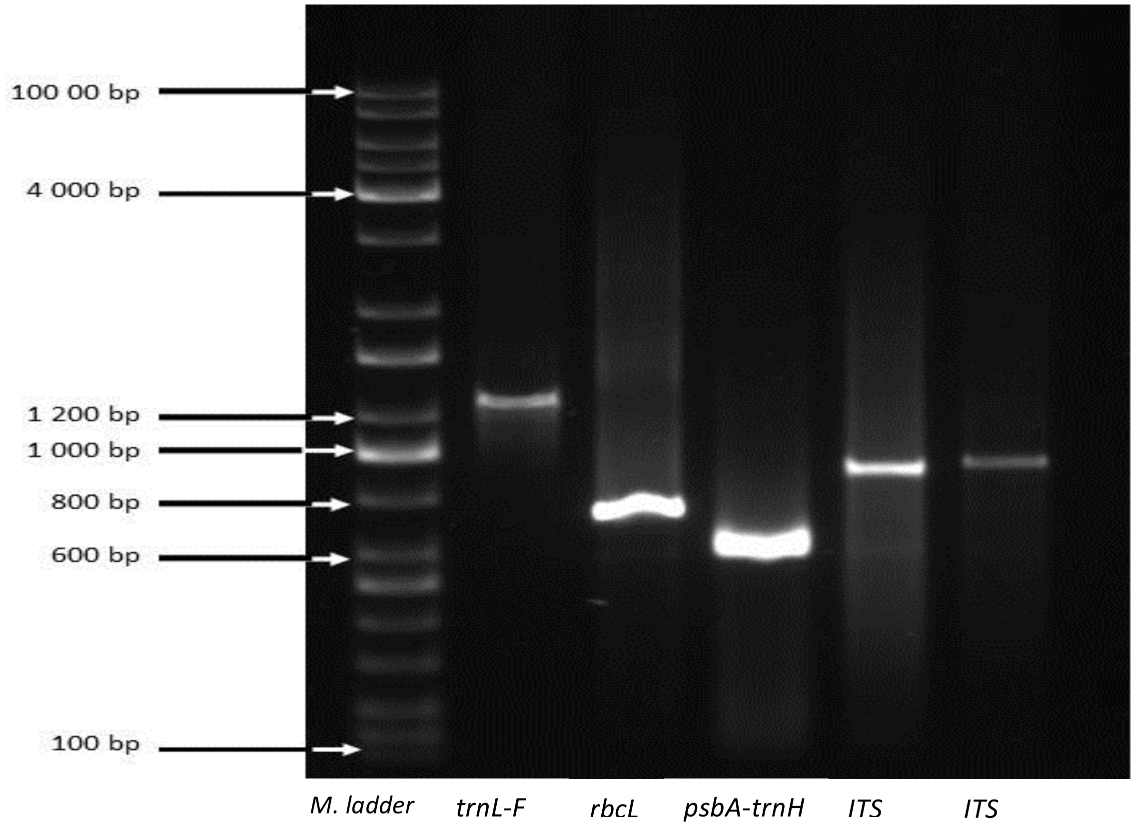

Figure 5.1. Estimated lengths of four phylogenetic genes (*trnL-F, ITS, psbA-trnH* and *rbcL*) ran for 1:30 min on 1% agarose gel. Each lane contains 6 µl of PCR products except for the faint bands, where 4 µl of PCR product was loaded. Molecular ladder was from KAPA Universal Ladder (KAPA Biosystems).

5.4.1. *Phylogenetic analysis of individual datasets*

5.4.1.1 *rbcL* dataset

The length of the unaligned *rbcL* sequences varied from 561 bp of *Eucomis pole-evansii* to 852 bp of *Lachenalia alba* (Table 5.3). The total length of aligned and trimmed *rbcL* sequences was 535 bp. The *rbcL* and *trnL-F* datasets have higher informative variation than other phylogenetic regions. However, when accessions *E. autumnalis*, *E. vandermerwei* and *Gloriosa superba* were excluded from the *rbcL* dataset, *rbcL* showed significant less informative variation (127 *rbcL* informative variation decreases to 56 when *E. autumnalis*, *E. vandermerwei* and *G. superba* were excluded). ML and BI had very low bootstrap values and a less resolved phylogenetic relationship of the *Lachenalia pusilla* group (*x = 9, 10, 13* plus *x = 7* and *8* species).

5.4.1.2. *psbA-trnH* dataset

Among the datasets analysed, *psbA-trnH* had a relatively constant length (forward and reverse), making the alignment easy and unambiguous. The lengths of unaligned sequences ranges from 531 bp of ingroup species to 703 bp in the outgroup species (Table 5.3). All the accessions showed almost constant conserved variation and only 3 outgroup accessions (*Veltheimia depressa*, *Eucomis autumnalis* and *Gloriosa superba*) were very variable. In addition theses three accessions were responsible for 40% of the variable characters. In comparison the *psbA-trnH* dataset had the lowest success rate of amplified DNA. Additionally, the *psbA-trnH* dataset had the lowest gap index (54) of all the phylogenetic genes.

Table 5.3. Summarised dataset Matrices used for phylogenetic inference. Combined dataset consists of concatenated *rbcL* + *trnH-psbA* + *trnL*-F (plastid) and plastid + *ITS* sequences. Sequences of combined datasets included coded indels.

	rbcL	*psbA-trnH*	*trnL-F*	*ITS*	Combined data set	
					Plastid	Plastid + ITS
Number of accessions	104	84	94	89	231	275
Range of length	561-852	531-703	582-685	609-809	531-852	531-852
Aligned length	535	584	675	179*	1867	2080
Variable characters (%)	220	78	324	59	324	1043
Conserved sites	292	76	298	114	298	858
Parsimony informative sites	127	28	223	21	223	403
Indels coded	92	54	88	38	88	101
Best-fitting model	K2	TN93+I	T92+G	T92+G	HKY+G	TN93+G

*Whole *ITS* region (*ITS*1, 5.8S rDNA, *ITS*2) amplified using *ITS*4 and *ITS*5 was restricted only to *ITS*2 region as most accessions showed better *ITS*2 region sequences within the whole *ITS region*.

5.4.1.3. *trnL-F* dataset

The final length of the unaligned and untrimmed *trnL-F* sequences ranged from 501 bp to 661 bp. Sequencing of the *trnL-F* spacer was done using nested primers (*PS3* and *PS4*) with annealing sites situated inside the *trnL-Fc* and *trnL-Ff* primer annealing sites*. trnL-F* had the highest number of variable characters and parsimony informative sites of 268 and 130 respectively. The evolutionary model was determined by MEGA 6.1 to be T92+G. The *trnL-F* dataset, had the highest parsimony informative sites of all the DNA regions included in this study.

5.4.1.4. *ITS* dataset

The summary statistics for the *IT*S dataset is presented in Table 5.3. Untrimmed *ITS* sequences ranged from 609 bp to 809 bp. However, the final *ITS* dataset was restricted only to *ITS*2 region, which is about 179 bp (Table 5.3). The restricted *ITS*2 dataset had a low number of variable characters of 59. In respect to the small *ITS* size the low number of variable characters could have been expected. The evolutionary model was tested to be T92 + G (Table 5.3).

5.4.2. Phylogenetic analysis of combined dataset

5.4.2.1. Combined plastid dataset

The combined plastid dataset included a total of 104 taxa, 1876 unambiguously aligned positions with 223 parsimony-informative characters. Species phylogenetic relationship was determined on the combined plastid dataset + indels. The combined plastid dataset + coded indels, yielded the most parsimonious tree with better supported trees than the individual plastid datasets or the non-coded indels combined plastid dataset. MP and ML of the combined dataset + indels showed tree topologies similar to the BI phylogeny (results not shown) and differed only in weakly supported clades. Additionally, the unrooted NJ tree and NeighbortNet networks (results not shown) show a similar species phylogenetic history to the MP and ML tree.

However, there is some incongruence between the plastids datasets. The most common congruence test, the Incongruence Length Difference (ILD) test also known as partition-homogeneity test (Ferris *et al.* 1994), implemented in PAUP and TNT were not executed, due to the lack of a license key (PAUP) or unsupported program format (TNT). However, ILD test can results in false positives for conflict (Sunllivan 1996; Reeves *et al*. 2001; Yoder *et al*. 2001; Pirie *et al*. 2009). Therefore, individual and combined dataset topologies were compared by eye (Pirie *et al*. 2009). None of the incongruence clades showed significances BS support as the majority of the nodes were all less than ≤ 50% and therefore all the plastids spacer were combined.

5.4.2.2. Combined plastid and nuclear (nuclear-plastid) dataset

Congruence analysis (by eye) and Tanglegram construction (conflict test) suggested some incongruence between the plastid and the *ITS* datasets (Fig. 5.2). Nonetheless, the *ITS* dataset was combined with plastid dataset due to variable reliability of incongruence test (Sunllivan 1996; Reeves *et al*. 2001; Yoder *et al*. 2001; Pirie *et al*. 2009). After all, none of the strongly supported clades were mutually incompatible (*x = 7*, *8* and *11*). The combined nuclear-plastid dataset consists of 2080 bp with 403 parsimony-informative sites. The combined nuclear-plastid dataset was similar to the tree topology generated from the combined plastid dataset but had relatively better resolution. Therefore, selected combined plastid-nucleus dataset (indels coded) were chosen to represent results and conclusion of this study. The evolutional model was determined to be TN93+G (Table 5.3). BI (results not showed), ML (Fig. 5.3) and MP (Fig. 5.4) showed similar species phylogenetically relationships differ slightly on tree topologies. Combined plastid + nucleus ML tree was selected to represent explicate the outcomes of this paper. There is a correlation between groups in the treelike phylogenetic species relationship, ML and the NJ networks phylogenetic relationships (Fig 5.5).

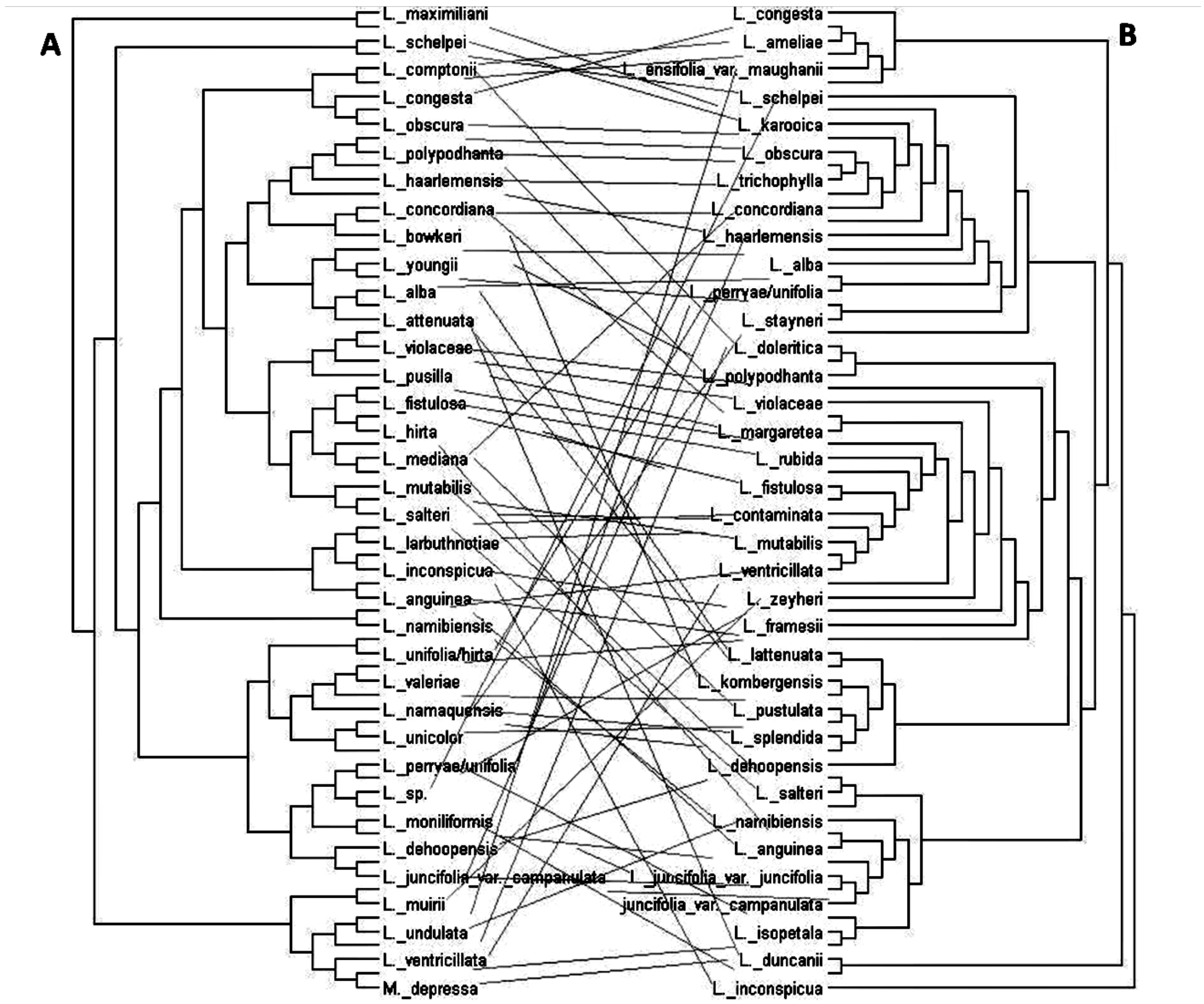

Figure. 5.2: Tanglegram of two BI trees from A, plastid *trnL-F* region and B, nuclear *ITS*2 region. Incongruence between nucleus-plastid dataset is as a result of polytomies generated due to the possibility of hybridization and or autopolyploid speciation. For visual purposes, Tanglegram results were compressed, therefore not all the clades/nodes can be seen. Phylogenetic relationship tree constructed using MrBayes v.3.1.2 plugin for Geneious. Graph generated using Dendroscope 3.2.1 (Huson & Linz 2012).

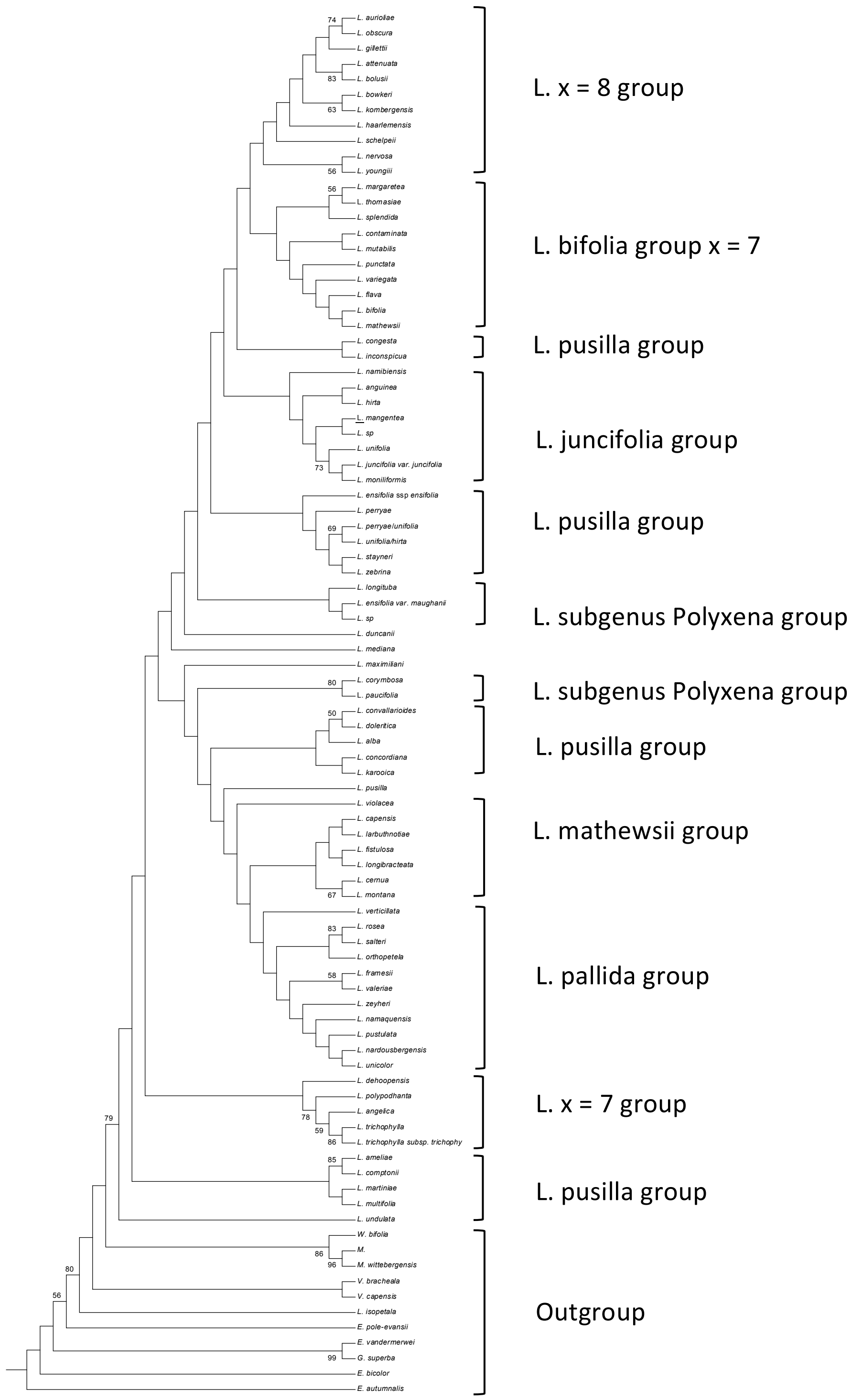

Figure 5.3. Maximum-likelihood estimate of the phylogenetic relationship of *Lachenalia* species based on the combined dataset of plastids (*rbcL* + *trnL*-F + *psbA*-*trnH*) and nucleus (*ITS*). For clarity purpose, multiple accessions from species show to be exclusive lineages were excluded from the tree. Bootstrap supports for clades >50% is given above branches. ***L. bifolia***, *x = 7*, ***L. juncifolia***, *x = 11*, ***L. mathewsii***, *x = 7*, ***Outgroup***, closely related taxa, ***L.* subgenus *Polyxena***, *x = 12, 13, 14*; **L. pusilla**, *x = 7, 8, 9, 10, 13*.

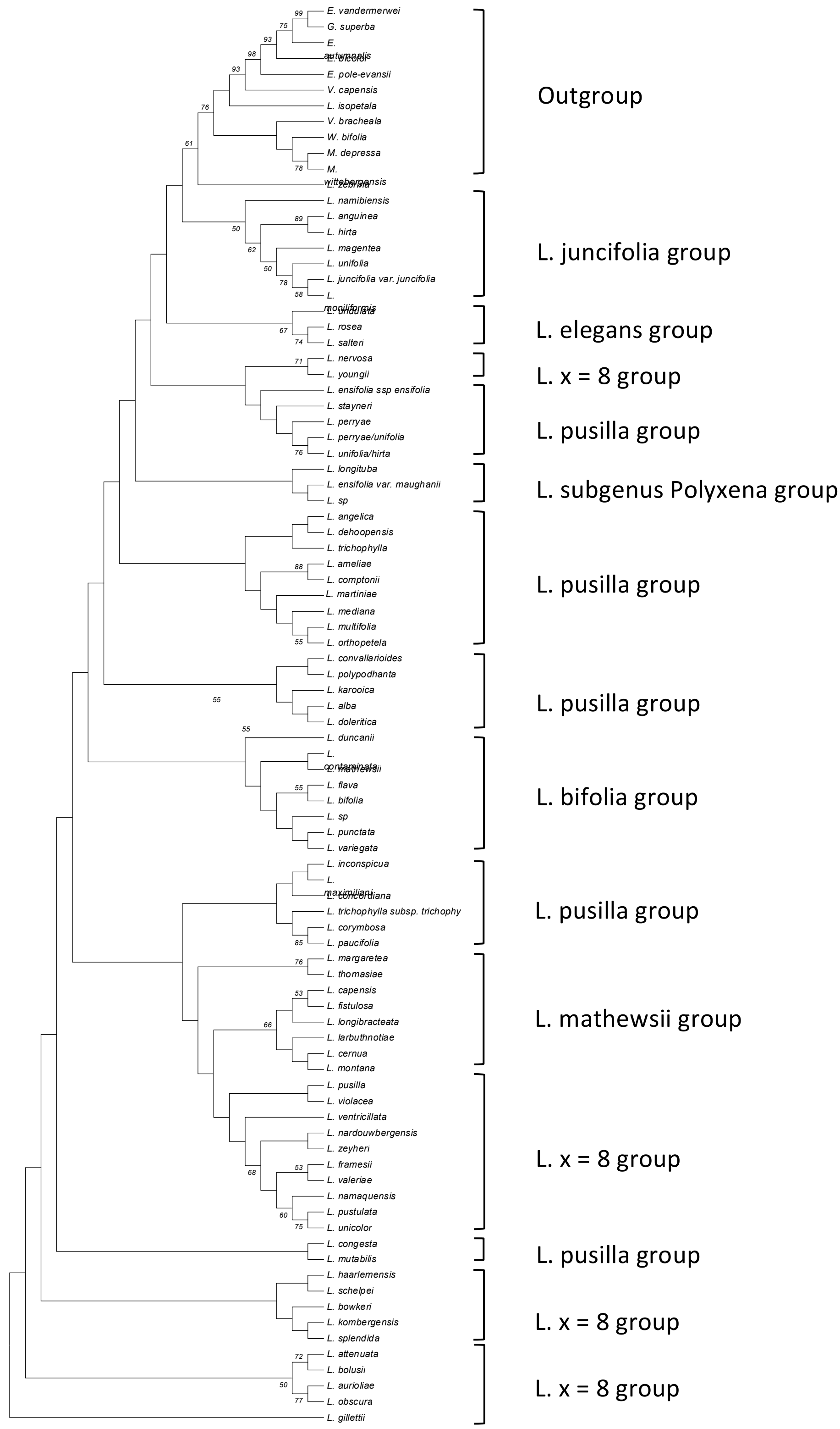

Figure 5.4. Maximum Parsimony estimate of the phylogenetic relationship of *Lachenalia* species based on the combined dataset of plastids (*rbcL* + *trnL-F* + *psbA-trnH*) and nucleus (*ITS*). For clarity purpose, multiple accessions from species show to be exclusive lineages were excluded from the tree. Bootstrap supports for clades >50% is given above branches. ***L. bifolia***, *x = 7*; ***L. elegans***, *x = 7*; ***L. juncifolia***, *x = 11*; ***L. mathewsii***, *x = 7*; **Outgroup**, closely related taxa; ***L. subgenus Polyxena***, *x = 12, 13, 14*; ***L. pusilla***, *x = 7, 8, 9, 10, 13*.

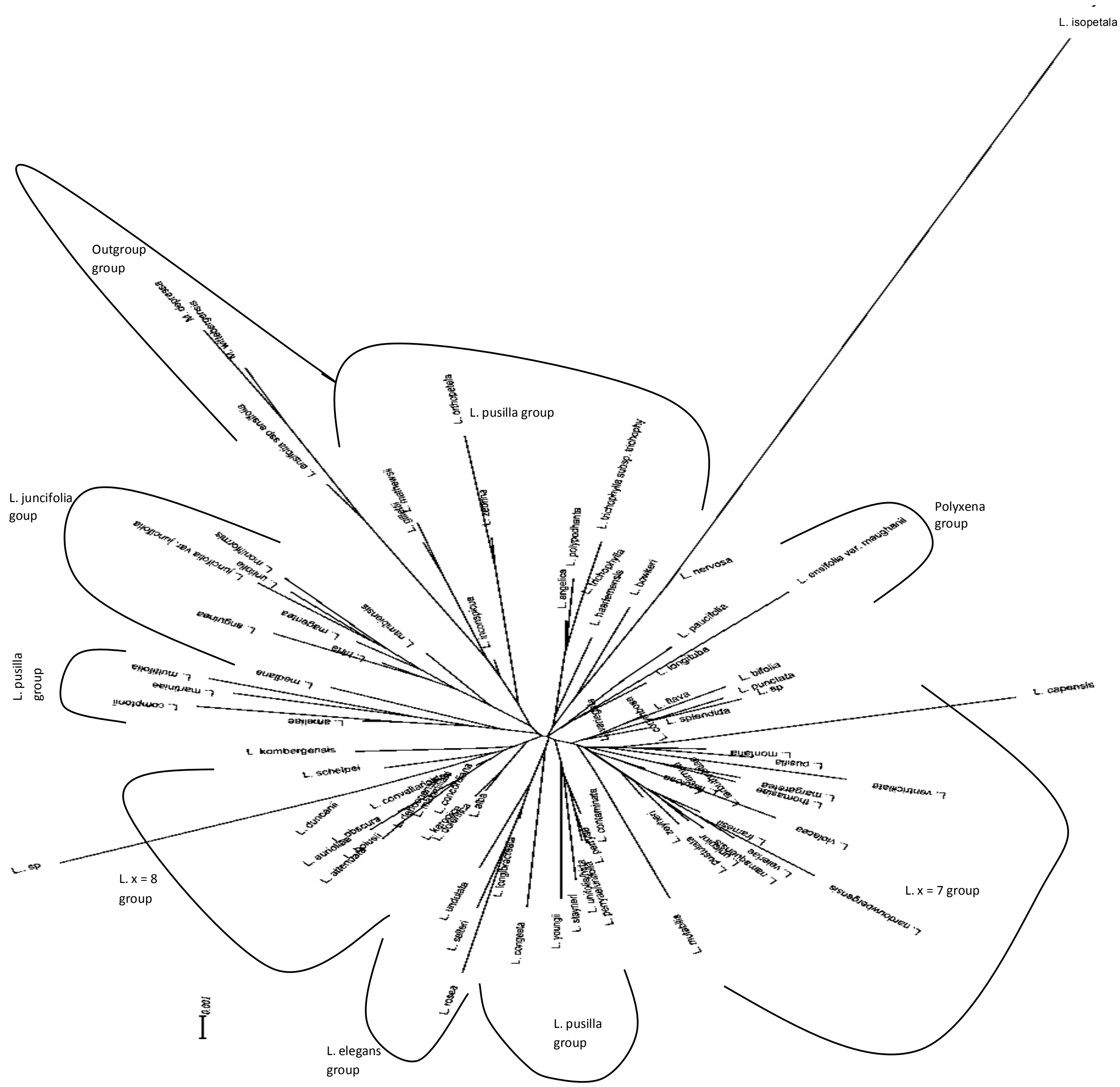

Figure 5.5. Unrooted Neighbor-Joining phylogeny network of *ITS* and combined plastids using uncorrected P distances (SplitTree4 v4.13.1) (Huson & Bryant 2006). Analysis was done on 80 *Lachenali*a accessions and two *Massonia* accessions (outgroup). Bootstrap supports analysis was excluded. ***L. elegans* group**, *x = 7*; ***L. juncifolia* group**, *x = 11*; **outgroup** = closely related taxa; ***L. pusilla* group**, *x = 7, 8, 9, 10* and *13;* ***L.* subgenus *Polyxena* group***.*

5.5. Discussion

A similar pattern as Spies (2004), emerged where species with similar chromosome numbers cluster together. The most distinct clades/ groups were *L. juncifoli*a group, *x = 11*, *L. pallida group*, *x = 8 and L. mathewsii* group *x = 7*. *Lachenalia elegans* group, x = 7 emerged on the MP cladogram and NJ networks. Other basic chromosome numbers *x = 9, 10*, *13* grouped together with some *x = 7* and/or 8 taxa, and formed polyphyletic clades. This resulted in an assumption that species that belong to *L. pusilla* group (*x = 7, 8, 9, 10* and *13*) have a hybrid origin from other *Lachenalia* species with different chromosome numbers.

Similar to previous studies (i.e. Hamatani *et al*. 2008), species with *x = 7* and *x = 8* were found to be sister clades. Nevertheless, some species of *x = 7* and *x = 8* ware scatted in almost all the clades beside the monophyletic clade of *x = 11* or formed several small clusters within the *Lachenalia* cladogram. Therefore someone can conclude that taxa with *x = 7* and *8* are polyphyletic groups on the large scale of analyses. Similar to group *x = 7* or *x = 8*, few species belonging to the clade *x = 11* ware also found in the other clades. Species miss identification might cause this polyphyletic relationship of the genus *Lachenalia*. Therefore the genus *Lachenalia* can be considered as a heterogeneous and highly polymorphic genus.

Observation and analysis of individual datasets or combined datasets (plastid and nuclear), did not clearly resolve all taxa. These gene regions are therefore not sufficient for species level phylogeny in the genus. Poor interspecific phylogenetic resolution suggested that there is high homoplasy within *Lachenalia* species in addition to their chromosomal number differences and morphological variation.

The homoplasy on the molecular level suggest a morphological plasticity due to (1) chromosome variation on the species level (*L. mutabilis x = 5, 6* and *7*), (2) geographical distribution (i.e. *L. bifolia*, Kleynhans & Spies 1999), (3) different species ploidy that may cause phenotypic variation on species level. Interspecific hybridization can significantly increase species homoplasy. Incongruence between datasets might be due to the ancient or recent hybridization within the genus (Fig. 5.2). Spies (2004), reported the possibility that the genus *Lachenalia* is a complex hybridization swarm with groups of *x = 7* and *x = 8* representing the primitive basic chromosome numbers.

Results indicated high homoplasy in the genus (Fig. 5.3, Fig. 5.4). Thus, the 50% consensus trees of ML, MP and BI could not well resolve the *Lachenalia* evolutional relationship. Spies (2004), used *trnL-F* (a molecular phylogenetic gene region proven to have high species phylogenetic relationship resolution) to determined phylogenetic relationship between *Lachenalia* species. The author determined a low CI index of 0.5308 within *Lachenalia* cladogram indication high homoplasy within the genus, thus suggesting that this genus is probably a hybrid swarm. This study further illustrates this hypothesis with SplitsTree Networks (Fig. 5.3).

Based on the phylogenetic analysis, species that belong to *L. pusilla* group might have a hybrid origin. The subgenus *Polyxena* group is a sister taxon to the hybrid clades (*Lachenalia pusilla* group) (Fig. 5.3; Fig. 5.4), however the statistic support of *L. Polyxena* group *and L. pusilla* group are very low to be considered accurate. SplitsTree Networks (Fig. 5.5) analysis on the combined dataset grouped the “*Polyxena* species” (species previously belonging to the genus *Polyxena*) together forming a monophyletic clade nested between the *L. pusilla* group and *Lachenalias* closest relative, the genus *Massonia*, thus supporting the inclusion suggested by Manning *et al*. (2004).

According to the results, DNA dataset alone cannot be used to draw a robust *Lachenalia* phylogenetic relationship. Spies (2004) suggested using multiple molecular makers to determine *Lachenalia* phylogenetic relationships. In this study multiple gene regions (three plastid and one nucleus genes) were used to determine *Lachenalia* phylogenetic relationships on species level. Results suggest that single molecular markers analysis is not useful to study phylogenetic relationships among *Lachenalia* species. Similar to single gene region analysis, multiple gene region analysis are not sufficient for species level phylogeny in the genus, due to a high level of incongruence between datasets. However, combined datasets produced better support for the clades but is not reliable (BS value are lower that 50%).

Morphological and physiological dataset has also been reported not to resolve phylogenetic relationships due to high level of homoplasy, and therefore, cannot results in robust cladogram either. Due to high chromosome variation, groupings in the genus *Lachenalia* based on chromosome karyotyping and chromosome counts result in a non-robust species classification. Therefore genomic *In Situ* hybridization studies (a tool to identify chromosomes of the parental species in hybrids studies, Chapter 4) is strongly recommended.

Neighbour-Joining network (Fig. 5.5) suggested a cluster of lachenalias with basic chromosome number of $x = 7$. Spies *et al*. (2009) and Hamatani *et al*. (2008; 2010) reported that species with basic chromosome number of $x = 7$ appear divided into sister clades within each other. Similar relationship within taxa with basic chromosome number of $x = 7$ (Fig. 5.5) was found susing NJ networks. Species with basic chromosome number $x = 9$, *10* and *13* forms paraphyletic clades. Taxa with basic chromosome number of $x = 11$ form a monophyletic clade. Neighbour-Joining network results were therefore consistent with that of ML and MP.

The evolutional original of species with *x = 11* needs to be investigated. Goldblatt *et al*. (2012), hypothesised that the tribe Massonieae possibly evolved from a *x = 10* ancestor and *Lachenalia* revolved from an ancestor of basic chromosomes *x = 9/10*. This may mean that taxa with *x = 9, 10, 11*, and subspecies *Polyxena* taxon are the basal taxa and an extensive descending dysploid series resulted in evolution of *x = 5, 6, 7* and *8* groups. Asexual reproduction via bulbils may have allowed low chromosome number species (group *x = 7* and *8*) to persist. The cross-ability between *x = 11* species is significant higher than crosses done on *x = 7* species (Appendix C). Could this imply that group *x = 11* species are basal species and are closest to the tribe Massonieae ancestry species (*x = 10*)?

The genus has a very complex chromosome constitution. The small chromosome within the genus supports the theory that *Lachenalia* is a more advanced genus (Spies 2004). Pfosser *et al*. (2003) reported that there is a remarkably decrease in size and weight of seeds in derived and advanced genera like *Whiteheadia, Massonia, Lachenalia,* etc. Basal taxa have brown to blackish-brown seeds and all advanced genera have black seeds (Pfosser & Speta 2003). The most advanced genus, genus *Lachenalia* is the perfect example of this correlation as it possesses both small and black seed.

Several species have more than one basic chromosome number i.e. *L. mutabilis*, *x = 5, 6* and *7* (Crosby 1986; Johnson & Brandham 1997; Spies *et al*. 2009). Few species i.e. *L. hirta* and *L. mediana* have a variable basic chromosome number and therefore no basic chromosome number can be determined, for example, *L. mediana* has a basic chromosome number of *x = 9* or *x = 13* (Crosby 1986; Johnson & Brandham 1997; Spies 2004);. These species therefore cannot be grouped based on chromosome number of that particular clade.

5.6. Conclusion

Species miss identification within the tribe Massonieae lead to a high polymorphic and heterogeneous genus. Polytomies can be solved by revisiting the classification of the species in order to determine accurate species inventory and delimitation. Nonetheless, based on chromosome analysis, the genus *Lachenalia* seem to be the most complex genus within the tribe Massonieae. Based on seed morphology, Pfosser *et al*. (2003) supported this conclusion. According to Goldblatt *et al*. (2012) the genus *Lachenalia* originated from an ancestral base of $x = 9/10$ ($n = 5$). This can mean that *Lachenalia* species with $x = 9$ and *10* are the most primitive and species with other basic chromosome numbers evolved by means of an extensive descending dysploid series (often, a very uncommon phenomenon in evolution).

Observations based on molecular systematics were largely similar to those of previous *Lachenalia* phylogenetic analysis. Thus species with basic chromosome number $x = 7$ and *8* are the most primitive species and other chromosomes evolved from them. In addition, subgenus *Polyxena*, *Lachenalia* $x = 9$, *10* and *13* and $x = 7$ and *8* species (*Lachenalia pusilla* group) appear to have evolved due to hybridization speciation with other *Lachenalia* species or with very closely related genera that belong to the tribe Massonieae (genus *Massonia*).

More studies are required to determine reticulate *Lachenalia* phylogenetic relationships and to determine the chromosome evolution of the tribe Massonieae.

6. General Discussion

The morphological classification of *Lachenalia* has created taxonomic confusion, and there is no certain correlation between species chromosome number and molecular systematic when all species within then genus are analyzed. Spies (2004), hypothesised that the genus *Lachenalia* is a possible hybrid swarm. Thus, the presence of natural hybrid species further complicates the phylogenetic relationship of the genus. Nonetheless, different studies suggested similar results regarding the phylogenetic relationship within the genus *Lachenalia*.

In this study similar results of polytomy existence of some species with basic chromosome number $x = 9, 10$ and 13, and few species with $x = 7$, $x = 8$ and 11 were observed. Similar to a study done on species diversity and reticulate evolution in the *Aspenium normale* complex (Aspleniaceae) in China and adjacent areas (Chang *et al*. 2013), significant incongruence of *Lachenalia* individual plastid and nucleus-plastid phylogenetic (Fig. 6.1) results may support reticulate speciation in the genus *Lachenalia*. Chromosome rearrangement (i.e. dysploidy*, L. latimerae* (Kleynhans *et al*. 2012)), polyploidization and hybridization are the key evolutionary processes in the genus.

It is unlikely that polyploidy acted alone forming autopolyploid species, and the more likely speciation event might be due to hybridization-polyploidization producing allopolyploids species. If the concept of allopolyploidy is correct, then *Lachenalia* subspecies (*Polyxena* species) may have risen from hybridization between the genera *Lachenalia* and *Massonia* soon followed by polyploidization. ML (Fig. 5.3) and MP (Fig. 5.4) trees suggest a possible multiple origin of the *Polyxena* species from a common ancestor with the *Lachenalia* species as it do not form a monophyletic clade, (rather group with other *Lachenalia* species). The other speciation scenario of the subgenus *Polyxena* (which could also account for the high morphological variation within the genus) is then hybridization of *Lachenalia* polyploids with different basic chromosome numbers forming new morphological variable species distinct from their parental species.

Interspecific hybridization ensures extensive morphological and chromosomal variation and plays a significant role in plant species diversification (Moraes *et al*. 2013). In spite of rarity per individual basis, natural hybridization is often common per species basis (Mallet 2005). The evolutional importance of natural hybridization is the ability to increase in ecological flexibility or colonization ability (Hegarty 2012). Therefore, taxonomic problems within *Lachenalia* are probably the results of hybridization and or autopolyploidization.

Available chromosome counts in the genus *Lachenalia* indicate that polyploidy is relatively high and common. Polyploidization in some cases has been associated with stress-survival mechanisms in plants. The deep maroon petal-inflorescence colour of *L. isopetala* ($2n = 40, n = 10$) species may be a stress response mechanism possessed by this species. Differences in chromosome number within species are not normally reflected in external morphology and morphological variation within species is more correlated with geographic distribution than with ploidy level (i.e. *L. bifolia*). This conclusion is based only on one single study of *L. bifolia* (Kleynhans & Spies 1999) and more studies will give a better insight.

Several authors have reported on the importance of structural and numerical chromosomal changes contributing to species adaptation (Otto 2007). Success of polyploid species is associated with adaptive plasticity, thus, the ability to colonise a wider range of habitats and to survive better in an unstable climate (Hahn *et al*. 2012). Therefore, polyploidization might not only contribute in *Lachenalia* speciation but may also have encoded advantageous survival characters (for instance, drought tolerance or pathogen resistance) that promote environmental shift of polyploid species into distinct ecological niche. The invasion of polyploids into isolated and colony selective location might have prevented gene flow enforcing population speciation. Song *et al*. (1995) stated that polyploidization can generate extensive genetic diversity in a short period of time. Therefore, polyploidization not only has a contribution to the survival success but a significant role in the diversification of many lachenalias (polyploid lineage).

Lachenalia unifolia and *L. hirta* (both with *x = 11*) differ mainly in regards to their hairiness. Van Rooyen *et al*. (2002), suggested that *L. unifolia* and *L. hirta* represent two subspecies of the same species rather than separate species. This gives an indication of phenotypic plasticity (the ability of the genotype to express different phenotypes depending on environmental conditions). Phenotypic plasticity is associated with environmental adaptation (Schlichting 1986; De Witt & Scheiner 2004) and invasiveness of species (Richards *et al*. 2006). *Lachenalia bifolia* is an appropriate example of *Lachenalia* phenotypic plasticity (Kleynhans *et al*. 1999). *Lachenalia* phenotypic plasticity may have resulted in miss identification and several unclear phylogenetical determinations. Thus giving the impression of most *Lachenalia* species are immediately descendent form their common ancestor or multiple speciation (polytomies) on the phylogenetic tree. The correlation between morphological variation in the genus *Lachenalia*, hybridization and polyploidization needs to be investigated. Is there any significant morphological variation and phenotypic plasticity with the increase in ploidy level?

Recombination of different genomes can also result in phenotypic diversity (Mallet 2005) and the origin of new hybrid taxa (Abbott 1992). Kleynhans *et al*. (2012) reported on the number of artificial inter-species crosses made at ARC over 35 years (Appendix C). As anticipated, hybridization among taxa with different ploidy levels resulted in high percentage of unsuccessful crosses. Even though the fertility of the 2.7% successful hybridization done among different ploidy level was not determined, it is expected that they have reduced fertility or some may have 0% fertility as different ploidy hybridization is often associated with hybrid sterility (Vallejo-Marin & Lye 2013). Like the hybrid, *Mimulus x robersii* (Vallejo-Marin & Lye 2013), in can be expected that sterile natural hybrids adapted through vegetative propagation resulting in population establishment.

The most dominant modes of speciation in *Lachenalia* are allopatric and ploidy changes (Duncan 2012). It is undoubtful that hybridization within species increase diversity and thus might results in speciation. The multivariate analysis using individual or the combined dataset did not clearly distinguish all the taxa from each other, indicating that *Lachenalia* species might have evolved due to ancient hybridization between the species in the subtribe Massonieae (genus *Massonia* and subgenus *Polyxena*) or they perhaps shared a recent common ancestor.

6.1. Conclusion

The most prominent basic chromosome number is $x = 7$ and $x = 8$ within the genus *Lachenalia*. The basic chromosome number has been determined in a substantial number of *Lachenalia* taxa (about 66.9% taxa with determined chromosome number). Chromosome counts and karyotype studies have been done on one or more specimens from one population.

The basic chromosome number *x = 8* might have evolved from *x = 7* soon after it evolved through gained aneuploidy (Spies 2004). Often plants tend to gain or loose chromosomes in responses to stressful conditions. This can results in the numerical chromosome complex. *Lachenalia bifolia* for an example, has *2n = 14, 28, 42, 49* and *56* (Moffett 1936; Crosby 1986; Johnson & Brandham 1997; Hamatani *et al*. 1998; Kleynhans & Spies 1999; Spies *et al*. 2008). This phenomenon might enhance the feasibility of chromosomal crossover of nonhomologous recombination.

Combined molecular systematic and molecular cytogenetic studies (e.g. Spies 2004 & Hamatani *et al*. 2009 respectively) on *Lachenalia* suggested that: (1), taxa with the same basic chromosome number (*x*) are closely related (2), taxa with basic chromosome number of *x = 7* and *x = 8* are closely related to each other (3), *x = 7* group seems to form two clusters. Hamatani *et al*. (2009), concluded that *x = 7* taxa, have two ancestral origins and *x = 8* taxa has a single origin. Furthermiore, Hamatani *et al*. (2008, 2009) suggested that *x = 7* species evolved from one common ancestor, diverged soon thereafter into parallel species, and *x = 8* taxa evolved from *x = 7* species. Species with basic chromosome number of *2n = 14* (*x = 7*) and *2n = 16* (*x = 8*) are abundant.

7. Summary

The geophytic genus *Lachenalia* Jacq.f.ex Murray is the largest genus (consists about 133 species, Duncan (2012)) in the tribe Massonieae. It is the most complex and advanced genus within the tribe Massonieae (sub-family Hyacinthoideae) (Pfosser *et al*. 2003). This highly morphological and chromosomal variable genus, is endemic to the south-western winter rainfall regions of Southern Africa with few exceptions and has been recorded in the literature as early as the 17^{th} century (1787 Jacquin).

The genus *Lachenalia* has commercial value as a garden pot plant or for cut flowers. From as early as the 1990s, the ARC started a breeding programme with the aims to improve and increase the international market potential of this plant. There is a correlation between species' basic chromosome number, molecular systematics and cross-ability, thus (1) based on molecular systematics, species with the same basic chromosome number group together on the phylogenetic tree and (2) species in the same group have higher cross-ability.

Several authors revised the classification and grouping of *Lachenalia* species. However, the inventory of the species and species delimitation is not yet complete. Frequently, different species within the genus *Lachenalia* are treated under the same name (species can be mis-identified and then recognised as a different species, i.e., *L. pallida*) or one plant is distributed between different names (i.e. *L. pallida*). This error results in a highly heterogeneous and polymorphic genus that forms polymers or high homoplastic phylogenetic trees. Species with $x = 7$ are ancestral species from which other species evolved.

The evolutional relationship of *x = 9*, *10* and *13* species, plus *x = 7* and *8* prostrate and geoflora like species (*Lachenalia pusilla* group) was tested using molecular phylogenetic markers (*ITS*, *rbcL*, *trnL-F* and *psbA-trnH*). Species with *x = 7* (group x = 7)*, x = 8* (group x = 8)*, x = 11* (group x = 11) and subspecies *Polyxena* (*Polyxena* group) formed monophyletic clades. The majority species from the *Lachenalia pusilla* group are scattered between the other groups. The *Lachenalia pusilla* group may be a hybridization product of *Lachenalia* species with different basic numbers, and/or with their closest *Lachenalia* relative (possibly with the genus *Massonia*). Incongruence test performed on two BI trees of the plastid dataset (*trnL-F*) and nucleus dataset (*ITS*2) (Tanglegram) suggested a hybrid evolution of the *Lachenalia pusilla* group. Evolution of the *Lachenalia pusilla* group (species with *x = 9, 10* and *13*) plus certain *x = 7* and *x = 8* species by means of hybridization was also supported by reticulate analyse (NJ tree).

This study suggested a reticulate evolution of the *Lachenalia pusilla* group (*x = 9*, *10* and *13*) and few taxon with *x = 7* and *8*. Previous studies recommended multiple gene phylogenetic analysis for better *Lachenalia* species resolution. However, due to high incongruence between datasets, multiple gene analysis does not provide better answers for *Lachenalia* classification. Genomic *in situ* hybridization, reticulate analysis and other phylogenetic methods can results in better species delimitation of *Lachenalia*.

Keywords: basic chromosome number, GISH, incongruence test, *Lachenalia*, *Lachenalia pusilla* group, *Massonia*, phenotypic plasticity, phylogenetic relationship, reticulate evolution.

8. Opsomming

Die geofietiese genus *Lachenalia* Jacq.f.ex Murray is die grootste genus (bestaan uit ongeveer 133 spesies, Duncan (2012) in die stam Massonieae. Dit is die mees komplekse en gevorderde genus binne die stam Massonieae (Hyacinthoideae sub-familie) (Pfosser *et al*. 2003). Hierdie genus wat mofologiese en chromosomaal hoogs variërend is, is meestal endemies aan die suid-westerlike winterreënvalstreek van Suid-Afrika (met 'n paar uitsonderings) en is reeds vroeg (1787 Jacquin) in die literatuur aangeteken.

Die genus *Lachenalia* het kommersiële waarde as 'n tuin plant, pot plant of snyblomme. So vroeg as die 1990's het die ARC met 'n teelprogram begin met die doelwit om die plante te verbeter en die internasionale markpotensiaal van hierdie plant verhoog. Daar is 'n korrelasie tussen spesies se basiese chromosoomgetal, molekulêre sistematiek en kruis-vermoë, dus (1) spesies met dieselfde basiese chromosoomgetal groepeer saam op die filogenetiese boom (2) spesies in dieselfde groep het 'n hoë kruis-vermoë.

Verskeie outeurs het die klassifikasie en groepering van *Lachenalia* spesies hersien. Maar die indeling van die spesies en spesies afbakening is nog nie voltooi nie. Dikwels word verskillende spesies in die genus *Lachenalia* onder dieselfde naam beskryf (spesies kan verkeerdelik geïdentifiseer word en as ‘n verkeerde spesie benaam word soos in die geval van *L. pallida*). Hierdie problem het 'n hoogs heterogene en polimorfiese genus tot gevolg wat polimere of ‘n groot mate van homoplastiese filogenetiese bome tot gevolg het. Spesies met $x = 7$ is die voorvaderlike spesies waaruit ander spesies ontwikkel het.

Ons het met behulp van molekulêre filogenetiese merkers (*ITS*, *rbcL*, *trnL-F* en *psbA-trnH*) die evolusionêre verwantskap tussen spesies met *x = 9*, *10* en *13* getoets, insluitend spesies met *x = 7* en *8*, wat die uitgestrekte en laag-groeiende spesies (*Lachenalia pusilla* groep) bevat. Spesies met *x = 7* (groep x = 7), *x = 8* (groep x = 8), *x = 11* (groep x = 11) en subspesies *Polyxena* (*Polyxena* groep) het monofiletiese groepe gevorm. Die meerderheid spesies van die *Lachenalia pusilla* groep is tussen die ander groepe versprei. Dit wil voorkom of die *Polyxena* groep 'n gemengde produk tussen *Lachenalia* spesies en die naverwante genus (moontlik die genus *Massonia*) is. Die inkongruensietoets wat op twee BI bome van die plastied datastel (*trnL-F*) en kern datastel (*ITS2*) (Tanglegram) uitgevoer is, suggereer 'n moontlike baster evolusie van die *Lachenalia pusilla* groep. Evolusie van die *Lachenalia pusilla* groep (spesies met *x = 9, 10* en *13*) tesame met sekere *x = 7* en *x = 8* spesies, weens verbastering word ook deur die retikulasie-analise (NJ boom) ondersteun.

Hierdie studie suggereer dat daar retikulêre evolusie van die *Lachenalia pusilla* groep (*x = 9*, *10* en *13*) en 'n paar takson met *x = 7* en *8* plaasgevind het. Vorige studies stel voor dat veelvuldige gene vir die filogenetiese analise gebruik moet word om sodoende 'n beter resolusie vir die genus *Lachenalia* te verseker. Maar as gevolg van die hoë mate van onverenigbaarheid tussen datastelle, verskaf die analisering van veelvuldige gene nie beter antwoorde vir die klassifikasie van *Lachenalia* nie. Genomiese in situ verbastering, netwerk analise en ander filogenetiese metodes kan lei tot beter spesies afbakening van *Lachenalia*.

Sleutelwoorde: basiese chromosoomgetal, 'GISH', inkongruensietoets, *Lachenalia*, *Lachenalia pusilla* groep, *Massonia*, fenotipiese plastisiteit, filogenetiese verwantskappe, retikulêre evolusie.

9. References

Abbott R.J. (1992). Plant invasions, interspecific hybridization and evolution of new plants taxa. **Trends in Ecology & Evolution**. 7 (2): 401-405.

Ali, S.S., Yu, Y., Pfosser, M., and Wetschning, W. (2012). Inferences of biogeographical histories with subfamily Hyacinthoideae using S-DIVA and Bayesian binary MCMC analysis implemented in RASP (Reconstruct ancestral state in Phylogenies). **Annals of Botany**. 109: 95-107.

Angiosperm Phylogeny Group III. (2009). An update of the Angiosperm Phylogeny Group classification for the order and families of flowering plants: APG III. **Botanical Journal of the Linnean Society**. 161: 105-121.

Arnold, T.H., Prentice, C.A., Hawker, L.C., Snyman, E.E., Tomalin, M., Crouch, N.R., and Pottas-Bircher, C. (2002). Medicinal and Magical Plants of Southern Africa: an Annotated Checklist. **Strelitzia** 13. National Botanical Institute, Pretoria.

Baker, J.G. (1897). *Lachenalia* Jacq. In: W. T. Thistleton-Deyer, Ed., **Flora Capensis**. 6: 421-436.

Beattie, A.J. (1985). **The evolutionary ecology of ant– plant mutualisms**. Cambridge: Cambridge University Press.

Bester, C., Blomerus, L.M., and Kleynhans, R. (2009). Development of new floriculture crop in South Africa. **Acta Horticulturae**. 813: 67-72.

Bettink, A. (2009). **Yellow soldier (*Lachenalia reflexa*)**. Draft strategic control plan of the Swan NRM Region.

Bie, T. D., Cao, Y., and Chen, P. D. (2007). Mass production of intergeneric chromosomal translocations through Pollen irradiation of *Triticum durum-Haynaldia vilosa* amphiploid. **Journal of Integrative Plant Biology**. 49(7): 1080-1086

Boshoff, H. (2010). Data supplied from Futures Trust databank compiled from a) Comtrade/WTO data, b) SA Customs & Excise data, c) PPECB data. **Futures Trust**.

Bryan, J.E. (1989). **Bulbs**. II. Timber Press Inc. Portland, Oregon.

Burger, J.T., and von Wachmar, M.B. (1988). Rapid diagnosis of *Ornithogalum* and *Lachenalia* viruses in propagation stock. **Acta Horticulturae**. 234: 31-38.

Burger, J.T., and Von Wechmar, M.B. (1988). Rapid diagnosis of Ornithogalum and Lachenalia virus in propagation stock. **Acta Horticultura**e. 234: 31- 38.

Chang, Y., Li, J., Lu, S., and Schneider, H. (2013). Species diversity and reticulate evolution in the *Aspenium normale* complex (Aspleniaceae) in China and adjacent areas. **Taxon**. 62 (4): 673-687.

Chase, M.W., Soltis, D., Soltis, P., Rudall, P.J., Fay, M.F., Hahn, W.J., Sullivan, S., Joseph, J., Molvray, M., Kores, P.J., Givinish, T.J., Sytsma, K.J., Pires, J.C. (2000). Higher level systematics of the monocotyledons: an assessment of current knowledge and a new classification. In: Wilson KL, Morrison DA (eds) Monocots: Systematics and Evolution. **CSIRO Melbourne**. 3–16

Chester, M., Leitch, A.R., Soltis, P.S., and Soltis D.E. (2010). Review of the application of modern cytogenetic methods (FISH/GISH) to the study of reticulation (polyploidy/hybridisation). **Genes**. 2010: 1: 166-192.

Coertze, A.F., Hancke, F.L., Louw, E., and Niederwieser, J.G. (1992). A review of hybridization and other research on *Lachenalia* in South Africa. **Acta Horticulture** 325: 605-609.

Crosby, T.S. (1986). The genus *Lachenalia*. **The Plantsman**. 8: 129–166.

De Hertogh, A. and Le Nard M. (1993). **The physiology of flower bulbs**. Elsevier Science Publishers. Netherlands.

De Wet, J.M.J. (1957). Chromosome numbers in the Scilleae. **Cytologia**. 145-159.

De Witt, T.J., and Scheiner, S.M. (2004). **Phenotypic Plasticity: Functional and Conceptual Approaches**. Oxford University Press. New York.

Devi, J. Ko, J.M., and Seo. B.B. (2004). FISH and GISH: Modern cytogenetic techniques. **Indian Journal of Biotechnology**. (4): 307-315.

Doyle, J.J. & Doyle, J.L. (1990). Isolation of plant DNA from fresh tissue. **Focus**. 12: 13–15.

Doyle, J.J., and Doyle, J.L. (1987). A rapid DNA isolation procedure for small quantities of fresh leaf tissue. **Phytochemical Bulletin**. 19: 11115.

Du Plessis, N.M., and Duncan, G.D. (1989). *Lachenalia*. **Bulbous Plant of Southern Africa**. 78-82

Du Preez, J.L., Spies, J.J. and Kleynhans, R. (2002). A preliminary study of interspecific hybrids in *Lachenalia* (Hyacinthaceae). **Acta Horticulturae.** 570:319-325.

Du Toit, E.S. (2002). Temperature effects on bulb growth and inflorescence development of *Lachenalia* cv. Ronina. Ph.D. (Agric) Dissertation. University of Pretoria, Pretoria, South Africa.

Du Toit, E.S., Robbertse, P.J. and Niederwieser, J.G. (2002). Effects of growth and storage temperature on *Lachenalia* cv. Ronina bulb morphology. **Scientia Horticulturae**. 94: 117-123.

Du Toit, E.S., Robbertse, P.J. and Niederwieser, J.G. (2004a). Plant carbohydrate partitioning of *Lachenalia* cv Ronina during bulb production. **Scientia Horticulturae**. 102: 433-440.

Du Toit, E.S., Robbertse, P.J. and Niederwieser, J.G. (2004b). Temperature regime during bulb production affecting foliage and flower quality of *Lachenalia* cv. Ronina pot plants. **Scientia Horticulturae**. 102: 441-448.

Duncan G.D. (1992). The genus *Lachenalia*: its distribution, conservation status and taxonomy. **Acta Horticulture**. 325, 843–845.

Duncan G.D. (1999). Note on some rare and newly published species of Lachenalia from South Africa and Namibia. **Hebertia**. 54: 171-179.

Duncan G.D. (2003). Endangered geophytes of the Cape Floral Kingdom. **Curtis's Botanical Magazine**. 20 (4): 245-250.

Duncan G.D. (2005). Character variation and a cladistics analysis of the genus *Lachenalia* Jacq.f. ex Murray (Hyacinthaceae: Massonieae). M.Sc thesis, University of KwaZulu Natal.

Duncan G.D. and Edwards, T.J. (2006). Notes on African plants. Hyacinthaceae: Massonieae. A new species of Lachenalia from Namaqualand, South Africa. **Bothalia**. 32 (2): 190-192.

Duncan, G.D., Edwards, T.J., and Mitchell, A. (2005). Character variation and a cladistics analysis of the genus *Lachenalia* Jacq. F. ex Murray (Hyacinthaceae). **Acta Horticulturae**. 673: 113- 120.

Duncan, G.D. (1988). The *Lachenalia* Handbook. **Annals of Kirstenbosch Botanic Gardens**. 17. National Botanical institute. Cape Town.

Duncan, G.D. (1996). Four new species and new subspecies of Lachenalia (Hyacinthaceae) from arid area of South Africa. **Bothalia**. 26 (1): 1-9.

Duncan, G.D. (1998). Notes on the genus *Lachenalia*. **Herbertia** 53: 40-48

Duncan, G.D. (2010). **Grow Bulbs**. Kirstenbosch Gardening series. South Africa National Biodiversity Institution, Cape Town.

Duncan, G.D. (2012). **The genus *Lachenalia***. Royal Botanic Gardens. Kew. UK.

Duncan, G.D., and Smith, L. C. (1999). *Lachenalia nervosa*. **Flowering Plants of Africa**. 56: 18-23.

Duncan, G.D., Edward, T.J., and Mitchell, A. (2005). Character variation and a cladistic analysis of the genus *Lachenalia* Jacq. f. ex Murray (*Hyacinthaceae*). **Acta Horticulturae**. 673: 113-120.

Edwards, D., and Leistner, O.A. (1971). A degree of reference system for citing biological records in southern Africa. **Mitteilugen aus der Botanischen Staatssammlung München**. 10: 501-509.

Engelbrecht, G.M., du Preez, C.C., and Spies, J.J. (2010). Response of Lachenalia growing in soil to interactions between nitrogen and phosphorus fertilisation in the nursery phase. **South African Journal of Plant and Soil**. 27 (3): 221-228.

Engelbrecht, G.M., Preez, C.C., and Du Spies J.J. (2008). Response of *Lachenalia* growing in soil to nitrogen fertilisation during the pot plant phase. **South African Journal Plant Soil**. 25(2): 92-98.

Faegri, K., and van de Pijl, L. (1979). **The principle of pollination Ecology**. Pergamon Press. Oxford.

Fernandes, A., and Neves, J.B. (1962). Sur la caryologie de quelques monocotyledons africaines. Compt. Rend. De la IV-e Reunion Pleniere de l'Association pour l'Etude Taxinomique de la Flora d'Afrique Tropicale, **Lisboa**. 439-463.

Ferris, J.S., Källersjö, M., Kluge, A.G., and Blut, C. (1994). Testing significance of incongruence. **Cladistics.** 10: 315-319.

Fredotovic, Ž., Šamanic, I., Weiss-Schneeweiss, H., Kamenjarin, J., Jang, T.S., and Puizina, J. (2014). Triparental origin of triploid onion, *Allium* x *cornutum* (Clementi ex Visiani, 1842), as evidenced by molecular, phylogenetic and cytogenetic analysis. **BMC Plant Biology**. 14- 24

Garrido, J.L., Rey, P.J., and Herrera, C.M. (2009). Influence of elaiosome on postdispersal dynamics of ant-dispersal plant. **Acta Oecologica**. 35: 393-399.

Goldblatt, P., Manning, J.C., and Forest, F. (2012). A review of chromosome cytology in Hyacinthaceae subfamilies Urginoideae and Hyacinthoideae (tribe Hyacintheae, Massoniea, Pseudoprospereae) in sub-Saharan Africa. **South African journal of Botany**. 83: 134-144.

Grace, O.M., and Van Staden, J. (2003). A horticultural History of *Lachenalia* (Hyacinthaceae). **South African Journal of Science**: 99: 526-531.

Hahn, M.A., van Kleunen, M., and Müler-Schärer. (2012). Increased phenotypic plasticity to climate may have boosted the invasion success of polyploid *Centaurea atoebe*. **PLoS ONE**. 7 (11): e50284. Doi:10.1371/journal.pone.0050284.

Halder, J., Rai, A.B., and Kodandaram, M.H. (2013). Compatibility of Neem Oil and different entomopathogens for management of major vegetable sucking pests. **National Academy Science Letters**. 36(1): 19-25.

Hamatani, S., Hashimoto, K. and Kondo, K. (1998). A comparison of somatic chromosomes at metaphase in *Lachenalia* (*Liliaceae*). **Chromosome Science**. 2: 21-25.

Hamatani, S., Ishida, G., Hashimoto, K. and Kondo, K. (2004). A chromosome study of ten species of *Lachenalia* (*Liliaceae*). **Chromosome Science.** 8: 55-62.

Hamatani, S., Kondo, K., Kodaira E., and Ogawa, H. (2007). Chromosome morphology of 12 spies and one variety of *Lachenalia* and five closely related, allied genera (*Liliaceae*). **Chromosome Botany**. 2: 79-86.

Hamatani, S., Masuda, Y., Kondo, K., Kodaira E., and Ogawa, H. (2008). Molecular phylogenetic relationships among *Lachenalia, Massonia* and *Polyxena* (*Liliaceae*) on the basic of the internal transcribed spacer (ITS) region. **Chromosome Botany.** 3: 65-72.

Hamatani, S., Masuda, Y., Uchida, M., Tagashira, N., Kusaba, M., and Kondo, K., (2012). Molecular cytogenetical and phylogenetical studies of *Lachenalia congesta* (Asparagaceae). **Chromosome Botany.** 7: 47-52.

Hamatani, S., Tagashira, N. and Kondo, K. (2010). Molecular cytogenetic analysis in seven species of *Lachenalia* (Liliaceae) with the chromosome numbers of 2n=18, 22, 23, 26 and 28 by DAPI staining and FISH using 5S rDNA and 18S rDNA probes. **Chromosome Botany**. 5: 55-59.

Hamatani, S., Tagashira, N., Ishida, G., and Kondo, K. (2009). Chromosome relationships among 13 species and one variety of *Lachenalia* (*Liliaceae*) with the chromosome number of 2n= 14 and 16 detected by FISH using 5S rDNA and 18 rDNA probes and DAPI staining. **Chromosome Botany**. 4: 57-63.

Hancke, F.L. and Liebenberg, H. (1990). B-chromosomes in some *Lachenalia* species and hybrids. **South African Journal of Botany.** 56: 659-664.

Hancke, F.L. and Liebenberg, H. (1998). Meiotic studies of interspecific *Lachenalia* hybrids and their parents. **South African Journal of Botany.** 64: 250-255.

Hancke, F.L., Liebenberg, H., and van Rensburg, J.W. (2001). Chromosome associations of three interspecific, dibasic Lachenalia hybrids. **South African Journal of Botany**. 67: 193–198.

Horst, R.K. (1988). Production of plants free of virus and prevention of reinfection. **Acta Horticulturae**. 234: 393-402.

Huson, D.H. and Linz, S. (2012). **Computing minimum hybridization networks from real phylogenetic trees**, submitted.

Huson, D.H., and Bryant, D. (2006). Application of phylogenetic networks in evolutionary studies. **Molecular Biology and Evolution.** 23(2): 254-267

Johnson, M.A.T., and Brandham, P.E. (1997). New chromosome numbers in petaloid monocotyledons and in other miscellaneous angiosperms. **Kew Bulletin**. 52: 121-138.

Johnson, S., Pauw, A., Midgley, J. (2001). Of mice and massonias. **Veld and Flora**. 87: 166–167.

Journet, D. (2003). Growing and enjoying *Lachenalia*. **Bulbs**. 5 (1); 24-33.

Kamenetsky, R. & Miller B. (2010). The global trade in Ornamental Geophytes. **Chronica Horticulturae**. 50 (4): 27-30.

Kapczńska, A. (2009). *Lachenalia*- breeding, culture and usage of a new ornamental bulbous plant. **Horticulture and Landscape Architecture**. 30: 5-10.

Kate, B., and Grazyna, P. (2011). Seed Dynamics of the Invasive Geophyte '*Lachenalia reflexa*' Thunb. in South-West Australia. **Plant Protection Quarterly**. 26 (2): 47-49.

Kirov, L., Divashuk, M., Laere, K.V., Soloviev, A., and Khrustaleva, L. (2014). An easy “SteamCrop” method for high quality plant chromosomes preparation. **Molecular Cytogenetics**. 7:

Kleynhans, R, Niederwieser, J.G., and Louw, E. (2009a). Temperature requirement for good quality *Lachenalia* pot plants. **Acta Horticulturae**. 813: 641-648.

Kleynhans, R. (1997). Genetic variation in *Lachenalia bulbifera.* Unpublished M. Sc. dissertation, University of the Free State.

Kleynhans, R. and Hancke, F.L. (2002). Problems and breeding strategies for development of new *Lachenalia* cultivars. **Acta Horticulturae**. 570: 233-240.

Kleynhans, R. (2006). *Lachenalia*, spp. p. 491-516. In: N.O. Anderson (ed.), **Flower Breeding & Genetics: Issues, Challenges, and Opportunities for the 21st Century**. Springer, Netherlands.

Kleynhans, R. (2011). Potential new lines in the *Hyacinthaceae*. **Acta Horticulturae**. 886: 130-146

Kleynhans, R. and Spies, J.J. (1999). Chromosome number and morphological variation in *Lachenalia bulbifera* (*Hyacinthaceae)*. **Southern Africa Botany.** 65 (5 &6): 357-360.

Kleynhans, R. and Spies, J.J. (2000). Evaluation of genetic variation in *Lachenalia bulbifera* (*Hyacinthaceae*) using RAPDs. **Euphytica.** 115: 141- 147.

Kleynhans, R. and Spies, J.J. (2011). Requirements for the development and breeding of new flower bulb crops. **Philosophical Transitions in Genetics**. 1: 80-101.

Kleynhans, R., and Spies, J.J. (1999). Chromosome number and morphological variation in *Lachenalia bulbifera* (Hyacinthaceae). **South Africa Journal of Botany**. 65: 357-360.

Kleynhans, R., Hancke, F.L., Louw, E., Oelofse, C.M., and Roodbol, F. (1995). Breeding and selection of *Lachenalia*. **Yearly Report**. 1994/95, ARC-Roodeplaat, Pretoria.

Kleynhans, R., Spies, J. J., and Spies, P. (2009b). Cross-ability in the genus *Lachenalia.* **Acta Horticulturae.** 813: 385- 392.

Kleynhans, R., Spies, P., and Spies, J.J. (2012). Cytogenetic and phylogenetic review of the genus *Lachenalia*. **Floriculture and Ornamental Biotechnology**. 6: 98-115.

Kodaira, E., and Fukai, S. (2005). Effect of temperature on flowering of *Lachenalia rubida* (Liliaceae). **Acta Horticulturae**. 673; 369-375.

Kono, Y., Hung, M.E., and Peng, C.I. (2012). Identification of genome constitution in Begonia x chungii and its putative parent, *B. longifolia* and *B. palmate*, by genomic *in situ* hybridization (GISH). **Plant Science**. (185-186): 156-160.

Kress, J., and Erickson, D.L. (2007). A two-locus global DNA barcode for land plants: the coding rbcL gene complements the non-coding *trnH-psbA* spacer region. **PLoS One**, 6:1-10.

Kumar, A. (2010). *In situ* Hybridization. **International Journal of Applied Biology and Pharmaceutical Technology**. 1 (2): 418- 430.

Langois, A., Mulholland, D.A., Duncan, G.D., Crouch, R.N., and Edwards, T.J. (2005). A novel 3-benzylchromone from the South Africa *Lachenalia rubida* (*Hyacinthaceae*). **Biochemical Systematics and Ecology**. 33: 961-996.

Lengyel, S., Gove, A., D., Latimer, A., M., Majer, J., D., and Dunn, R., R. (2010). Convergent evolution of seed dispersal by ants, and phylogeny and biogeography in flowering plants: A global survey. **Perspectives in Plant Ecology, Evolution and Systematics**. 12: 43–55.

Levin, R.A., Wagner, W.L., Hoch, P.C., and (2003). Family-level relationships of Onagraceae based on chloroplast *rbcL* and *ndhF* data. **American Journal of Botany**. 90: 107-115.

Li, W.H. (1997). Molecular evolution. pp 90-97, 99-147. Sinauer Associates, inc., Publishers.

Liu, L.Q., and Gu, J.Z. (2011). Genomic in situ hybridization identifies genome donors of *Camellia reculata* (*Theaceae*). **Plant Science**. 180: 554-559

Louw, C.A.M., Reginier, T.J.C., Korsten, L. (2002). Medicinal bulbous plants of South Africa and their traditional relevance in the control of infectious diseases. **Journal of Ethnopharmacology**. 82: 147-154.

Louw, E., (1991). The effect of temperature on inflorescence initiation and differentiation and development of *Lachenalia* cv. Romelia. M. Sc. (Agric) Dissertation. University of Pretoria. South Africa.

Lubbinge, J. (1980). *Lachenalia* breeding. I. Introduction. **Acta Horticulturae**. 109: 289-295.

Lysak, M.A., Koch, M.A., Pecinka, A., Schubert, I. (2006). Chromosome triplication found across the tribe *Brassiceae*. **Genome Research**. 15: 516-525.

Ma, Y., Islam-Faridi, M. N., Crane, .C.F., Stelly, D.M., Price, H.J., and Byrne, D.H. (1996). A new procedure to prepare slides of metaphase chromosomes of roses. **HortScience**. 31(5): 855-857.

Mallet, L. (2005). Hybridization as an invasion of the genome. **Trends in Ecology & Evolution**. 20 (50): 230- 237.

Manning, J., Goldblatt, P., and Snijman, D. (2002). **The color encyclopedia of Cape bulbs**. Timer Press. Portland/ Cambridge.

Manning, J.C., Goldblatt, P., and Fay, M.F., (2004). A revised generic synopsis of Hyacinthaceae in sub-Sahara Africa, based on molecular evidence, including new combinations and the new tribe Pseudoprosperae. **Edinburgh Journal of Botany**. 60: 533-568

Manning, J.C., Goldblatt, Parker, E., Kaiser, R. (2012). First record of pollination in the Afro-Eurasian *Dipcadi* Medik. (Hyacinthaceae): pollination of *D. brevifolium* by the owlet month Syngrapha circumflexa (Noctuidea). **South African Journal of Botany**. 81: 15-18.

Mirzaghaderi, G. (2010). A simple metaphase chromosome preparation from meristematic root tip cells of wheat for karyotyping or in situ hybridization. **African Journal of Biotechnology**. 9(3): 314- 318.

Moffett, A.A. (1936). The Cytology of *Lachenalia*. **Cytologia**. 7:490-498.

Mogford, D. J. (1978). Centromeric heterochromatin in *Lachenalia tricolor* (L.) Thunb. J. S. **South African Journal of Botany.** 44:111-117.

Moraes, A., Chinaglia, M., Palma-Silva, C., and Pinheiro, F. (2013). Interploidy hybridization in sympatric zones: the formation of *Epidendrum fulgens* x *E. puniceoluteum* hybrids (Epidendroideae, Orchidaceae). **Ecology and evolution**. 3824-3837.

Mucina, L. and Rutherford, M.C. (2006). The vegetation of South Africa, Lesotho and Swaziland. **Strelitzia**. 19. South African National Biodiversity Institute, Pretoria.

Müller-Doblies, U., and Müller-Doblies, D. (1997). A partial revision of the tribe Massonieae (Hyacinthaceae). 1. Survey, including three novelties from Namibia: A new genus, a second species in the monotypic *Whiteheadia*, and a new combination in Massonia. **Feddes Repertorium**. 108: 49-96.

Ndou, A.M., Niederwieser, J.G., and Robbertse, P.J., (2002). Effect of leaf-section position and physiological stage of the donor plant on Lachenalia leaf-cutting performance. **South African Journal Plant Soil**. 19: 178-181.

Niederwieser, J.G. and van Staden, J. (1990). The relationship between genotype, tissue age and endogenous cytokinin level on adventitious bud formation on leaves of *Lachenalia*. **Plant Cell, Tissue and Organ Culture**. 22: 223-228.

Niederwieser, J.G. and Vcelar, B.M. (1990). Regeneration of *Lachenalia* species from leaf explants. **HortScience**. 25: 684–687.

Niederwieser, J.G., and Ndou, A.M. (2002). Review on adventitious bud formation in *Lachenalia*. **Acta Horticulturae**. 570: 135- 140.

Nordenstam, B. (1982). Chromosome numbers of Southern African plants 2. **Journal of South African Botany**. 48:273-275.

Ornduff, R and Watters, P.J. (1978). Chromosome numbers in *Lachenalia* (*Liliaceae*). **Journal of South African Botany.** 44:387-390.

Otto, S.P. (2007). The evolutionary consequences of polyploidy. **Cell**. 131: 452- 462

Parks, C.R. and Griffiths, A. (1963). The *saluenensis-pitardii-reticulata* complex, ***Camellia Review.*** 25: 12-29.

Pasanskiene, I., Anamthawat-Jonsson, K., Humphreys, M.W., Paplauskiene, V., Jones, R.N. (1998). New Molecular evidence on genome relationship and chromosome identification on fescue (*Festuca*) and ryegrass (*Lolium*). **Heredity**. 81: 659-665.

Pearson, M. N., Cohen, D., Cowell, S.J., Blouin, A., Lebas, B.S.M., Shiller, J.B., and Clover, G.R.G. (2009). A survey of virus of flower bulbs in New Zealand. **Australian plant Pathology**. 38: 305-309.

Perrignon, R.J. (1992). Bulblet production in vivo from leaves of *Lachenalia* (Jacq.). **Acta Horticulturae***.* 325: 341–347.

Pfosser, M., and Speta, F. (1999). Phylogenetics of Hyacinthaceae on plastid DNA sequences. **Annals of Missouri Botanical Garden**. 86 (4): 852-875.

Pfosser, M., and Speta, F. (2001). Bufadienolides and DNA sequences: on lumping and smashing of subfamily Urgineoideae (Hyacinthaceae). **Stapfia**. 75:177–250.

Pfosser, M., Wetschnig, W., Ungar, S., Prenner, G. (2003). Phylogenetic relationships among genera of Massonieae (Hyacinthaceae) inferred from plastid DNA and seed morphology. **Journal Plant Research**. 116-132.

Pirie, M.D., Humphreys, A.M., Barker, N.P., and Linder, H.P. (2009). Reticulation, data combination, and inferring evolutionary history: An example from Danthonionideae (Poaceae). **Systematic Biology**. 58 (6): 612-628.

Pohl, T.S., Crouch, N.R., Mulholland, D.A. (2000). Southern African Hycinthaceae: Chemistry, bioactivity and ethnobotany. **Current Organic Chemistry**. 4: 1287-1324.

Proctor, M., and Yeo, P. (1972). **The pollination of flower**. Traplinger. New York.

Ramstad, E. (1953). Alkaloid biogenesis. **Pharmaceutica Acta Helvetiae**. 28- 45.

Reeves, G., Chase, M.W., Goldblatt, P., Rudall, P., Fay. M.F., Cox, A.V., Lejeune, B., and Souza-Chies, T. (2001). Molecular systematics of Iridaceae: evidence from four plastid DNA regions. **American Journal of Botany**. 88 (11): 2074-2087.

Richards, C.L., Bossdorf, O., Muth, N.Z., Gurevitch, J., and Picliucci, M. (2006). Jack of all trades, master of some? On the role of phenotypic plasticity in plant invasions. **Ecology Letters**. 9: 981-993.

Riley, H.P. (1962). Chromosome studies in some South African monocotyledons. **Canadian Journal of Genetics and Cytology.** 4: 40-55.

Roh, M.S. (2005). Flowering and inflorescence development of *Lachenalia aloides* 'Pearsonii' as influenced by bulb storage and forcing temperature. **Scientia Horticulturae**. 305-323

Roh, M.S., Grassotti, A., and Guglieri, L. (1998). Storage and forcing temperatures affect inflorescence initiation, flowering and floret blast of *Lachenalia aloides* 'Pearsonii'. **Acta Horticulturae**. 454: 213–222.

Ronquist, F. and J. P. Huelsenbeck. (2003). MrBayes 3: Bayesian phylogenetic inference under mixed models. **Bioinformatics**. 19: 1572-1574.

Roodbol, F., and Niederwieser, J.G. (2002). Effects of nutrient supply on nutrient element content of two *Lachenalia* cultivars. **South African Journal of Plant Soil**. 19: 216-218.

Roodbol, F., Louw, E., and Niederwieser, J.G. (2002). Effects of nutrient regime on bulb yield and plant quality of *Lachenalia* Jacq. (Hyacinthaceae). **South African Journal of Plant Soil**. 19: 23–26.

Rozas, J. (2009). DNA Sequence Polymorphism Analysis using DnaSP. **Bioinformatics for DNA Sequence Analysis; Methods in Molecular Biology**. 537**:** 337-350.

Ryan, J., and Vasu, K. (2013). Development of an improved method of mitotic metaphase chromosome preparation compatible for fluorescence in situ hybridization in cotton. **The Journal of Cotton Science**. 17: 149- 156.

SANBI, (2009). List of SA red data listed species. **Available online**: http://www.sanbi.org/index.php?option+com_docman&task=documentdetails&id+43.

Sang, T., Crawford, D.J., and Stuessy, T.F. (1997). Chloroplast DNA phylogeny, reticulate evolution and biogeography of Paeonia (Paeoniaceae). **American Journal of Botany**. 84: 1120–1136.

Sato, D. (1942). Karyotype alteration and phylogeny in *Liliaceae* and allied families. **Journal of Japanese Botany.** 12: 57-161.

Schietl, F.P., and Johnson, S.D. (2013). Pollinator-mediated evolution of floral signals. **Trends in Ecology & Evolution**. 28 (5): 307-315.

Schlichting, C.D. (1986). The evolution of phenotypic plasticity in plants. **Annual Review of Ecology and Systematics**. 17; 667-693.

Schwarzacher, T., and Heslop-Herrison, P. (2000). **Practical in situ Hybridization**. Springer-Verlag. New York (USA).

Sochacki, D. (2003). *Lachenalia* – nowośćz Południowej Afryki. **Hasło Ogrodnicze.** 7.

Song, K., Lu, P., Tang, K., and Osborn, T.C. (1995). Rapid genome change in synthetic polyploidy of Brassica and its implications for polyploidy evolution. **Proceedings of the National Academy of Science of the United States of America**. 92: 7719-7723.

Speta, F. (1998). Systematische Analyse der Gattung Scilla L. (Hyacinthaceae). **Phyton**. 38: 1–141

Spies, J.J. Spies, P., and Kleynhans, R. (2011). Basic chromosome number in the genus *Lachenalia* (Hyacinthaceae). **Philosophical Transaction in Genetics**. 1:67-79.

Spies, J.J., Du Preez, J.L., Minnaar, A. and Kleynhans, R. (2000). *Hyacinthaceae:* Chromosome studies on African plants. 13. *Lachenalia mutabilis*, *L. pustulata* and *L. unicolor*. **Bothalia** 30: 106-110.

Spies, J.J., Spies, P., Minnaar, A., Reinecke, S.M., du Preez, J.L., and Kleynhans, R. (2009). Hyacinthaceae. In: K. Marhold (ed.). IAPT/IOPB chromosome data 8. **Taxon**. 58 (4): 1288-1289.

Spies, J.J., Spies, P., Reinecke, S.M., Kleynhans, R., Duncan, G.D., and Edwards, T.J. (2008). Lachenalia. In: K. Marhold (ed.). IAPT/IOPB chromosome data 5. **Taxon**. 57 (2): 554-555.

Spies, J.J., Van Rooyen, P. and Kleynhans, R. (2002). The subgeneric delimitation of *Lachenalia* (*Hyacinthaceae*). **Acta Horticulturae.** 570: 225-232.

Spies, P. (2004). Phylogenetic relationships of the genus *Lachenalia* with other related liliaceous taxa. M. Sc thesis. University of the Free State.

Sunllivan, J. (1996). Combining data with different distributions of among-site rate variation. **Systematic Biology**. 45 (3): 375–380.

Tamura, K., Stecher, G., Peterson, D., Filipski, A., and Kumar, S. (2013). MEGA6: Molecular Evolutionary genetic analysis version 6.0. **Molecular Biology & Evolution**. 30: 2725-2729.

Tate, J.A., and Simpson, B.B. (2003). Paraphyly of Tarasa (Malvaceae) and diverse origins of the polyploid species. **Systematic Botany**. 28: 723–737.

Therman, E. (1956). Chromocentres in the mitosis of *Liliaceae*. **Archivum Societatis Zoologicae Botanicae Fennicae "Vanamo".** 11: 189-193.

Theron, K.I., and Jacobs, G. (1996). The effect of irradiance, defoliation, and bulb size on flowering of *Nerine bowdenii* W. Watson (*Amaryllidaceae*). **Journal of the American Society for Horticultural Science.** 121: 115–122.

Vallejo-Marin, M., and Lye, G.C. (2013). Hybridisation and genetic diversity in introduced Mimulus (Phrymaceae). **Heredity**. 111-122.

Van der Pijl, L. (1982). **Principles of Dispersal in Higher Plants**. Springer-Verlag, Berlin.

Van Rooyen, P., Spies, J. J. and Kleynhans, R. (2002). The species delimitation of *Lachenalia unifolia* and *L. hirta*. **Acta Horticulturae**. 570: 395-402.

Van Wyk, A.E., and Smith, G.F. (2001). **Regions of Floristic Endemism**. Umdaus Press. Pretoria.

Vcelar, B.M., Ferreira, D.I., and Neiderwieser, J.G. (1992). Elimination of ornithogalum mosaic virus in the Ornithogalum cv. Rogel through meristem tip culture and chemotherapy. **Plant Cell, Tissue and Organ Culture**. 29: 51-55.

Vittoz, P., and Engler, R. (2007). Seed dispersal distances: a typology based on dispersal modes and plant traits. **Botanica Helvetica. Zurich**. 117: 109–124.

Watt, J.M., and Breyer-Brandwijk, M.G. (1962). **The Medicina land Poisonous Plants of Southern and Eastern Africa**. 2rd edd. E. & S. Livingstone Ltd., Edinburgh.

Wester, P. (2011). Sticky snack for sengis. **Veld & Flora**. 97: 112–113.

Hegarty, M.J. (2012). Invasion of the hybrids. **Molecular Ecology**. 21: 4669-4671.

Wetschnig, W., and Pfosser, M. (2003). The *Scilla plumbea* puzzle-present status of the genus *Scilla* sensu lato in southern Africa and description of *Spetaea lachenaliiflora*, a new genus and species of Massonieae (Hyacinthaceae). **Taxon**. 52: 75-91.

White, T.J., Bruns, T., Lee, S., and Taylor, J. (1990). **Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: PCR Protocols: a guide to methods and applications**. (Innis MA, Gelfand DH, Sninsky JJ, White TJ, eds). Academic Press, New York, USA: 315–322.

Williams, C.A., Harborne, J.B., Crosby, T.S. (1976). **Phytochemistry**. 15: 349.

Yoder, A.D., Irwin, J.A., and Payseur, B.A. (2001). **Systematic Biology**. 50 (3): 408-424.

Fan, Q.H., and Zhang, Z.Q. (2003). Rhizoglyphus echinopus and Rhizoglyphus robini (Acari:v Acaride) from Australia and New Zealand: identification, host plants and geographical distribution. **Systematic and Applied Acarology Special Publications**. 12:1-6.

Appendix A: List of specimens used for the molecular and /or cytogenetic* studies with their localities and voucher specimen numbers. Species are alphabetically arranged and are listed according to the degree reference system (Edwards & Leistner 1971).

Eucomis autumnalis

Locality unknown, grown from seeds, *Spies 9113.*

E. bicolor

Locality unknown grown from seeds, *Spies 9114.*

E. pole-evansii

Locality unknown, grown from seeds, *Spies 9115.*

E. eucomis

Locality unknown, grown from seeds, *Spies 9116.*

Gloriosa superba

Locality unknown, grown from seeds, *Spies 9117.*

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

NORTHERN CAPE.–3119 (Calvinia): Nieuwoudtville (-AD), *Spies 8897.*

***L. flava*.**

WESTERN CAPE.–3319 (Worcester): Bainskloof (-AC)*, G. Duncan 363.*

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

WESTERN CAPE.–3319 (Worcester): Karoopoort (-BA), *Spies 8927.*

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

NORTHERN CAPE.–3017 (Hondeklipbaai): Soebatsfontein (-BA), *Spies 8926.*

***L. anguinea* Sweet**

WESTERN CAPE.–3118 (Vredendal): Vredendal (-AB), *Spies 8917.*

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

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

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

WESTERN CAPE.–3319 (Worcester): De Doorns (-BC), *Spies 8308.*

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

WESTERN CAPE.–3219 (Clanwilliam): Bidouw (-AA), *Spies 7987**.

***L. bowkeri* Baker**

WESTERN CAPE.–3123 (Murraysburg): Murraysburg (-DD), *Spies 8930.*

L. bifolia **(Cirillo) Engl.**

WESTERN CAPE.–3419 (Caledon): Pearly Beach (-CB), *Spies 7064*.*

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

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

L. cernua

WESTERN CAPE.–3319 (Worcester): Goudini (-BA), *Spies 8222.*

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

WESTERN CAPE.–3321 (Cape Town): Kirstenbosch (-AB), *Spies 7067*.*

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

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

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

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

L. contaminata **Aiton**

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

L. convallarioides **Baker**

EASTERN CAP.– 3326 (Grahamstown): Grahamstown (-BC), *A. Dold 1018.*

L. corymbosa **(L.) J.C.**

Locality unknown, grown from seeds, *Spies 9107.*

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

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

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

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

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

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

L. ensifolia **subsp. (Thunb.) J.C. Manning & Goldblatt**

Locality unknown, grown from seeds, *Spies 9108.*

L. ensifolia **subsp. *maughanii* (W.F. Barker)**

Locality unknown, grown from seeds, *Spies 9109.*

L. fistulosa **Baker**

WESTERN CAPE.–3318 (Cape Town): Signal Hill (-CD), *G. Duncan 3032.*

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

NORTHERN CAPE.–2917 (Komaggas): Komaggas (-CD), *Spies 8241.*

L. gillettii **W.F. Barker**

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

L. haarlemensis **Fourc.**

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

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

WESTERN CAPE.–3218 (Clanwilliam): 3 km. from Elandsbaai (-AD), *Spies 6858.* 3318 (Cape Town): Jonkershoek Forestry Station (-DD), *Spies 6891.*

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

NORTHERN CAPE.–2918 (Gamoep): Gamoep (-AD), *Spies 8906.*

L. isopetala **Jacq.**

NORTHERN CAPE.–3120 (Calvinia): Middelpos (DC), *Spies 8913.*

Locality unknown, frown from seeds, *Spies 9110.*

L. juncifolia **var** ***juncifolia*** **Baker**

WESTERN CAPE.–3319 (Worcester): Rawsonville (-CD), *Spies 8245*.*

L. magentea

Locality unknown, grown from seed, *Spies 8313*.*

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

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

L. kombergensis

Locality unknown, grown from seed, *Spies 8131.*

L. longibracteata

WESTERN CAPE.–3218 (Clanwilliam): Piketberg (-DA), *Spies 7768.*

L. longituba **(A.M. van der Merwe). J.C. Manning & Goldblatt**

Locality unknown, grown from seeds, *Spies 9111.*

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

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

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

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

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

Locality unknown, grown from seed, *Spies 6938.*

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

WESTERN CAPE.–3418 (Simons town): Wuppertal (-BB), *G. Duncan 284.*

L. mediana

EASTERN CAPE.-3325 (Port Elizabeth): Van Staadens Reserve (-CC), *Spies 9028*.*

NORTHERN CAPE.-3320 (Montagu): Laingsburg (-BB), *Spies 8321.*

WESTERN CAPE.-3318 (Cape Town): Potsdam behind Killarneys Race Course (-DC), *Spies 9031*.*

Locality unknown, *Spies 9027*.*

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

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

***L. montana* W.F. Barker**

WESTERN CAPE.–3419 (Caledon): Hermanus (-AC), *Spies 8314.*

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

Locality unknown, grown from seed, *Spies 8263.*

***L. mutabilis* Sweet**

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

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

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

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

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

L. nardouwbergensis

WESTERN CAPE.–3119 (Vanrhynsdorp): Moedverloor (-CC), *Spies 8267.*

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

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

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

WESTERN CAPE.–3320 (Matjiesfontein): Matjiesfontein, on a farm near the Wauchope memorial (-AB), *Spies 8898*.*

***L. orthopetala* Jacq.**

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

***L. paucifolia* (W.F. Barker) J.C. Manning & Goldblatt**

WESTERN CAPE.–3217 (Vredenburg): Vredenburg (-DD), *Spies 8915.*

Locality unknown, grown from seeds, *Spies 912.*

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

WESTERN CAPE.–3218 (Clanwilliam): Paleisheuwel (-BC), *Spies 6961.*

L. perryae/unifolia

NORTHERN CAPE.-3320 (Montagu): Matjiesfontein, on the road to Whitehill Station (-BA), *Spies 9039*.*

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

NORTHERN CAPE.–2918 (Springbok): Varsputs, between Springbok and Pofadder (-AD), *Spies 8912.*

L. pusilla **Jacq.**

WESTERN CAPE.–3218 (Clanwilliam): Piketberg (-DA), *Spies 8911*.*

L. pustulata **Jacq.**

Locality unknown, grown from seed, *Spies 8284.*

L. rosea **Andrews**

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

L. punctata **Jacq.**

WESTERN CAPE.–3418 (Simons town): 60 km from Faure turn off, Cape Town area (-BB), *Spies 7093*.*

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

WESTERN CAPE.–3420 (Bredasdorp): Bredasdorp (-CA), *Spies 8289.*

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

NORTHERN CAPE.–3018 (Kamiesberg): Knersvlakte (-DA), *Spies 8904.*

L. splendida **Diels**

Locality unknown, grown from seed, *Spies 8290.*

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

WESTERN CAPE.–3319 (Worcester): Worcester (-CB), *Spies 8316.*

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

WESTERN CAPE.–3218 (Clanwilliam): Die Poort (-BB), *Spies 8905.*

L. trichophylla **Baker**

NORTHERN CAPE.–3019 (Kamiesberg): Loeriesfontein (-CD), *Spies 8910.*

L. trichophylla subsp. trichophylla

Locality unknown, grown from seeds, *Spies 8293*

L. undulata

WESTERN CAPE.–3118 (Vredendal): Between Lutzville and Vredendal (-AC), *Spies 8317*.*

***L. unicolor* Jacq.**

WESTERN CAPE.- 3318 (Cape town): Koringberg (-BA), *Spies 8294*.*

***L. unifolia* Jacq.**

NORTHERN CAPE.–3017 (Hondeklipbaai): Soebatsfontein road, 5 km from Kamieskroon (-BB), *Spies 6878**.

WESTERN CAPE.–3318 (Wuppertal): Jonkershoek forestry station (-DD), *Spies 6874**.

L. unifolia/hirta

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

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

NORTHERN CAPE.–3017 (Hondeklipbaai): Wallekraal- Soebatsfontein road, west of Kammiesberg (-BB*), Spies 8919**.

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

Locality unknown, grown from seed, *Spies 7097.*

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

NORTHERN CAPE.–2917 (Springbok): Springbok (-DB), Spies 8914; Steinkopf (-BD), *D. Müller-Doblies 88125.*

L. violacea

NORTHERN CAPE.–3017 (Hondeklipbaai): Road between Garies and Kamieskroon (-BB), Spies 7101.

***L. youngii* Baker**

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

L. zebrina* Baker forma *zebrina

NORTHERN CAPE.–3120 (Calvinia): Middelpos (-DC), *Spies 8920.*

***L. zeyheri* Baker**

Locality unknown, grown from seed, *Spies 7099.*

***Lachenalia* sp**

Locality unknown, grown from seeds, *Spies 9101.*

L. sp

Locality unknown, grown from seeds, *Spies 9102.*

***Massonia depressa* Houtt**

Locality unknown, grown from seeds, *Spies 9103.*

M. wittebergensis

Locality unknown, grown from seeds, *Spies 9104.*

Veltheimia brachteata

Locality unknown, grown from seeds, *Spies 9105.*

***V. capensis* (L.) D.C.**

Locality unknown, grown from seeds, *Spies 9106.*

Whiteheadia bifolia

Locality unknown, grown from seeds. *Spies 9118.*

Appendix B. List of taxon and their phylogenetic marker unsuccessfully amplified or sequenced.

trnL-F*— Eucomis autumnalis, E. pole-evansii; Gloriosa superba; Massonia wittebergensis; Lachenalia longibracteata, L. nardouwbergensis, L. orthopetala, L. sp, L. trichophylla subsp. trichophylla.* ***ITS****— Eucomis autumnalis, E. pole-evansii, E. bicolor, E. vandermerwei; Gloriosa superba; Lachenalia ensifolia.* subsp *ensifolia, L. gillettii, L. multifolia, L. nervosa, L. variegata; Veltheimia brachteata, V. capensis.* ***psbA-trnH****— Eucomis autumnalis, E. pole-evansii, E. bicolor, E. vandermerwei; Massonia depressa, M. wittebergensis Lachenalia concordiana, L. contaminate, L. convallarioides, L. dehoopensis, L. duncanii, L. fistulosa, L. inconspicua, L. arbuthnotiae, L. mathewsii, L. maximiliani, L. namibiensis, L. polypodantha, L. salteri, L. trichophylla, L. zebrina.*

Appendix C: Number of inter-species crosses made among various different *Lachenalia* species and the results obtained from these crossing combinations. (Table copied from Kleynhans *et al*. 2012 with permission of the authors).

Basic chromosome number of parents	**No. of successful crosses**	**No of unsuccessful crosses**		
		No. of crosses with no seed set	**No. of crosses with abnormal seed**	**No. of crosses with seedling death**
7x7	169(27%)	274(44%)	169(27%)	10(2%)
8x8	72(46%)	44(28%)	40(45%)	1(1%)
11x11	2(67%)		1(33%)	
7x8	20(6%)	251(79%)	44(14%)	3(1%)
8x7	59(18%)	111(34%)	155(47%)	6(2%)
7x10		17(100%)		
10x7	1(5%)	5(25%)	13(65%)	1(5%)
7x11	1(2%)	54(86%)	8(13%)	
11x7	4(6%)	23(33%)	39(57%)	3(4%)
9x8			1(100%)	
8x10		1(33%)	2(67%)	
10x8	2(33%)	1(17%)	2(33%)	1(17%)
8x11	1(3%)	23(79%)	5(17%)	
11x8	1(3%)	15(39%)	22(58%)	
11x10		1(100%)		
15x7		2(67%)	1(33%)	
Unknown basic numbers in one or both of the parents	4(2%)	117(59%)	78(39%)	
L	336(18%)	939(50%)	580(31%)	25(1%)

Appendix D: Aligned sequences of the comibed *ITS*2 and indels dataset of all the specimens used for cladistics analysis. *M. = Massonia*, *L. = Lachenalia*, *W. = Whiteheadia.*

L. angelica	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. alba	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. flava	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. ameliae	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. anguinea	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCTTT
L. attenuata	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. aurioliae	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. bolusii	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. bowkeri	AGTTGCTCCGGAGGGTATCCG-GCCGAGGGCACGCCAGCCTGGGCTTCACGCATTGCGTC
L. bifolia	AGTTGCCCCCGAGGCTATCCG-GCCGAGGGCACGCCAGCCTGGGCGTCACGCATCGCGTC
L. capensis	AGTTGCTCCGGAGGCTATCCG-GCCGAGGGCACGCCGACCTGGGCGTCACGCATCGCGT-
L. cernua	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. comptonii	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. concordiana	AGTTGCGCCGGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. congesta	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. contaminata	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. convallarioides	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. dehoopensis	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. doleritica	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. duncanii	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. ensifolia var. maughanii	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. fistulosa	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. framesii	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. haarlemensis	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. hirta	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. inconspicua	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. isopetala	AGTTGCGCATGAGGCTATCCG-GCTGAGGGCACGCCCGCCTGGGCGTCACGCATCGCGTC
L. magentea	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. juncifolia var. juncifolia	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. karooica	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTTACGCATCGCGTC
L. kombergensis	AGTTGCGCCGGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. arbuthnotiae	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. longituba	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. longibracteata	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. margaretea	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTC-CGCATCGTGTC
L. martiniae	AGTTGCGCCCGAGGCTATCCGCGCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. mathewsii	AGTTGCGCCGGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC

L. maximiliani	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. mediana	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. moniliformis	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. muirii	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. mutabilis	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCATGCATCGCGTC
L. namaquensis	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. namibiensis	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. nardousbergensis	AGTTGCTCCGGAGGCTATCCG-GCCGAGGGCACGCATACCTGGGCGTCACGCATCGCGTC
L. obscura	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. orthopetala	AGTTGCGCCGGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. paucifolia	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. perryae	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. perryae/unifolia	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. polypodantha	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. pusilla	AGTTGCTCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. pustulata	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. rosea	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. punctata	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. salteri	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. schelpei	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. sp	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. sp	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. splendida	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. stayneri	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. thomasiae	AGTTGCGCCGGAGGCTATCCG-GCCAAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. trichophylla	AGTTGCGCCCTAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. trichophylla subsp. trichophylla	AGTTGCGCCCTAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. undulata	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. unicolor	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. unifolia	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. unifolia/hirta	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. valeriae	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. verticillata	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. violacea	?GTTGCGCCCGAGG-TATCCG-GCCGAGGGCACGCATGCCTGGGCGTCACGCATCGCGTC
L. youngii	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. zebrina	AGTTGCGCCGGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
L. zeyheri	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
M. depressa	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATTGCGTC
M. wittebergensis	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC
W. bifolia	AGTTGCGCCCGAGGCTATCCG-GCCGAGGGCACGCCTGCCTGGGCGTCACGCATCGCGTC

L. angelica	GCTT-CGCG-TACCCC-ACGCCCCC-GCCCAGTGCGGAC-GGCGGCGGCGGACGCGGACG
L. alba	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. flava	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. ameliae	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGC-GGCGGCGGCGGACGCGGACG
L. anguinea	TTTT-TCTTGTACCCC-ACGTCCCC-GCACAGCGCGGGT-GGCGGCGGCGGACGCGGACG
L. attenuata	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. aurioliae	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGTACGCGGACG
L. bolusii	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. bowkeri	GCTT-TGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. bifolia	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGAGGGT-GGCGGCGGCGGACGCGGACG
L. capensis	GCTC-CGGCGTACCCC-ACGTAACC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. cernua	GCTC-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. comptonii	GCTCGCG---TACCCC-ACGTCCCC-GCCTAGTGCGGGC-GGCGGCGGCGGACGCGGACG
L. concordiana	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. congesta	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGC-GGCGGCGGCATACGCGGACG
L. contaminata	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGAT-GGCGGCGGCGGACGCGGACG
L. convallarioides	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. dehoopensis	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGATG
L. doleritica	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. duncanii	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. ensifolia var. maughanii	GCTC-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. fistulosa	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. framesii	GCTC-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGGCGCGGACG
L. haarlemensis	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGAGGAGGACGCGGACG
L. hirta	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. inconspicua	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. isopetala	GCTC-CGTG-TACTTC-GTGTCCCCCGACATTTGCGGGT-GATGATGGTGGCCGTGGAAG
L. magentea	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGATG
L. juncifolia var. juncifolia	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. karooica	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. kombergensis	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. arbuthnotiae	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. longituba	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. longibracteata	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. margaretea	GCTC-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. martiniae	GCTT-CGCG-TACCCC-ATGTCCCC-GCCCATTGCGGGT-GGCGGCGGCGGACGCGGACG
L. mathewsii	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. maximiliani	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. mediana	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. moniliformis	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. muirii	GCTC-CGCG-TACCCC-ATGTCCCC-GCCCAGTGCGGGT-GGCGGCGGTGGACGCGGACG

L. mutabilis	GCTT-CGCG-TACCCC-ACGTCTCC-ACCTAGTGCGGAT-GGCGGCGGCGGACGCGGACG
L. namaquensis	GCTC-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGATGCGGACG
L. namibiensis	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. nardousbergensis	GCTC-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. obscura	GCTT-CGCG-TACCCC-ATGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGTACGCGGACG
L. orthopetala	GCTC-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. paucifolia	GCTT-CGCG-TACCCC-ACGTCCC----CCATTGCGGGT-GGCGGCGGCGGACGCGGACG
L. perryae	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGTGGACGCGGACG
L. perryae/unifolia	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. polypodantha	GCTT-CGCG-TACCCCCACGCCCCC-GCCCAGTGCGGAC-GGCGGCGGCGGACGCGGACG
L. pusilla	GCTC-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCAGC---GGACGCGGACG
L. pustulata	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. rosea	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. punctata	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. salteri	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGAT-GGCGGCTGCGGACGCGGACG
L. schelpei	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. sp	GCTT-CGCG-TACCCC-ACGTCCCC-GCCAAGTGCGGGC-GGCGGCGGCGGACGCGGACG
L. sp	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. splendida	GCTC-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. stayneri	GCTC-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACACGGACG
L. thomasiae	GCTC-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. trichophylla	GCTC-CGCG-TACCCC-ACGCCCCC-GCCCAGTGCGGAC-GGCGGCGGCGGACGCGGACG
L. trichophylla subsp. trichophylla	GCTC-CGCG-TACCCC-ACGCCCCC-GCCCAGTGCGGAC-GGCGGCGGCGGACGCGGACG
L. undulata	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCATTGCGGGT-GGCGGCGGCGGACGCGGACG
L. unicolor	GCTC-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACACGGACG
L. unifolia	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. unifolia/hirta	GCTC-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. valeriae	GCTC-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. verticillata	GCTC-CGCG-TACCCC-ACGTCCCCCGCCCGGTGCGGGT-GGCGTTGGCGGACGCGGACG
L. violacea	GCTC-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. youngii	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
L. zebrina	GCTC-CGGG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACACGGACG
L. zeyheri	GCTT-CGCG-TACCCC-ACGTCCCC-GCCCAGTGCGGGT-GGCGGCGGCGGACGCGGACG
M. depressa	GCTT-CGCG-TACCCT-ATGTCCTCCGCCTAGTGTGGGT-GGCTATG-CGGACGCGGACG
M. wittebergensis	GCTT-CGTG-TACCCT-ATGTCCTC-GCCTAGTGTGGGT-GGCTAT-GCGGACGCGGACG
W. bifolia	GCTC-CGCG-TACCCT-ATGTCCTCCGCCTGGTGCGGGT-GTCTATGGCGGACGCGGATG

L. angelica	TGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. alba	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. flava	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. ameliae	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG

L. anguinea	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. attenuata	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. aurioliae	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGG????????
L. bolusii	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. bowkeri	CGGAGATTGGCCCCCC-GTG---CCTCGGGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. bifolia	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TTGAAGTGTGGG-CCGCCG
L. capensis	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TTGAAGTTCGGG-CTGCCG
L. cernua	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. comptonii	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. concordiana	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-TCGCCG
L. congesta	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TTGAAGTGCGGG-CCGCCG
L. contaminata	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCTGG-CCGCCG
L. convallarioides	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. dehoopensis	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. doleritica	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. duncanii	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. ensifolia var. maughanii	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCTGG-CCGCCG
L. fistulosa	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGTGGG-TCGAAGTGCGGG-CCGCCG
L. framesii	CGGATATTGGCCCCTC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCTGG-CCGCCG
L. haarlemensis	TGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. hirta	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. inconspicua	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TTGAAGTTCGGGTCCGCCG
L. isopetala	CGGAGATTGGCCCCCC-ATG---CCTGGGGGCGCGGCGGG-TGGAAGTGCTGG-CCGCCG
L. magentea	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCTGG-CCGCCG
L. juncifolia var. juncifolia	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCTGG-CCGCCG
L. karooica	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. kombergensis	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. arbuthnotiae	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TTGAAGTTCGGG-CTGCCG
L. longituba	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCTGG-CCGCCG
L. longibracteata	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. margaretea	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. martiniae	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGTGGG-CCGCCG
L. mathewsii	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGTGGGTATGAAAGTGCGGGCCGCCG
L. maximiliani	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGCG-CCGCCG
L. mediana	CGGATATTGGCCCCCC-GTG---CCTTGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. moniliformis	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCTGG-CCGCCG
L. muirii	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. mutabilis	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCAGG-TCGAAGTGCGGG-CCGCCG
L. namaquensis	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCTGG-CCGCCG
L. namibiensis	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. nardousbergensis	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGTTGG-CCTCCG

L. obscura	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. orthopetala	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TTGAAGTTCTGG-CTGCCG
L. paucifolia	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCTGG-CCGCCG
L. perryae	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. perryae/unifolia	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCTGG-CCGCCG
L. polypodantha	TGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. pusilla	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. pustulata	CGGATATTGGCCCCCC-GTG---CCTTGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. rosea	CGGATATTGGCCCCCC-GTG---CCTTGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. punctata	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGTGGG-TCGAAGTGCGGG-CCGCCG
L. salteri	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCTGG-CCGCCG
L. schelpei	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. sp	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCTGG-CCGCCG
L. sp	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCTGG-CCGCCG
L. splendida	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCTGG-CCGCCG
L. stayneri	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCTGG-CCGCCG
L. thomasiae	TGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TTGAAGTGCGGG-CCGCCG
L. trichophylla	TGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. trichophylla subsp. trichophylla	TGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. undulata	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. unicolor	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCTGG-CCGCCG
L. unifolia	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCTGG-CCGCCG
L. unifolia/hirta	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCTGG-CCGCCG
L. valeriae	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCTGG-CCGCCG
L. verticillata	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. violacea	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. youngii	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCGGG-CCGCCG
L. zebrina	CGGATATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TTGAAGTGCTGG-CCGCCG
L. zeyheri	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGCTGG-CCGCCG
M. depressa	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGTGGG-CCGCCG
M. wittebergensis	CGGAGATTGGCCCCCC-GTG---CCTCGCGGCGCGGCGGG-TCGAAGTGTGGG-CCGCCG
W. bifolia	CGGAGATTGGCCCCCC-GTC---CCTCGCGGCGCGGCGGG-TCGAAGTGTGGG-CCGCCG

L. angelica	GCCGAAGAAGAGGAGGAAAGGGAG
L. alba	GCCGAAGAAGAGGAGGAAAGGGAG
L. flava	GCCGAAGAAGAGGAGGAAAGGGAG
L. ameliae	GCCGAAGAAGAGGAGGAAAGGGAG
L. anguinea	GCCGAAGAAGAAGAGGAAAGGGAG
L. attenuata	GCCGAAGAAGAGGAGGAAAGGGAG
L. aurioliae	????AAGAAGAGGAGGAAAGGGGA
L. bolusii	GCCGAAGAAGAGGAGGAAAGGGAG

L. bowkeri	GCCGAAGAAGAGGAGGAAAGGGAG
L. bifolia	GCCGAAGAAGAGGAGGAAAGGGAG
L. capensis	GCCGAAGAGGAAGAGGAAAGGGAG
L. cernua	GCCGAAGAAGAGGAGGAAAGGGAG
L. comptonii	GCCGAAGAAAGAGAGGAAAGGGAG
L. concordiana	GCCGAAGAAGAGGAGGAAAGGGAG
L. congesta	GCCGAAGAAGAGGAGGAAAGGGAG
L. contaminata	GCCGAAGAAGAGGAGGAAAGGGAG
L. convallarioides	GCCGAAGAAGAGGAGGAAAGGGAG
L. dehoopensis	GCCGAAGAAGAGGAGGAAAGGGAG
L. doleritica	GCCGAAGAAGAGGAGGAAAGGGAG
L. duncanii	GCCGAAGAAGAGGAGGAAAGGGAG
L. ensifolia var. maughanii	GCCGAAGAAGAGGAGGAAAGGGAG
L. fistulosa	GCCGAAGAAGAGGAGGAAAGGGAG
L. framesii	GCCGAAGAAGAGGAGGAAAGGGAG
L. haarlemensis	GCCGAAGAAGAGGAGGAAAGGGAG
L. hirta	GCCGAAGAAGAGGAGGAAAGGGAG
L. inconspicua	GCCGAAGAAGAGGAGGAAAGGGAA
L. isopetala	ACTGAAGAAGAGGAAGAAAGGGAG
L. magentea	GCCGAAGAAGAGGAGGAAAGGGAG
L. juncifolia var. juncifolia	GCCGAAGAAGAGGAGGAAAGGGAG
L. karooica	GCCGAAGAAGAGGAGGAAAGGGAG
L. kombergensis	GCCGAAGAAGAGGAGGAAAGGGAG
L. arbuthnotiae	GCCGAAGAAGAGGAGGAAAGGGAG
L. longituba	GCCGAAGAAGAGGAGGAAAGGGAG
L. longibracteata	GCCGAAGAAGAGGAGGAAAGGGAG
L. margaretea	GCCGAAGGAGAGGAGGAAAGGGAG
L. martiniae	GCCGAAAAAGAGGAGGAAAGGGAG
L. mathewsii	GCCGAAGAAGAGGAGGAAAGGAAA
L. maximiliani	GCCGAAGAAGAGGAGGAAAGGGAG
L. mediana	GCCGAAGAAGAGGAGGAAAGGGAG
L. moniliformis	GCCGAAGAAGAGGAGGAAAGGGAG
L. muirii	GCCGAAGAAGAGGAGGAAAGGGAG
L. mutabilis	GCCGAAGAAGAGGAGGAAAGGGAG
L. namaquensis	GCCGAAGAAGAGGAGGAAAGGGAG
L. namibiensis	GCCGAAGAAGAGGAGGAAAGGGAG
L. nardousbergensis	GCCGAAGAAGAGGAGGAAAGGGAG
L. obscura	GCCGAAGAAGAGGAGGAAAGGGAG
L. orthopetala	GCCGAAGAAGAGGAGGAAAGGGAG
L. paucifolia	GCCGAAGAAGAGGGAGAAAGGGAG
L. perryae	GCCGAAGAAGAGGAGGAAAGGGAG

L. perryae/unifolia	GCCGAAGAAGAGGAGGAAAGGGAG
L. polypodantha	GCCGAAGAAGAGAAGGAAAGGGAG
L. pusilla	GCCGAAGAAGAGGAGGGAAGGGAG
L. pustulata	GCCGAAGAAGAGGAGGAAAGGGAG
L. rosea	GCCGAAGAAGAGGAGGAAAGGGAG
L. punctata	GCCGAAGAAGAGGAGGAAAGGGAG
L. salteri	GCCGAAGAAGAGGAGGAAAGGGAG
L. schelpei	GCCGAAGAAGAGGAGGAAAGGGAG
L. sp	GCCGAAGAAGAGGAGGAAAGGGAG
L. sp	GCCGAAGAAGAGGAGGAAAGGGAG
L. splendida	GCCGAAGAAGAGGAGGAAAGGGAG
L. stayneri	GCCGAAGAAGAGGAGGAAAGGGAG
L. thomasiae	GCCGAAGAAGAGGAGGAAAGGGAG
L. trichophylla	GCCGAAGAAGAGGAGGAAAGGGAG
L. trichophylla subsp. trichophylla	GCCGAAGAAGAGGAGGAAAGGGAG
L. undulata	GCCGAAGAAGAGGAGGAAAGGGAG
L. unicolor	GCCGAAGAAGAGGAGGAAAGGGAG
L. unifolia	GCCGAAGAAGAGGAGGAAAGGGAG
L. unifolia/hirta	GCCGAAGAAGAGGAGGAAAGGGAG
L. valeriae	GCCGAAGAAGAGGAGGAAAGGGAG
L. verticillata	GCCGAAGAAGAGGAAGAAAGGGAG
L. violacea	GCCGGGGAAGAGGAGGAAAGGGAG
L. youngii	GCCGAAGAAGAGGAGGAAAGGGAG
L. zebrina	GCCGAAGAAGAGGAGGAAAGGGAG
L. zeyheri	GCCGAAGAAGAGGAGGAAAGGGAG
M. depressa	GCCGAAGAAGAGGAAGAAGGGGAG
M. wittebergensis	GCCGAAGAAGAGGAGGAGAGGGAG
W. bifolia	GCCGAAGAAGAGGAAGAAAGGGAG

Appendix E: Aligned sequences of the combined *psbA-trnH* and indels dataset of all the specimens used for cladistics analysis. *E. = Eucomis, G. = Gloriosa*, *M. = Massonia*, *L. = Lachenalia*, *V. = Veltheimia, W = Whiteheadia bifolia.*

G. superba	????????????G----AAGCTCC-GTCCA-----CAAAGGGA-TAAG-------ACATC
L. angelica	TAATGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. alba	TAATGTA-TTAAG----AATCTTT-GAATT-----CAAGGAGC-TATTC------CCAAT
L. flava	TAATGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. ameliae	TAATGTA-TTAAG----AATCCTT-GAATTCAAGGCAAGGAGC-TATCC------CCAAT
L. anguinea	TAATGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. attenuata	TAATGTA-TTAAGAAAGAATCTTT-GAATT-----CAAGGA-C----CC-------CAAT
L. aurioliae	TAATGTA-TTAAG----AATCTTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. bolusii	TAATGTA-TTAAGAAAGAATCTTT-GAATT-----CAAGGA-C----CC-------CAAT
L. bowkeri	TAATGTA-TTAAGAAAGAATCTTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. bifolia	????G------------AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. capensis	TAGTGTA-TTAATC---AATTCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. cernua	TAATGTA-TTAAG----AATTCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. comptonii	TAGTGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. congesta	TAATGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. corymbosa	TAATGTA-TTAAG----AATCGTT-GAATT-----CAAAGAGC-TATCC------CCAAT
L. doleritica	TAATGTA-TTAAG----AATCTTT-GAATT-----CAAGGAGC-TATTC------CCAAT
L. ensifolia subsp. ensifolia	TA-TG-A-TCAC-----AA-C-TT-CC--------CCGGGAGC-TATCC------CCCTT
L. ensifolia var. maughanii	TAATGTA-TTAAG----AATCGTT-GAATT-----CAAAGAGC-TATGGGCCCC-CCAAT
L. framesii	TAGTGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. gillettii	TATTAAC-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. haarlemensis	TA---T--TTAAGAAAGAATCTTT-GAATT-----CAAGGAGC-TATCC------CCA--
L. hirta	TAATGTA-TTAAT----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. isopetala	TAATGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. magentea	TAATGTA-TTAAG----AATTCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. juncifolia var. juncifolia	TATT-AAGATAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. karooica	TAATGTA-TTAAG----AATCTTT-GAATT-----CAAGGAGC-TATTC------CCAAT
L. kombergensis	TA-T-T--TTAAGAATGAATCTTT-GAAAT-----TCAAGAGC-TATCC------CCAAT
L. longituba	TAATGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. longibracteata	TAATGTA-TTAAG----AATTCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. margaretea	TAATGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. martiniae	TAATGTATTTAAG----AATCTTT-GAATT-----CAAGGAGC-TATCCCCAC--CCAAT
L. mediana	????G------------AATCCTT-GAATT-----CAAGGAGC-TATCCCCCCCACCAAT
L. moniliformis	TAATGTC-TTACG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. muirii	TAATGTA-TTAAG----AATTCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. multifolia	TAGTGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TGTCC------CCAAT
L. mutabilis	TAATGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCCCCCC--CCAAT

L. namaquensis	TAGTGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCA--
L. nardousbergensis	TAGTGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. nervosa	TAATGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. obscura	TAATGTA-TTAAG----AATCTTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. orthopetala	TAGTGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TGTCC------CCAAT
L. paucifolia	TAATGTA-TTAAG----AATCGTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. perryae	TAATGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. perryae/unifolia	TAATGTA-TTAAG-----ATCCTT-GAATT-----CAAGGAGC-TATCCC-----CCAAT
L. pusilla	TAATGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. pustulata	????????????G----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. rosea	TAGTGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. punctata	TAATGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. schelpei	TAATGTA-TTAAG----AATCTTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. sp	TAATGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. sp	TAATGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. splendida	TA---T--TTAAGAAAGAATCTTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. stayneri	TATT-AAGATAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. thomasiae	TAATGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. trichophylla subsp. trichophylla	TAATGTA-TTAAG----AATCGTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. undulata	TAATGTA-TTAAG----AATCTTT-GAATT-----CAAGGAGC-TATCCCCAC--CCAAT
L. unicolor	TAGTGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. unifolia	TATT-AAGATAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. unifolia/hirta	TAATGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. valeriae	TAGTGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCA--
L. variegata	TAATGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. verticillata	TAGTGTA-TTAAA----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. violacea	TAATGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. youngii	TAATGTA-TTAAG----AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
L. zeyheri	TAGTGTA-TTAAGA---AATCCTT-GAATT-----CAAGGAGC-TATCC------CCAAT
V. bracheata	TATTGTA-TTAAG----AATCGTT-GAATT-----CAAGGAGC-TATCC------CCAAT
V. capensis	????????????????????CCT-GGAACTAA---AAATGGGC-AATCCTGAG--CCAAA
W. bifolia	TATTGTA-TTAAG----AATCCTT-GAATT-----CAAGGTGC-TTTCC------CCAAT

G. superba	--------TGTCTTAGTGTATACGAA-----TCGTTGA-----------AGG-AGCA---
L. angelica	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCC---
L. alba	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. flava	----ATTTTG--TTTACGAAAACAAGCTATTCTATTGG-----------GGACAGCT---
L. ameliae	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCC---
L. anguinea	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCC---
L. attenuata	----AGCTTG--TTTTCGTAAACAAG-----CTATTGG-----------GG--T------
L. aurioliae	----AGCTTG--TTTTCGTAAACAAA-----ATATTGG-----------GGACAGCT---

L. bolusii	----AGCTTG--TTTTCGTAAACAAG-----CTATTGG-----------GG--T------
L. bowkeri	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGC----
L. bifolia	----ATTTTG--TTTACGAAAACAAGCTATTCTATTGG-----------GGACAGCT---
L. capensis	----ATTTTG--TTTACGAGAACAAA-----CTATTGG-----------GGACAGCT---
L. cernua	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. comptonii	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCC---
L. congesta	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGAGAGCC---
L. corymbosa	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCC---
L. doleritica	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. ensifolia subsp. ensifolia	----CCCTTG--TTTGCGAAAACCAG-----CTATTGG-----------GGACAGCC---
L. ensifolia var. maughanii	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCC---
L. framesii	----ATTTTGTTTTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. gillettii	----AGCTTG--TTTTCGTAAACAAG-----CTATTGG-----------GGACAGCTAAG
L. haarlemensis	-----TT--G--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. hirta	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCC---
L. isopetala	ATATTTGTTT--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. magentea	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. juncifolia var. juncifolia	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCC---
L. karooica	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. kombergensis	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGAT---
L. longituba	----GTTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCC---
L. longibracteata	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. margaretea	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. martiniae	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-------GTGGGGATAGCT---
L. mediana	----AGCTTG--TTTACGAAAACAAG-----CTATTGGT----GGGGATAGATAGCC---
L. moniliformis	----ATTTTG--TTGACGAAAACAAG-----CTATTGG-----------GGACAGCC---
L. muirii	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. multifolia	----AGCTTG--TTTTCGTAAACAAG-----CTATTGG-----------GGTTATTTTAT
L. mutabilis	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGTGGGGT---
L. namaquensis	-----TT--GTTTTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. nardousbergensis	----ATTTTGTTTTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. nervosa	AAATATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. obscura	----AGCTTG--TTTTCGTAAACAAA-----ATATTGG-----------GGACAGCT---
L. orthopetala	----AGCTTG--TTTACGAAAACAAG-----CTATGGG-----------GGACAGTC---
L. paucifolia	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCC---
L. perryae	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCC---
L. perryae/unifolia	-----TTTTG---TTACGAAAACAAG-----CTATTGG-----------GGACAGCC---
L. pusilla	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. pustulata	----ATTTTGTTTTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. rosea	-ATTTTTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCC---
L. punctata	----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---

L. schelpei ----ATTTTG--TTTACGAGAACAAG-----CTATTGG-----------GGACAGCT---
L. sp ----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. sp ----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCC---
L. splendida ----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. stayneri ----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCC---
L. thomasiae ----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. trichophylla subsp. trichophylla ----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCC---
L. undulata ----ATTTTG--TTTACGAAAACAAG-----CTATTGG-------GTGGGGATAGCT---
L. unicolor ----ATTTTGTTTTTACGAAAACAAG-----CTATTGG-----------GGATAGCT---
L. unifolia ----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCC---
L. unifolia/hirta ----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCC---
L. valeriae -----TT--GTTTTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. variegata ----ATTTTG--TTTACGAGAACAAG-----CTATTGG-----------GGACAGCT---
L. verticillata ----AGCTTG--TTTACGAAAACAAG-----CTATTGG-----------G----------
L. violacea ----ATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. youngii -ATTATTTTG--TTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
L. zeyheri ----ATTTTGTTTTTACGAAAACAAG-----CTATTGG-----------GGACAGCT---
V. bracheata ----ATTTTG--TTTACGAAAACAGG-----CTATTGG-----------GGACAGCC---
V. capensis ----TCTTTATTTTTAGAAAAACAAG-----GGTTTAA-----------AAACTAGA---
W. bifolia ----GTTTTG--TTTACCAAAACAAG-----CTATTGG-----------GGACAGCC---

G. superba -----A----------TACC------------AA------------ACCTACTCC-----
L. angelica -----C------C---TGGC-AATGAATGATTAA----------CTATTTATTCC-----
L. alba -----C------C---TGCC-AATGAATGATTAG-ATTAAGTATCTATTTATTCC-----
L. flava -----C------C---TGCC-AATGAATGATTAAATTAAATTAACTATTTATTCC-----
L. ameliae -----C------C---TGCC-AATGAATGATTAA------G----TATTTATTCC-----
L. anguinea -----C------T---CGCC-AATGAATGATTAA----------CTATTTATTCC-----
L. attenuata -----C------C---TGCC-AATGAATGATTAA-----GTTAAGTATTTATTCC-----
L. aurioliae -----C------C---TGCC-AATGAATGATTAA------TTAAGTATTTATTCC-----
L. bolusii -----C------C---TGCC-AATGAATGATTAA-----GTTAAGTATTTATTCC-----
L. bowkeri -----C------C---TGCC-----AATGATTAA----------GTATTTATTCC-----
L. bifolia -----C------C---TGCC-AATGAATGATTAAATTAAATTAACTATTTATTCC-----
L. capensis -----C------C---TGCC-AATGAATGATTAA-ATTAAGTATCTATTTATTCC-----
L. cernua -----C------C---TGCC-AATGAATGATTAA-ATTAAGTATCTATTTATTCC-----
L. comptonii -----C------C---TGCC---------------------------------------
L. congesta -----C------C---TGCC-AATGAATGATTAA----------GTATTTATTCC-----
L. corymbosa -----CCTCC--C---TGCC-AATGAATGATTAA------GTATCTATTTATTCC-----
L. doleritica -----C------C---TGCC-AATGAATGATTAG-ATTAAGTATCTATTTATTCC-----
L. ensifolia subsp. ensifolia -----C------C---TGCC-CATGAATGATTAA-----ATTAACTATTTAATCT-----
L. ensifolia var. maughanii -----C------C---TGCC-AATGAATGATTAA----------CTATT----CC-----
L. framesii -----C------C---TGCC-AATGAATGATTAA------------GTATCTTCC-----

L. gillettii	ATTTAT------TTTATCCCCAATGAATGATAAT------------GATTAACCA-----
L. haarlemensis	-----C------C---TGCC------TTAATTAA----------GTATTTATTCC-----
L. hirta	-----C------C---TGCC-AATGAATGATTAA----------CTATTTATTCC-----
L. isopetala	-----CCTTC--C---TGCC-AATCAATGAATGA-------AATTTATTTATTCC-----
L. magentea	-----C------C---TGCC-AATGAATGATTAA-ATTAAGTATCTATTTATTCC-----
L. juncifolia var. juncifolia	-----C------C---TGCC-AATGAATGATTAA----------CTATTTAATTT-----
L. karooica	-----C------C---TGCC-AATGAATGATTAG-ATTAAGTATCTATTTATTCC-----
L. kombergensis	-----CAA--------TGCC-----AATGATTAA----------GTATTTATTCC-----
L. longituba	-----C------C---TGCC-AATGAATGATTAA------GTATCTATTTATTCC-----
L. longibracteata	-----C------C---TGCC-AATGAATGATTAA-ATTAAGTATCTATTTATTCC-----
L. margaretea	-----C------C---TGCC-AATGAATGATTAA-----ATTAAGTATTTATTCC-----
L. martiniae	-----C------C---TGCC-AATGAATGATTAA---------------TATTCC-----
L. mediana	-----C------C---TGCC-AATGAATGATTAA------GTATCTATTTATTCCAAACC
L. moniliformis	-----C------C---TGCC-AATGAATGATTAA----------CTATTTAATTT-----
L. muirii	-----C------C---TGCC-AATGAATGATTAA-ATTAAGTATCTATTTATTCC-----
L. multifolia	T----C------C---TGCC-AATGAATGATTAA-ATTAAGTATCTATTTATTCC-----
L. mutabilis	-----C------C---TGCC-AATGAATGATTAA-----ATTAAGTATTTATTCC-----
L. namaquensis	-----C------C---TGCC-AATGAATGATTAA----------GTAT--CTTCCAAATC
L. nardousbergensis	-----C------C---TGCC-AATGAATGATTAA----------GTAT--CTTCCAAATT
L. nervosa	-----C------C---TGCC-GATTAAT--------------------------------
L. obscura	-----C------C---TGCC-AATGAATGATTAA------TTAAGTATTTATTCC-----
L. orthopetala	-----C----------TGCC-AATGAATGATTAA-ATTAAGTATGTATTTATTCC-----
L. paucifolia	-----CCTCC--C---TGCC-AATGAATGATTAA------GTATCTATTTATTCC-----
L. perryae	-----C------C---TGCC-AATGAATGATTAA----------CTATTTAATTT-----
L. perryae/unifolia	-----C------C---TGCCAAATGAATGATTAA----------CTATTTAATTT-----
L. pusilla	-----C------CAATTGCC-AATGAATGATTAA-ATTAAGTATCTATTTATTCC-----
L. pustulata	-----C------C---TGCC-AATGAATGATTAA----------GTAT--CTTCC-----
L. rosea	-----C------C---TGCC--
L. punctata	-----C------C---TGCC-AATGAATGATTAA-----ATTAACTATTTATTCC-----
L. schelpei	-----C------C---T----------TAATTAA--------------TTATTCC-----
L. sp	-----C------C---TGCC-AATGAATGATTAA-----ATTAACTATTTATTCC-----
L. sp	-----C------C---TGCC-AATGAATGATTAA-----------AATTTATTCC-----
L. splendida	-----C------C---TGCC-----AATGATTAA----------GTATTTATTCC-----
L. stayneri	-----C------C---TGCC-AATGAATGATTAA----------CTATTTAATTT-----
L. thomasiae	-----C------C---TGCC-AATGAATGATTAA-ATTAAGTAT----TTATTCC-----
L. trichophylla subsp. trichophylla	-----C------C---TGCC-AATGAATGATTAA----------CTATTTATTCC-----
L. undulata	-----C------C---TGCC-AATGAATGATTAA---------------TATTCC-----
L. unicolor	-----C------C---TGCC-AATGAATGATTAA----------GTAT--CTTCC-----
L. unifolia	-----C------C---TGCC-AATGAATGATTAA----------CTATTTAATTT-----
L. unifolia/hirta	-----C------C---TGCC-AATGAATGATTAA----------CTATTTAATTT-----
L. valeriae	-----C------C---TGCC-AATGAATGATTAA------------GTATCTTCC-----

L. variegata	-----C------C---TGCC-AATGAATGATTAA-----ATTAACTATTTATTCC-----
L. verticillata	----------------GCC-AATGAATGATTAA-ATTAAGTATCTATTTATTCC-----
L. violacea	-----CCTCCCTCTCCTGCC-AATGAATGATTAA---------ATTAACTTTCCC-----
L. youngii	-----C------C---TGCC-AATGAATGATAAT----GATTAAGTATT--AT-------
L. zeyheri	-----C------C---TGCC-AATGAATGATTAA----------GTAT--CTTCC-----
V. bracheata	-----C------C---TGCC-AATGAATGAATGA--TTAAGTATCTATTTATTCC-----
V. capensis	-----C------T---AGAATAAAAAGGGATAGG-----TGCAGAGACTCAATGG-----
W. bifolia	-----C------C---TGCC-------------------GTATCTATTTATTCC-----
G. superba	----T-----TTAGCAGTAGGTTTGGTATTGCTCCCT---------------------T
L. angelica	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. alba	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. flava	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. ameliae	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. anguinea	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. attenuata	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. aurioliae	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. bolusii	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. bowkeri	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. bifolia	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. capensis	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. cernua	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. comptonii	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. congesta	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. corymbosa	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. doleritica	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. ensifolia subsp. ensifolia	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. ensifolia var. maughanii	T-AAC-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. framesii	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. gillettii	--AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. haarlemensis	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. hirta	G-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. isopetala	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. magentea	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. juncifolia var. juncifolia	CTAAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. karooica	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. kombergensis	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. longituba	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. longibracteata	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. margaretea	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. martiniae	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T

L. mediana	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. moniliformis	AGAAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. muirii	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. multifolia	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. mutabilis	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. namaquensis	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. nardousbergensis	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. nervosa	--AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. obscura	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. orthopetala	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. paucifolia	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. perryae	ATAAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. perryae/unifolia	AGAAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. pusilla	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. pustulata	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. rosea	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. punctata	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. schelpei	A-AAT-----TAACGAGGAGATTTATTATCGTTTCTCGCATG-----------------T
L. sp	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. sp	A-AAT-----TAACGACGAGATTTATTATCTTTTCTCGCATC-----------------T
L. splendida	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. stayneri	CTAAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. thomasiae	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. trichophylla subsp. trichophylla	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. undulata	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. unicolor	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. unifolia	CTAAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. unifolia/hirta	ATAAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. valeriae	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. variegata	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. verticillata	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. violacea	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. youngii	--AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
L. zeyheri	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
V. bracheata	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T
V. capensis	A-AGCTGTTCTAACGAATAGAGTTGACTACGTTGCGTTAATAACAGGAACAGGAATCCTT
W. bifolia	A-AAT-----TAACGACGAGATTTATTATCGTTTCTCGCATG-----------------T

G. superba	TTTGTTGGATTCAGTCATATG---GTGT---------------TTTG-------------
L. angelica	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. alba	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------

L. flava	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. ameliae	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. anguinea	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. attenuata	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. aurioliae	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. bolusii	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. bowkeri	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. bifolia	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. capensis	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. cernua	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. comptonii	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. congesta	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. corymbosa	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. doleritica	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. ensifolia subsp. ensifolia	CTCGCGAAAGTCAG--AGTAG---GCGCCAATTCT---CCCAATTTG-------------
L. ensifolia var. maughanii	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. framesii	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. gillettii	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. haarlemensis	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. hirta	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. isopetala	CTCGCGAAAGTCAG--AGTCG---GCGCGAATTCT---CCCAATTTG-------------
L. magentea	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. juncifolia var. juncifolia	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. karooica	CTCGAGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. kombergensis	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. longituba	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. longibracteata	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. margaretea	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. martiniae	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. mediana	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. moniliformis	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. muirii	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. multifolia	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. mutabilis	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. namaquensis	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. nardousbergensis	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. nervosa	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. obscura	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. orthopetala	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. paucifolia	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. perryae	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------

L. perryae/unifolia	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. pusilla	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. pustulata	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. rosea	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. punctata	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. schelpei	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. sp	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. sp	CTCGCGAAACGCAG--AGTAG---GCACGAATTCT---CCCAACTTG-------------
L. splendida	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. stayneri	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. thomasiae	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. trichophylla subsp. trichophylla	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. undulata	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. unicolor	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. unifolia	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. unifolia/hirta	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. valeriae	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. variegata	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. verticillata	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. violacea	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. youngii	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
L. zeyheri	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
V. bracheata	CTCGCGAAAGTAAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------
V. capensis	CTATCGAAATTAAAGAAAAAGAAAGGGTGACCTATATATCTAATACGTACGTATACATAC
W. bifolia	CTCGCGAAAGTCAG--AGTAG---GCGCGAATTCT---CCCAATTTG-------------

G. superba	CGCACTAAACACAC----------------------------ATATAAATATAAACACAC
L. angelica	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. alba	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. flava	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. ameliae	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. anguinea	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. attenuata	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. aurioliae	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. bolusii	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. bowkeri	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. bifolia	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. capensis	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. cernua	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. comptonii	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. congesta	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT

L. corymbosa	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. doleritica	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. ensifolia subsp. ensifolia	TGA-CCCACCATACGATC--------------------TGTTATATAAATAAGAAAATGT
L. ensifolia var. maughanii	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. framesii	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. gillettii	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. haarlemensis	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. hirta	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. isopetala	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. magentea	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. juncifolia var. juncifolia	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. karooica	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. kombergensis	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. longituba	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. longibracteata	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. margaretea	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. martiniae	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. mediana	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. moniliformis	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. muirii	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. multifolia	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. mutabilis	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. namaquensis	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. nardousbergensis	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. nervosa	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. obscura	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. orthopetala	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. paucifolia	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. perryae	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. perryae/unifolia	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. pusilla	TGACCCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. pustulata	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. rosea	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. punctata	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. schelpei	CGA-CCCACCATAGGATG--------------------TGTTATATAAATAGGAAAATGT
L. sp	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. sp	TGA-CCCACCATACAATC--------------------TGTTATATAAATAAGAAAAAGT
L. splendida	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. stayneri	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. thomasiae	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. trichophylla subsp. trichophylla	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT

L. undulata	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. unicolor	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. unifolia	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. unifolia/hirta	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. valeriae	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. variegata	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. verticillata	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. violacea	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. youngii	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
L. zeyheri	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
V. bracheata	TGA-CCCACCATACGATC--------------------TGTTATATAAATAGGAAAATGT
V. capensis	TGA-CATATCAAACGATTAATCATGACCCGAATCCATATATTATATATACATGTATATGC
W. bifolia	TGA-CCCACCATACGATC--------------------CGTTATATAAATAGGAAAATGT

G. superba	----ATA-TATC----------------------------------TTTTAGGTGT----
L. angelica	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. alba	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. flava	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. ameliae	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. anguinea	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. attenuata	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. aurioliae	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. bolusii	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. bowkeri	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. bifolia	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. capensis	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. cernua	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. comptonii	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. congesta	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. corymbosa	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. doleritica	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. ensifolia subsp. ensifolia	----TCC-TTTCCATTATGAATAGGGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. ensifolia var. maughanii	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. framesii	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. gillettii	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. haarlemensis	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. hirta	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. isopetala	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. magentea	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. juncifolia var. juncifolia	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. karooica	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----

L. kombergensis	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. longituba	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. longibracteata	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. margaretea	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. martiniae	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. mediana	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. moniliformis	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. muirii	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. multifolia	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. mutabilis	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. namaquensis	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. nardousbergensis	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. nervosa	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. obscura	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. orthopetala	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. paucifolia	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCT-TTTTGGGTAT----
L. perryae	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. perryae/unifolia	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. pusilla	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. pustulata	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. rosea	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. punctata	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. schelpei	----TCC-TTTCCACTATGAATAGCGATTGTATGGCC---AATCAGTTTTGGGTAT----
L. sp	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. sp	----TCC-TTTCCATTATGAATAACGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. splendida	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. stayneri	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. thomasiae	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. trichophylla subsp. trichophylla	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. undulata	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. unicolor	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. unifolia	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. unifolia/hirta	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. valeriae	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. variegata	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. verticillata	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. violacea	----TCCTTTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. youngii	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
L. zeyheri	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
V. bracheata	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
V. capensis	AATATTA-TATGTAATATGCGCAATATATGCAAAATTCAGAGTTA-TTGTGGATCTATTC

W. bifolia	----TCC-TTTCCATTATGAATAGCGATTGTATGGCC---AATCA-TTTTGGGTAT----
G. superba	-A----TAAATG------------AAATT-------------------------------
L. angelica	-AACGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. alba	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. flava	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. ameliae	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. anguinea	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. attenuata	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. aurioliae	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. bolusii	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. bowkeri	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. bifolia	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. capensis	-AATGGTATATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. cernua	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. comptonii	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. congesta	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. corymbosa	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. doleritica	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. ensifolia subsp. ensifolia	-AATGGGAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCCCCTCCCTCATGTTGA
L. ensifolia var. maughanii	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. framesii	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. gillettii	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. haarlemensis	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. hirta	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. isopetala	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. magentea	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. juncifolia var. juncifolia	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. karooica	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. kombergensis	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. longituba	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. longibracteata	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. margaretea	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. martiniae	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. mediana	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. moniliformis	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. muirii	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. multifolia	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. mutabilis	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. namaquensis	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. nardousbergensis	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA

L. nervosa	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. obscura	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. orthopetala	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. paucifolia	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. perryae	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. perryae/unifolia	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. pusilla	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. pustulata	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. rosea	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. punctata	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. schelpei	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. sp	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. sp	-AATGGAAAATGCCCGAGGACACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGCGGA
L. splendida	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. stayneri	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. thomasiae	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. trichophylla subsp. trichophylla	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. undulata	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. unicolor	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. unifolia	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. unifolia/hirta	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. valeriae	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. variegata	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. verticillata	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. violacea	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. youngii	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
L. zeyheri	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
V. bracheata	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCCTCATGTTGA
V. capensis	CAATCGAAGTTGACGGAAGAATCGAATATTCAGTGATCAAATCATTTATTCCAGAGTTTA
W. bifolia	-AATGGTAGATGCCCGAG---ACCAAGTTACTATTATTTCTTTCTCCTCCTTCATGTTGA

G. superba	--------------------AAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. angelica	GTTTTTCATTTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. alba	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. flava	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. ameliae	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. anguinea	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. attenuata	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. aurioliae	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. bolusii	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. bowkeri	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT

L. bifolia	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. capensis	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. cernua	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. comptonii	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. congesta	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. corymbosa	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. doleritica	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. ensifolia subsp. ensifolia	GTTTTTCAATTTTTCTAGAAAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. ensifolia var. maughanii	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. framesii	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. gillettii	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. haarlemensis	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. hirta	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. isopetala	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. magentea	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. juncifolia var. juncifolia	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. karooica	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. kombergensis	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. longituba	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. longibracteata	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. margaretea	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. martiniae	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. mediana	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. moniliformis	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. muirii	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. multifolia	GTTTTTCAATTCTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. mutabilis	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. namaquensis	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. nardousbergensis	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. nervosa	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. obscura	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. orthopetala	TTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. paucifolia	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. perryae	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. perryae/unifolia	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. pusilla	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. pustulata	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. rosea	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. punctata	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. schelpei	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. sp	GTTTTTCAATTTTTCTAGAAAAATGATTAGCT-----------ACAAAAGGATTTTTTTT

L. sp	TTTTTTCAATTTTTCTATATAAAAGATTAGCT-----------ACTAAAGGATTTTTTTT
L. splendida	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. stayneri	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. thomasiae	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. trichophylla subsp. trichophylla	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. undulata	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. unicolor	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. unifolia	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. unifolia/hirta	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. valeriae	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. variegata	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. verticillata	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. violacea	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. youngii	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
L. zeyheri	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
V. bracheata	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT
V. capensis	ATAGACCCCTTTTTTTGAAAAACTGATTAATCGGACGAGAATAAAGAGAGAGTCCCGTTC
W. bifolia	GTTTTTCAATTTTTCTAGATAAATGATTAGCT-----------ACAAAAGGATTTTTTTT

G. superba	TAGTGAAC-GTGTCACGGCGGATTACTCC--TTTTTTTTACATTAT-TAAAATG-GGT-A
L. angelica	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. alba	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATT-GGC-A
L. flava	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. ameliae	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. anguinea	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. attenuata	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. aurioliae	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. bolusii	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. bowkeri	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. bifolia	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. capensis	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATT-GGC-A
L. cernua	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATT-GGC-A
L. comptonii	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATT-GGC-A
L. congesta	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. corymbosa	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATT-GGC-A
L. doleritica	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATT-GGC-A
L. ensifolia subsp. ensifolia	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. ensifolia var. maughanii	TAGTGAAC-GTGTCACAGCCGATTACTCCTTTTTTTTTTACATTTT-AAAGATT-GGC-A
L. framesii	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATT-GGC-A
L. gillettii	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. haarlemensis	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTG-AAAGATT-GGC-A

L. hirta	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. isopetala	TAGTGAAC-GTGTCACA---GATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. magentea	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATT-GGC-A
L. juncifolia var. juncifolia	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. karooica	TAGTGAAC-GTGTCACAGCCGATTACTCCTTTTTTTTTTACATTTT-AAAGATT-GGC-A
L. kombergensis	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. longituba	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. longibracteata	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATT-GGC-A
L. margaretea	TAGTGAAC-GTGTCACAGCCGATTACTCC---TTTTTTTACATTTT-AAAGATT-GGC-A
L. martiniae	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. mediana	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTCCATTTT-AAAGATT-GGC-A
L. moniliformis	TAGTGAAC-GTGTCACAGCCGATTACTCC---TTTTTTTACATTGT-AAAGATT-GGC-A
L. muirii	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATT-GGC-A
L. multifolia	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. mutabilis	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. namaquensis	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATG-GGC-A
L. nardousbergensis	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATT-GGC-A
L. nervosa	TAGTGAAC-GTGTCACAGCC--TTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. obscura	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. orthopetala	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTG-AAAGATT-GCC-A
L. paucifolia	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATT-GGC-A
L. perryae	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. perryae/unifolia	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. pusilla	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATT-GGC-A
L. pustulata	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATT-GGC-A
L. rosea	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATT-GGC-A
L. punctata	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. schelpei	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. sp	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. sp	TTTTGTACGGTGGCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. splendida	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. stayneri	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. thomasiae	TAGTGAAC-GTGTCACAGCCGATTACTCC---TTTTTTTACATTTT-AAAGATT-GGC-A
L. trichophylla subsp. trichophylla	TAGTGAAC-GTGTCACAGCCGATTACTCC---TTTTTTTACATTTT-AAAGATT-GGC-A
L. undulata	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. unicolor	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATT-GGC-A
L. unifolia	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. unifolia/hirta	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. valeriae	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATT-GGC-A
L. variegata	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
L. verticillata	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATT-GGC-A

L. violacea	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATT-GGC-A
L. youngii	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATT-GGC-A
L. zeyheri	TAGTGAAC-GTGTCACAGCCGATTACTCC-TTTTTTTTTACATTTT-AAAGATT-GGC-A
V. bracheata	TAGTGAAC-GTGTCACAGCCGATTACTCC--TTTTTTTTACATTTT-AAAGATT-GGC-A
V. capensis	T---ACA-TGTCAATACCGACAACAATGAAATTTATAGTAAGAGG-AAAATCCGTCGACT
W. bifolia	TAGTGAAC-GTGTCACAGCCGATTACTCCTTTTTTTTTTTCTTTTA-AAAGATT-GGA-A
G. superba	TTCTATG-CCCAATA???????AAGAAGAAGGGAAGGAGAGAGGGAAGGGAGGAAGAAGA
L. angelica	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. alba	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAG
L. flava	TTCTATG-TCCAATAGAATATAAAGAAGGAAGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. ameliae	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. anguinea	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. attenuata	TTCTATG-TCCAATAGAATATAAAGGGAGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. aurioliae	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. bolusii	TTCTATG-TCCAATAGAATATAAAGGGAGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. bowkeri	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. bifolia	TTCTATG-TCCAATAGAATATAAAGAAGGAAGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. capensis	TTCTATG-TCCAATAAAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAG
L. cernua	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAG
L. comptonii	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAG
L. congesta	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. corymbosa	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAG
L. doleritica	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAG
L. ensifolia subsp. ensifolia	TTCTATG-TCCAATAGAATATAGAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. ensifolia var. maughanii	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAA
L. framesii	TTCTATG-TCCAATAGAATATAAAGAAGAAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAG
L. gillettii	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. haarlemensis	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. hirta	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. isopetala	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGGAGA
L. magentea	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAG
L. juncifolia var. juncifolia	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. karooica	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAA
L. kombergensis	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. longituba	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. longibracteata	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAG
L. margaretea	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAA
L. martiniae	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. mediana	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. moniliformis	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAA

L. muirii	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAG
L. multifolia	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. mutabilis	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. namaquensis	TTATATG-TCCAATAGAATATAAAGAAGAAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAG
L. nardousbergensis	TTCTATG-TCCAATAGAATATAAAGAAGAAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAG
L. nervosa	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAGGA
L. obscura	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. orthopetala	TTGTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. paucifolia	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAG
L. perryae	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. perryae/unifolia	TTCTATG-TCCAATAGAATATAAAGAAGAGGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. pusilla	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGAAGGGAGGGAAGAGAAGAAAG
L. pustulata	TTCTATG-TCCAATAGAATATAAAGAAGAAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAG
L. rosea	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAG
L. punctata	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. schelpei	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGAGAAGAGAAGAAGA
L. sp	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. sp	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAAAGAAAAAGA
L. splendida	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. stayneri	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. thomasiae	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAA
L. trichophylla subsp. trichophylla	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAA
L. undulata	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. unicolor	TTCTATG-TCCAATAGAATATAAAGAAGAAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAG
L. unifolia	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. unifolia/hirta	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. valeriae	TTCTATG-TCCAATAGAATATAAAGAAGAAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAG
L. variegata	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
L. verticillata	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAG
L. violacea	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGAAGGGAAGAGAAGAAAG
L. youngii	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAG
L. zeyheri	TTCTATG-TCCAATAGAATATAAAGAAGAAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAG
V. bracheata	TTCTATG-TCCAATAGAATATAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAGA
V. capensis	TTAGAAATCGTGAGGGTTCAAGAGAAAGAAGAAAAAAAAGAAAGAAGAAAAAAGGAAAAA
W. bifolia	TTCTATGCCCCAATAAAAATTAAAGAAGGAGGAGGGAGGGAGGGAGGGAAGAGAAGAAAA

G. superba	AAGGGGGA
L. angelica	AAGGGGAG
L. alba	AAGGGGAG
L. flava	AAGGGGAG
L. ameliae	AAGGGGAG

L. anguinea	AAGGGGAG
L. attenuata	AAGGGGAG
L. aurioliae	AAGGGGAG
L. bolusii	AAGGGGAG
L. bowkeri	AAGGGGAG
L. bifolia	AAGGGGAG
L. capensis	AAGGGGAG
L. cernua	AAGGGGAG
L. comptonii	AAGGGGAG
L. corymbosa	AAGGGGAG
L. doleritica	AAGGGGAG
L. ensifolia subsp. ensifolia	AAGGGGAG
L. ensifolia var. maughanii	AAGGGGAG
L. framesii	AAGGGGAG
L. gillettii	AAGGGGAG
L. haarlemensis	AAGGGGAG
L. hirta	AAGGGGAG
L. isopetala	AAGGGGAG
L. magentea	AAGGGGAG
L. juncifolia var. juncifolia	AAGGGGAG
L. karooica	AAGGGGAG
L. kombergensis	AAGGGGAG
L. longituba	AAGGGGAG
L. longibracteata	AAGGGGAG
L. margaretea	GAGGGGAG
L. martiniae	AAGGGGAG
L. mediana	AAGGGGAG
L. moniliformis	GAGGGGAG
L. muirii	AAGGGGAG
L. multifolia	AAGGGGAG
L. mutabilis	AAGGGGAG
L. namaquensis	AAGGGGAG
L. nardousbergensis	AAGGGGAG
L. nervosa	AAGGGGAG
L. obscura	AAGGGGAG
L. orthopetala	AAGGGGAG
L. paucifolia	AAGGGGAG
L. perryae	AAGGGGAG
L. perryae/unifolia	AAGGGGAG
L. pusilla	AAGGGGAG
L. pustulata	AAGGGGAG

L. rosea	AAGGGGAG
L. punctata	AAGGGGAG
L. schelpei	AAGGGGAG
L. sp	AAGGGGAG
L. sp	AAGGGGAG
L. splendida	AAGGGGAG
L. stayneri	AAGGGGAG
L. thomasiae	GAGGGGAG
L. trichophylla subsp. trichophylla	GAGGGGAG
L. undulata	AAGGGGAG
L. unicolor	AAGGGGAG
L. unifolia	AAGGGGAG
L. unifolia/hirta	AAGGGGAG
L. valeriae	AAGGGGAG
L. variegata	AAGGGGAG
L. verticillata	AAGGGGAG
L. violacea	AAGGGGAG
L. youngii	AAGGGGAG
L. zeyheri	AAGGGGAG
V. bracheata	AAGGGGAG
V. capensis	AGAAAAAG
W. bifolia	AAGGGAAG

Appendix F: Aligned sequences of the combined *TrnL-F* and indels dataset of all the specimens used for cladistics analysis. *E. = Eucomis, G. = Gloriosa*, *M. = Massonia*, *L. = Lachenalia*, *V. = Veltheimia. W. = Whiteheadia bifolia.*

E. bicolor	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
E. vandermerwei	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. alba	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. flava	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTGTTAGAAAAACAA---G
L. ameliae	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. angelica	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. anguinea	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. attenuata	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. aurioliae	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. bolusii	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. bowkeri	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. bifolia	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. capensis	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. cernua	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. comptonii	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. concordiana	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. congesta	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. contaminata	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. convallarioides	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. corymbosa	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTATAAAAACAA---G
L. dehoopensis	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. doleritica	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. duncanii	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. ensifolia subsp. ensifolia	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAACAAG
L. ensifolia var. maughanii	CCCTGGAACTAAAAATGGGCAATCCCTGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. fistulosa	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. framesii	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. gillettii	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. haarlemensis	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. hirta	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. inconspicua	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. isopetala	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. magentea	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAA-CAA---G
L. juncifolia var. juncifolia	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAA-CAA---G
L. karooica	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. kombergensis	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. arbuthnotiae	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G

L. longituba	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. margaretea	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. martiniae	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. mathewsii	CCCGGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. maximiliani	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. mediana	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. moniliformis	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAA-CAA---G
L. muirii	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. multifolia	CCCAGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. mutabilis	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. namaquensis	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. namibiensis	CCCTGGAACTAAAAATGGGCAACCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. nervosa	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. obscura	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. paucifolia	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTATAAAAACAA---G
L. perryae	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. perryae/unifolia	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. polypodantha	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAA-------
L. pusilla	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. pustulata	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. rosea	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. punctata	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. salteri	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. schelpei	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. sp	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. splendida	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. stayneri	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. thomasiae	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. trichophylla	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. undulata	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. unicolor	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. unifolia	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAA-CAA---G
L. unifolia/hirta	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. valeriae	CCCCGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. variegata	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. verticillata	CCCTGGAACTAAAAATGGGTAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. violacea	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. youngii	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. zebrina	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
L. zeyheri	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
M. depressa	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G

V. bracheata	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
V. capensis	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G
W. bifolia	CCCTGGAACTAAAAATGGGCAATCC-TGAGCCAAATCTTTATTTTTAGAAAAACAA---G

E. bicolor	GGTTTA---AAAT----ACTAGAATAAAAAATAAAAA-----GGGATAGGTGCAGAGACT
E. vandermerwei	GGTTTA---AAAT----ACTAGAATAAAAAATAAAAA-----GGGATAGGTGCAGAGACT
L. alba	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA-----GGATAGGTGCAGAGACT
L. flava	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. ameliae	GGTTTA---AAAG----ACTAGAATAAAAAAA------G---GGGATAGGTGCAGAGACT
L. angelica	GGTTTA---AAA-----ACTAGACTAGAATAAAAA-------GGGATAGGTGCAGAGACT
L. anguinea	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAAAA--GGGATAGGTGCAGAGACT
L. attenuata	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. aurioliae	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. bolusii	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAAA---GGGATAGGTGCAGAGACT
L. bowkeri	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. bifolia	GGTTAA---AAAAAAAAACTAGACTAGAATAAAAAAAAA---GGGATAGGTGCAGAGACT
L. capensis	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. cernua	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. comptonii	GGTTTA---AAA------CTAGAATAAAAAAA----------GGGATAGGTGCAGAGACT
L. concordiana	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. congesta	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. contaminata	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. convallarioides	GGTTTA---AAA-----ACTAGACTAGAATAAAAAA------GGGATAGGTGCAGAGACT
L. corymbosa	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAA-----GGGATAGGTGCAGAGACT
L. dehoopensis	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. doleritica	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA-----GGATAGGTGCAGAGACT
L. duncanii	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAAA---GGGATAGGTGCAGAGACT
L. ensifolia subsp. ensifolia	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAA-----GGGATAGGTGCAGAGACT
L. ensifolia var. maughanii	GGTTTA---AAAAA---AAAAAAATAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. fistulosa	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. framesii	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. gillettii	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAAG---GGGATAGGTGCAGAGACT
L. haarlemensis	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. hirta	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. inconspicua	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. isopetala	GGTTTCAATAAAA----ACTAGACTAGAATAAAAA-------GGGATAGGTGCAGAGACT
L.magentea	GGTTTA---AAA-----ACTAGACTAGAATAAAAAA------GGGATAGGTGCAGAGACT
L. juncifolia var. juncifolia	GGTTTA---AAA-----ACTAGACTAGAATAAAAAA------GGGATAGGTGCAGAGACT
L. karooica	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAA-----GGGATAGGTGCAGAGACT
L. kombergensis	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. arbuthnotiae	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAAA---GGGATAGGTGCAGAGACT

L. longituba	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAAA---AGGATAGGTGCAGAGACT
L. margaretea	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. martiniae	GGTTTA---AAAG----ACTAGAATAAAAAAAGGGATA----GGGATAGGTGCAGAGACT
L. mathewsii	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAA-----GGGATAGGTGCAGAGACT
L. maximiliani	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. mediana	GGTTTA---AAA-----ACTAGACTAGAATTAAAAAAA----GGGATAGGTGCAGAGACT
L.moniliformis	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAA-----GGGATAGGTGCAGAGACT
L. muirii	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. multifolia	GGTTTA---AAAG----ACTAGAATAAAAAAAA---------GGGATAGGTGCAGAGACT
L. mutabilis	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAA-----GGGATAGGTGCAGAGACT
L. namaquensis	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAAA---GGGATAGGTGCAGAGACT
L. namibiensis	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAAA---GGGATAGGTGCAGAGACT
L. nervosa	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAAA---GGGATAGGTGCAGAGACT
L. obscura	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAAA---GGGATAGGTGCAGAGACT
L. paucifolia	GGTTTA---AAA-----ACTAGACTAGAATAAA-AAAA----GGGATAGGTGCAGAGACT
L. perryae	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. perryae/unifolia	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAAA---GGGATAGGTGCAGAGACT
L. polypodantha	--TTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. pusilla	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. pustulata	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAAG---GGGATAGGTGCAGAGACT
L. rosea	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAAG---GGGATAGGTGCAGAGACT
L. punctata	GGTTTA---AAA-----ACTAGA-----ATAAAAAAAAA---GGGATAGGTGCAGAGACT
L. salteri	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAAAAGGGGGATAGGTGCAGAGACT
L. schelpei	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. sp	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. splendida	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAAA---GGGATAGGTGCAGAGACT
L. stayneri	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. thomasiae	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAA-----GGGATAGGTGCAGAGACT
L. trichophylla	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAAAAA-GGGATAGGTGCAGAGACT
L. undulata	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAA-G---GGGATAGGTGCAGAGACT
L. unicolor	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAAG---GGGATAGGTGCAGAGACT
L. unifolia	GGTTAA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. unifolia/hirta	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. valeriae	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAAA---GGGATAGGTGCAGAGACT
L. variegata	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. verticillata	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
L. violacea	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAA-----GGGATAGGTGCAGAGACT
L. youngii	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAAAA--GGGATAGGTGCAGAGACT
L. zebrina	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAA-----GGGATAGGTGCAGAGACT
L. zeyheri	GGTTTA---AAA-----ACTAGACTAGAATAAAAAAAA----GGGATAGGTGCAGAGACT
M. depressa	GGTTTA---AAA-----ACTAGACTAGAATAAAAA-------GGGATAGGTGCAGAGACT

V. bracheata	GGTTTA---AAA-----ACTAGACTAGAATAAAAA-------GGGATAGGTGCAGAGACT
V. capensis	GGTTTA---AAA-----ACTAGACTAGAATAAAAA-------GGGATAGGTGCAGAGACT
W. bifolia	GGTTTA---AAA-----ACTAGACTAGAATAAAAA-------GGGATAGGTGCAGAGACT

E. bicolor	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTG------ATAA-CAGG-
E. vandermerwei	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTG------ATAA-CAGG-
L. alba	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. flava	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGTGTTATA----ATA-----GA
L. ameliae	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. angelica	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. anguinea	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. attenuata	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTT-----ATA----ATAA-CAGGA
L. aurioliae	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAAACAGGA
L. bolusii	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGTGTTATA----ATAA-CAGGA
L. bowkeri	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAAACAGGA
L. bifolia	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGTGTTATA----ATAA-CAGGA
L. capensis	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGTGTTATA----ATAA-CAGGA
L. cernua	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGTGTTATA----ATAA-CAGGA
L. comptonii	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L.concordiana	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. congesta	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. contaminata	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGTGTTATA----ATAA-CAGGA
L. convallarioides	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. corymbosa	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. dehoopensis	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. doleritica	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. duncanii	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. ensifolia subsp. ensifolia	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. ensifolia var. maughanii	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. fistulosa	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGTGTTATA----ATAA-CAGGA
L. framesii	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGTGTTATA----ATAA-CAGGA
L. gillettii	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTT-----ATA----ATAA-CAG--
L. haarlemensis	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAAACAGGA
L. hirta	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAAACAGGA
L. inconspicua	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGAA
L. isopetala	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTG------ATAA--A---
L. magentea	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. juncifolia var. juncifolia	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. karooica	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. kombergensis	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTT-----ATA----ATAA-CAGGA
L. arbuthnotiae	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGTGTTATA----ATAA-CAGGA

L. longituba	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. margaretea	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGTGTTATATATAATAA-CAGGA
L. martiniae	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. mathewsii	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGTGTTATA----ATAA-CAGGA
L. maximiliani	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. mediana	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. moniliformis	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAAACAGGA
L. muirii	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGTGTTATA----ATAA-CAGGA
L. multifolia	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. mutabilis	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGTGTTATA----ATAA-CAGGA
L. namaquensis	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTT-----ATA----ATAA-CAGGA
L. namibiensis	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAAACAGGA
L. nervosa	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. obscura	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. paucifolia	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. perryae	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAAACAGGA
L. perryae/unifolia	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. polypodantha	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATT----ATAA-CAGGA
L. pusilla	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGTGTTATA----ATAA-CAGGA
L. pustulata	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTT-----ATA----ATAA-CAAGA
L. rosea	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGTGTTATA----ATAA-CAGGA
L. punctata	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTATAATA-A----ATAA-CAGGA
L. salteri	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGTGTTATA----ATAA-CAGGA
L. schelpei	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. sp	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. splendida	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTT-----ATA----ATAA-CAGGA
L. stayneri	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. thomasiae	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGTGTTATATATAATAA-CAGGA
L. trichophylla	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. undulata	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. unicolor	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTT-----ATA----ATAA-CAGGA
L. unifolia	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. unifolia/hirta	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. valeriae	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTT-----ATA----ATAA-CAGGA
L. variegata	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGTGTTATA----ATAA-CAGGA
L. verticillata	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGTGTTATA----ATAA-CAGGA
L. violacea	CAATGGAAGCTGTTCTAACGAATGGAGTTGATTACGTTGTGTTATA----ATAA-CAGGA
L. youngii	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTATA----ATAA-CAGGA
L. zebrina	CAATGGAAGTTGTTCTAACGAATGGAGTTGACTACGTTGCGTTA------ATAA-CA---
L. zeyheri	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGTGTTATA----ATAA-CAGGA
M. depressa	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTA------ATAA--A---

V. bracheata	CAATGGAAGCTGTTCTAACGAATAGAGTTGACTACGTTGCGTTA------ATAA-CAGGA
V. capensis	CAATGGAAGCTGTTCTAACGAATAGAGTTGACTACGTTGCGTTA------ATAA-CAGGA
W. bifolia	CAATGGAAGCTGTTCTAACGAATGGAGTTGACTACGTTGCGTTA------ATAA-CAGG-

E. bicolor	-----------AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
E. vandermerwei	-----------AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. alba	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. flava	ATA -----ATCAATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. ameliae	ATAGAATAAATAATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. angelica	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. anguinea	AT-GAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. attenuata	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. aurioliae	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. bolusii	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. bowkeri	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. bifolia	ATAGAATAATCAATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA-----ATATATCTA
L. capensis	ATAGAATAATCAATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. cernua	ATAGAATAATCAATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. comptonii	ATAGAATAAATAATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATTTA
L. concordiana	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. congesta	AT---------AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. contaminata	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. convallarioides	ATA-----ATCAATCCTTCTATCGAAATTAAAGAAAGGGTGGCCTA------TATATCTA
L. corymbosa	ATATAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. dehoopensis	ATAGAATAATTAATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. doleritica	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. duncanii	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. ensifolia subsp. ensifolia	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. ensifolia var. maughanii	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. fistulosa	ATAGAATAATCAATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. framesii	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. gillettii	---GAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. haarlemensis	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. hirta	AT---------AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. inconspicua	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. isopetala	-CAGG------AATCCTTCTATCGAAATTAAAGAAAGGGTGACCCA------TATATCTA
L. magentea	AT---------AATCCTTCTATCGAAATTAAAGAAAGGGGGACCTA------TATATCTA
L. juncifolia var. juncifolia	AT---------AATCCTTCTATCGAAATTAAAGAAAGGGGGACCTA------TATATCTA
L. karooica	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. kombergensis	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. arbuthnotiae	ATAGAATAATCAATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA

L. longituba	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. margaretea	ATAGAATAATCAATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. martiniae	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. mathewsii	ATAGAATAATCAATCCTTCTATCGAAATTAAAGAAAGGGTGACGTA------TATATCTA
L. maximiliani	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. mediana	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. moniliformis	AT-GAAT----AATCCTTCTATCGAAATTAAAGAAAGGGGGACCTA------TATATCTA
L. muirii	ATAGAATAATCAATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. multifolia	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. mutabilis	ATAGAATAATCAATCCTTCTATCGAAATTAAAGAAAGGGTGACCTATA--TATCTATCTA
L. namaquensis	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. namibiensis	AT---------AATCCTTCTATCGAAATTAAAGAAAGGGTGACGTA------TATATCTA
L. nervosa	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGCGACCTA------TATATCTA
L. obscura	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. paucifolia	ATATAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. perryae	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. perryae/unifolia	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. polypodantha	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. pusilla	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. pustulata	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. rosea	ATAGAATAAATAATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. punctata	ATAGAATAATCAATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA-----ATATATCTA
L. salteri	ATAGAATAAATAATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. schelpei	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. sp	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. splendida	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. stayneri	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGCGACCTA------TATATCTA
L. thomasiae	ATAGAATAATCAATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. trichophylla	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. undulata	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. unicolor	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. unifolia	AT---------AATCCTTCTATCGAAATTAAAGAAAGGGGGACCTA------TATATCTA
L. unifolia/hirta	ATAGAAT----AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. valeriae	ATAGAAT-----ATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. variegata	ATAGAATAATCAATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. verticillata	ATAGAAT------TCCTTCTATTGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. violacea	ATAGAAT-----ATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. youngii	ATAGAAT----AATCCTTCTATCGAAATGAAAGAAAGGGCGACCTA------TATATCTA
L. zebrina	--AGG------AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
L. zeyheri	ATAGAATAATCAATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA
M. depressa	-CAGG------AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA

V. bracheata	ACAGG------AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA-TATTATATATCTA
V. capensis	ACAGG------AATCCTTCTATCGAAATTAAAGAAAAAGAAAGGGTGACCTATATATCTA
W. bifolia	-----------AATCCTTCTATCGAAATTAAAGAAAGGGTGACCTA------TATATCTA

E. bicolor	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
E. vandermerwei	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. alba	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. flava	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. ameliae	ATACGTACGTATACATACTGACATATCAAACGATTAATGATGACCCGAATCCATATAT-T
L. angelica	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. anguinea	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. attenuata	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. aurioliae	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. bolusii	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. bowkeri	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. bifolia	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. capensis	ATACGTACGTATACATACTGACATATCAAACGATTAATTATGACCCGAATCCATATAT-T
L. cernua	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. comptonii	ATACGTACGTATACATACTGACATATCAAACGATTAATGATGACCCGAATCCATATAT-T
L. concordiana	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. congesta	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. contaminata	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. convallarioides	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. corymbosa	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. dehoopensis	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. doleritica	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. duncanii	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. ensifolia subsp. ensifolia	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. ensifolia var. maughanii	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. fistulosa	ATACGTACGTATACATACTGACATATCAAACGATTAATTATGACCCGAATCCATATAT-T
L. framesii	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. gillettii	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. haarlemensis	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. hirta	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. inconspicua	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. isopetala	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATT-ATATATAT
L. magentea	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. juncifolia var. juncifolia	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. karooica	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. kombergensis	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. arbuthnotiae	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T

L. longituba	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. margaretea	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. martiniae	ATACGTACGTATACATACTGACATATCAAACAATTAATCATGACCCGAATCCATATAT-T
L. mathewsii	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. maximiliani	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. mediana	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. moniliformis	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. muirii	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. multifolia	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. mutabilis	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. namaquensis	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. namibiensis	ATACGTACGTATACATACT-----ATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. nervosa	ATACGTACGTATACATACTGACATATCAAACAATTAATCATGACCCGAATCCATATAT-T
L. obscura	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. paucifolia	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. perryae	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. perryae/unifolia	ATACGTACATATACATACTGACATATCAAACGATTAATCATGATCCGAATCCATATAT-T
L. polypodantha	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. pusilla	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. pustulata	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATGTAT-T
L. rosea	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. punctata	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCAAATCCATATAT-T
L. salteri	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. schelpei	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. sp	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. splendida	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. stayneri	ATACGTACGTATACATACTGACATATCAAACAATTAATCATGACCCGAATCCATATAT-T
L. thomasiae	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. trichophylla	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. undulata	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. unicolor	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. unifolia	ATACGTACGTATAC----TGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. unifolia/hirta	ATACGTACATATACATACTGACATATCAAACGATTAATCATGATCCGAATCCATATAT-T
L. valeriae	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. variegata	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. verticillata	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. violacea	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
L. youngii	ATACGTACGTATACATACTGACATATCAAACAATTAATCATGACCCGAATCCATATAT-T
L. zebrina	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCC----CCATATAT-T
L. zeyheri	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
M. depressa	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T

V. bracheata	ATACGTACGT--------TGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
V. capensis	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T
W. bifolia	ATACGTACGTATACATACTGACATATCAAACGATTAATCATGACCCGAATCCATATAT-T

E. bicolor	ATA---TATA----CATGTATATGCAATATTATATGCAATATGCGCAATATATGCAAAAT
E. vandermerwei	ATA---TATA----CATGTATATGCAATATTATATGCAATATGCGCAATATATGCAAAAT
L. alba	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. flava	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. ameliae	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. angelica	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. anguinea	ATA---TATACACGTATGTATATGCAATAT------------ATGC---------AAAAT
L. attenuata	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. aurioliae	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. bolusii	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. bowkeri	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. bifolia	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. cernua	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. comptonii	-TA---TATA----CACGTATATGCAATAT------------ATGCAATATATGCAAAAT
L. concordiana	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. congesta	ATA---TATA----CACGTATATACAATAT------------ATGC---------AAAAT
L. contaminata	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. convallarioides	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. corymbosa	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. dehoopensis	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. doleritica	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. duncanii	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. ensifolia subsp. ensifolia	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. ensifolia var. maughanii	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. fistulosa	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. framesii	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. gillettii	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. haarlemensis	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. hirta	ATA---TATACACGTATGTATATGCAATAT------------ATGC---------AAAAT
L. inconspicua	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. isopetala	ATA---TATA----CATGTATATGCAATAT------------GCGCAATATATGCAAAAT
L. magentea	ATA---TATACACGTATGTATATGCAATAT------------ATGC---------AAAAT
L. juncifolia var. juncifolia	ATA---TATACACGTATGTATATGCAATAT------------ATGC---------AAAAT
L. karooica	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. kombergensis	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. arbuthnotiae	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. longituba	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT

L. margaretea	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. martiniae	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. mathewsii	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. maximiliani	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. mediana	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. moniliformis	ATA---TATACACGTATGTATATGCAATAT------------ATGC---------AAAAT
L. muirii	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. multifolia	ATA---TATA----CACGTATATGCGATAT------------ATGC---------AAAAT
L. mutabilis	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. namaquensis	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. namibiensis	ATA---TATACACGTATGTATATGCAATAT------------ATGC---------AAAAT
L. nervosa	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. obscura	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. paucifolia	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. perryae	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. perryae/unifolia	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. polypodantha	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. pusilla	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. pustulata	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. rosea	GCA---TATA----CGTGTGTGTATATATAATAT--------ATGC---------AAAAT
L. punctata	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. salteri	GCA---TATA----CGTGTATATATAATAT------------ATGC---------AAAAT
L. schelpei	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. sp	ATAATATATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. splendida	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. stayneri	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. thomasiae	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. trichophylla	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. undulata	GCA---TATA----CGTGTATATATAATAT------------ATGC---------AAAAT
L. unicolor	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. unifolia	ATA---TATACACGTATGTATATGCAATAT------------ATGC---------AAAAT
L. unifolia/hirta	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. valeriae	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. variegata	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. verticillata	ATA---TATA----CACGTATATACAATAT------------ATGC---------AAAAT
L. violacea	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. youngii	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
L. zebrina	ATA---TATA----CATGTATATGCAATAT------------ATGC---------AAAAT
L. zeyheri	ATA---TATA----CACGTATATGCAATAT------------ATGC---------AAAAT
M. depressa	ATA---TATA----CATGTATATGCAA------------------------------AAT
V. bracheata	ATA---TATA----CATGTATATGCAATATTATATGTAATATGCGCAATATATGCAAAAT

V. capensis	ATA---TATA----CATGTATATGCAATATTATATGTAATATGCGCAATATATGCAAAAT
W. bifolia	ATA---TATA----CATGTATATGCAATAT------------GCGCAATATATGCAAAAT

E. bicolor	TCGGAGTTATTGTGGATCTATTCCAATCGAAATTGAC----GGAAGAATCGAAT----AG
E. vandermerwei	TCGGAGTTATTGTGGATCTATTCCAATCGAAATTGAC----GGAAGAATCGAAT----AG
L. alba	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L . flava	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. ameliae	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. angelica	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. anguinea	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATC-AATATTCAG
L. attenuata	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. aurioliae	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. bolusii	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. bowkeri	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. bifolia	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. capensis	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. cernua	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. comptonii	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. concordiana	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. congesta	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGATCA---AA
L. contaminata	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. convallarioides	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. corymbosa	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. dehoopensis	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. doleritica	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. duncanii	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. ensifolia subsp. ensifolia	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. ensifolia var. maughanii	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. fistulosa	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. framesii	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. gillettii	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. haarlemensis	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. hirta	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATC-AATATTCAG
L. inconspicua	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. isopetala	TCAGAGTTATTGTGGATCTATTCCACCAATCGAAGAC----GGAAGAATCTAATATTCAG
L. magentea	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATC-AATATTCAG
L. juncifolia var. juncifolia	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATC-AATATTCAG
L. karooica	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. kombergensis	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. arbuthnotiae	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. longituba	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG

L. margaretea	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. martiniae	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. mathewsii	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. maximiliani	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. mediana	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. moniliformis	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATC-AATATTCAG
L. muirii	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. multifolia	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. mutabilis	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. namaquensis	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. namibiensis	TCAGAG-----ATGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. nervosa	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. obscura	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. paucifolia	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. perryae	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. perryae/unifolia	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. pusilla	TC---------GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. pustulata	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. rosea	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. punctata	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. salteri	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. schelpei	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. sp	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. splendida	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. stayneri	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. thomasiae	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. trichophylla	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. undulata	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. unicolor	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. unifolia	TCAGAG-----GTGGATCTATTCCTATCGAAGTTGAC----GGAAGAATC-AATATTCAG
L. unifolia/hirta	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. valeriae	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. variegata	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. verticillata	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGATTGATGGAAGAATCGAATATTCAG
L. violacea	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. youngii	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. zebrina	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
L. zeyheri	TCAGAG-----GTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
M. depressa	TCAGAATTATTGTGGATCTATTCCAATCGAAGTTGAT----GGAAGAATCGAATATTCAG
V. bracheata	TCAGAGTTATTGTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
V. capensis	TCAGAGTTATTGTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG

W. bifolia	TCAGAGTTATTGTGGATCTATTCCAATCGAAGTTGAC----GGAAGAATCGAATATTCAG
E. bicolor	TGATCAAATCATT------CCAG----AGTT-----TAAT----AAACCC----TTT---
E. vandermerwei	TGATCAAATCATT------CCAG----AGTT-----TAAT----AAACCC----TTT---
L. alba	TGATCAAATCATTC------CAG----AGTT-----TAAT----AGACCCC---TTT--T
L. flava	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. ameliae	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. angelica	TGATCAAATCATTC------CAG----AGTT-----TAAT----AGACCCC---TTT--T
L. anguinea	TGATCAAATTATTC--ATTTCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. attenuata	TGGTCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. aurioliae	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. bolusii	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. bowkeri	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. bifolia	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. capensis	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. cernua	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. comptonii	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---CTT--T
L. concordiana	TGATCAAATCATTC------CAG----AGTT-----TAAT----AGACCCC---TTT--T
L. congesta	TCAT--------TC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. contaminata	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. convallarioides	TGATCAAA----TC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. corymbosa	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. dehoopensis	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. doleritica	TGATCAAA----TC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. duncanii	TGATCAAATCATTC------CAG----AGTT-----TAAT----AGACCCC---TTT--T
L. ensifolia subsp. ensifolia	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. ensifolia var. maughanii	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---CTT--T
L. fistulosa	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. framesii	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. gillettii	TGATCAAATCATTC--ATTCCAG----AGTT-----TAATAGATAGACCCC---TTT--T
L. haarlemensis	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. hirta	TGATCAAATTATTC--ATTTCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. inconspicua	TGATCAAATCATTC----T--AG----AGTT-----TAAT----AGACCCC---TTT--T
L. isopetala	TGATCAAATCATTC--ATTCCAG----AGTT--GTTTAAT----AGACCC----TTT--T
L. magentea	TGATCAAATTATTC--ATTTCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. juncifolia var. juncifolia	TGATCAAATTATTC--ATTTCAG----AGTT-----TAAT----AGACCC----TTT-TT
L. karooica	TGATCAAATCATTC------CAG----AGTT-----TAAT----AGACCCC---TTT--T
L. kombergensis	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. arbuthnotiae	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. longituba	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCCC--TTTTTT
L. margaretea	TGATCAAATCATTC------CAG----AGTT-----TAAT----AGACCCC---TTT--T

L. martiniae	TGATCAAATCATTC--ATTCCAGCCAGAGTT-----TAAT----AGACCCC---TTT--T
L. mathewsii	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. maximiliani	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. mediana	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. moniliformis	TGATCAAATTATTT--ATTTCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. muirii	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. multifolia	TGATCAAATCATTC--ATTCC--------TT-----TAAT----AGACCCC---TTT--T
L. mutabilis	TGATCAAATCATTCTCATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. namaquensis	TGATCAAATCATTC--ATTCCAG----AGTT-----TAATAGATAGACCCC---TTT--T
L. namibiensis	TGATCAAATCATTC--ATT-CAG----AGTT-----TAAT----AGACCCC---TTT--T
L. nervosa	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCCAG-TTT--T
L. obscura	TGATCAAATCATTC--ATT-CAG----AGTT-----TAAT----AGACCCC---TTT--T
L. paucifolia	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. perryae	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. perryae/unifolia	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. polypodantha	TGATCAAA----TC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. pusilla	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. pustulata	TGATCAAATCATTC--ATTCCAG----AGTT-----TAATAGATAGACCCC---TTT--T
L. rosea	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. punctata	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. salteri	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. schelpei	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. sp	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---CTT--T
L. splendida	TGATCAAATCATTC--ATTCCAG----AGTT-----TAATAGATAGACCCC---TTT--T
L. stayneri	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. thomasiae	TGATCAAATCATTC------CAG----AGTT-----TAAT----AGACCCC---TTT--T
L. trichophylla	TGATCAAATCATTC------CAG----AGTT-----TAAT----AGACCCC---TTT--T
L. undulata	TGATCAAATCAT------TCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. unicolor	TGATCAAATCATTC--ATTCCAG----AGTT-----TAATAGATAGACCCC---TTT--T
L. unifolia	TGATCAAATTATTC--ATTTCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. unifolia/hirta	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. valeriae	TGATCAAATCATTC--ATTCCAG----A--T-----AGAT----AGACCCC---TTT--T
L. variegata	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. verticillata	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. violacea	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. youngii	GGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
L. zebrina	TGATCAAA----TC--ATTCCAG----AGTT-----TAAT----AGACCC----TTT--T
L. zeyheri	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCCC---TTT--T
M. depressa	TGATCAAATCATTC--ATTCCAG----AGTTTAGTTTAAT----AGACCC----TTT-TT
V. bracheata	TGATCAAATCATTT--ATTCCAG----AGTT-----TAAT----AGACCC---TTTTTTT
V. capensis	TGATCAAATCATTT--ATTCCAG----AGTT-----TAAT----AGACCC----TTT--T

W. bifolia	TGATCAAATCATTC--ATTCCAG----AGTT-----TAAT----AGACCC----TTT-TT
E. bicolor	TTGAAAAACGGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
E. vandermerwei	TTGAAAAACGGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. alba	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. flava	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. ameliae	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. angelica	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. anguinea	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. attenuata	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. aurioliae	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. bolusii	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. bowkeri	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. bifolia	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. capensis	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. cernua	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. comptonii	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. concordiana	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. congesta	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. contaminata	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. convallarioides	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. corymbosa	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. dehoopensis	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. doleritica	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. duncanii	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. ensifolia subsp. ensifolia	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L._ensifolia var. maughanii	TTGATAATCTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. fistulosa	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. framesii	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. gillettii	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. haarlemensis	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. hirta	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. inconspicua	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. isopetala	TTGAAAAACTGATTAATCGAACGAGAATCGAGAATAAAGAGAGAGTCCCGTTCTACATGT
L. magentea	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. juncifolia var. juncifolia	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. karooica	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. kombergensis	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. arbuthnotiae	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. longituba	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. margaretea	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT

L. martiniae	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. mathewsii	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. maximiliani	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. mediana	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. moniliformis	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. muirii	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. multifolia	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. mutabilis	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. namaquensis	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. namibiensis	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. nervosa	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. obscura	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. paucifolia	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. perryae	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. perryae/unifolia	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. polypodantha	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. pusilla	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. pustulata	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. rosea	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. punctata	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. salteri	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. schelpei	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. sp	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. splendida	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. stayneri	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. thomasiae	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. trichophylla	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. undulata	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. unicolor	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. unifolia	TTGAAAAACTGATTAATCGGACGAGAATA------AAAGAGAGAGTCCCGTTCTACATGT
L. unifolia/hirta	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. valeriae	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. variegata	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. verticillata	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. violacea	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. youngii	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. zebrina	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
L. zeyheri	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
M. depressa	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
V. bracheata	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
V. capensis	TTGAAAAACTGATTAATCGGACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT

W. bifolia	TTGAAAAACTGATTAATCGTACGAGAATA------AA-GAGAGAGTCCCGTTCTACATGT
E. bicolor	CAATATGTCAATACCGACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAGAAAAAAAA
E. vandermerwei	CAATATGTCAATACCGACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAGAAAAAAAA
L. alba	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. flava	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. ameliae	CAATAT-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. angelica	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. anguinea	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. attenuata	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAGAAGAAAAAA
L. aurioliae	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. bolusii	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. bowkeri	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. bifolia	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. capensis	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. cernua	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. comptonii	CAATAT-------C-GACAACAA-TGAA-TTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. concordiana	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. congesta	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. contaminata	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. convallarioides	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. corymbosa	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. dehoopensis	CAATAC-------C-GACAACAA-TGAA-TTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. doleritica	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. duncanii	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. ensifolia subsp. ensifolia	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAAGAAAAGAAAAAA
L. ensifolia var. maughanii	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGAAAGGAAAAGAAAAAA
L. fistulosa	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. framesii	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. gillettii	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAGAAGAAAAAA
L. haarlemensis	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. hirta	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. inconspicua	CAATAC-------C-GACACCAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. isopetala	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGAAAGAAAAAAAG
L. magentea	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGGAGGAAAAGAAAAAA
L. juncifolia var. juncifolia	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGGAGGAAAAGAAAAAA
L. karooica	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. kombergensis	CAATAC-------C-GACAACAAATGAAATTT-ATAGTAAGAGGGAAGGAGAAGAAAAAA
L. arbuthnotiae	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. longituba	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. margaretea	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAAAAAAAA

L. martiniae	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. mathewsii	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. maximiliani	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. mediana	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. moniliformis	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGGAGGAAAAGAAAAAA
L. muirii	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. multifolia	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. mutabilis	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. namaquensis	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAGAAGAAAAAA
L. namibiensis	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAGAA
L. nervosa	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. obscura	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. paucifolia	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. perryae	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. perryae/unifolia	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. polypodantha	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAGAGAAAAGAAAAAA
L. pusilla	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. pustulata	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAGAAGAAAAAA
L. rosea	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. punctata	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGGAAGGAAAAAA
L. salteri	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. schelpei	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. sp	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. splendida	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAGAAGAAAAAA
L. stayneri	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. thomasiae	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAAAAAAAA
L. trichophylla	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. undulata	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. unicolor	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAGAAGAAAAAA
L. unifolia	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGGAGGAAAAGAAGAAA
L. unifolia/hirta	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. valeriae	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAGAAGAAAAAA
L. variegata	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. verticillata	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. violacea	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
L. youngii	CAATAC-------C-GACAACAA-TGAAATTT-AGAGTAAGAGGGAAGGAAAAGAAAAAA
L. zebrina	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAGAAAAAAGA
L. zeyheri	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAAAGAAAAAA
M. depressa	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAGAAAAAAAA
V. bracheata	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAGAAGAAAAA
V. capensis	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAGAAAAAAAA

W. bifolia	CAATAC-------C-GACAACAA-TGAAATTT-ATAGTAAGAGGGAAGGAAGAAAAAAAA
E. bicolor	GAGGAAGAGAAAAGAGAGAAGGGAAGAAG
E. vandermerwei	GAGGAAGAGAAAAGAGAGAAGGGAAGAAG
L. alba	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. flava	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. ameliae	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. angelica	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. anguinea	GAGAAGGGAAAAAGAGAGGAAGGGGGAAG
L. attenuata	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. aurioliae	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. bolusii	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. bowkeri	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. bifolia	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. capensis	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. cernua	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. comptonii	GGGGAGGAAAAAAGAGAGGAAGGGGGGAG
L. concordiana	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. congesta	GAGGAGGAAGGAAGAGAGGAAGGGGGAAG
L. contaminata	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. convallarioides	GAGGAGGAAAAGAGAGAGGAAGGGGGAAG
L. corymbosa	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. dehoopensis	GAGGAGGAAAAAAGAGAGGAAGGGGGGAG
L. doleritica	GAGGAGGAAAAGAGAGAGGAAGGGGGAAG
L. duncanii	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. ensifolia subsp. ensifolia	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. ensifolia var. maughanii	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. fistulosa	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. framesii	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. gillettii	GAGGAGGAAAAAAGAGAAGAAGGGGGAAG
L. haarlemensis	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. hirta	GAGAAGGGAAAAAGAGAGGAAGGGGGAAG
L. inconspicua	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. isopetala	AAGGAAGAAAAAAGAAGGGAAAAGGGAAG
L. magentea	GAGAAGGGAAAAAGAGAGGAAGGGGGAAG
L. juncifolia var. juncifolia	GAGAAGGGAAAAAGAGAGAGAGGGGGAAG
L. karooica	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. kombergensis	GAGGAGGAAAAAAGAGAGGAAGGGGAAAG
L. arbuthnotiae	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. longituba	GAGGAGGAAAAAAGAGAGAAAGGGGGAAG
L. margaretea	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG

L. martiniae	GAGGAGGAAAAAAAAGAGGAAGGGGGAAG
L. mathewsii	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. maximiliani	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. mediana	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. moniliformis	GAGAAGGGAAAAAGAGAGGAAGGGGGAAG
L. muirii	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. multifolia	GAGGAGGAAAAAGAAGAGGAAGGGGGAAG
L. mutabilis	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. namaquensis	GAGGAGGAAAAAAGAGAAGAAGGGGGAAG
L. namibiensis	GAGAAGGAAAAAAGAGAGGAAGGGGGAAG
L. nervosa	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. obscura	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. paucifolia	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. perryae	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. perryae/unifolia	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. polypodantha	GAGGAGGAAAAGAGAGAGGAAGGGGGAAG
L. pusilla	GAGGGAGAAAAAAGAGAGGAAGGGGGAAG
L. pustulata	GAGGAGGAAAAAAGAGAAGAAGGGGGAAG
L. rosea	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. punctata	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. salteri	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. schelpei	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. sp.	GAAGAGGAAAAAAGAGAGGAAGGGGGAAG
L. splendida	GAGGAGGAAAAAAGAGAAGAAGGGGGAAG
L. stayneri	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. thomasiae	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. trichophylla	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. undulata	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. unicolor	GAGGAGGAAAAAAGAGAAGAAGGGGGAAG
L. unifolia	GAGAAGGGAAAAAGAGAGGAAGAGGGAAG
L. unifolia/hirta	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. valeriae	GAGGAGGAAAAAAGGGAGGAAGGGGGAAG
L. variegata	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. verticillata	GAGGAGAAAAAAAGAGAGGAAGGGGGAAG
L. violacea	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. youngii	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
L. zebrina	GAGGAGGAAAAGAGAGAGGAAGGGGGAAG
L. zeyheri	GAGGAGGAAAAAAGAGAGGAAGGGGGAAG
M. depressa	GAGGAAGAAAAAAGAAAGAGAGGGGGAAG
V. bracheata	GAGGAAGAAAAAAGAGAGAAAGGGGGAAG
V. capensis	GAGGAAGAAAAAAGAGAGGAAGGGGGAAG

W. bifolia GAGGAAGAAAAAAGAGAGAGAGAGGGGGAAG

Appendix G: Aligned sequences of the combined *rbcL* and indels dataset of all the specimens used for cladistics analysis. *E. = Eucomis, G. = Gloriosa*, *M. = Massonia*, *L. = Lachenalia*, *V. = Veltheimia, Whiteheadia bifolia.*

E. autumnalis	GATTGACTT--ATTATAC-------TCGTATTATTACGAAACCAAAGATACTGATATT--
E. bicolor	TATTTTGAC--GCCGTGG-------TCTTGTTT-TTACG--CG-GTGGAATTGATTTT--
E. pole-evansii	GATTGACTTGTATTATACTCGGTGGACCTGATT-ACGAAA-CCAAAGATACTGATATTAC
E. vandermerwei	GATTGACTTT-ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
G. superba	AATTGACTT--ATTATAC-------TCCTGAAT-ACAAAACCCAAGGATACTGATATC--
L. angelica	???????????ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. alba	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. flava	?ATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. ameliae	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. anguinea	GATTAACTT--ATTATAC-------TCCTGATTTACGAAA-CCAAAGATACTGATATT--
L. attenuata	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. aurioliae	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. bolusii	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. bowkeri	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. bifolia	?ATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. capensis	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. cernua	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. comptonii	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. concordiana	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. congesta	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. contaminata	???TGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. convallarioides	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. cornymabosa	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. corymbosa	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. dehoopensis	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. doleritica	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. duncanii	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. ensifolia subsp. ensifolia	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. ensifolia var. maughanii	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. fistulosa	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. framesii	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. gillettii	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. haarlemensis	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. hirta	?ATTAACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. inconspicua	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. isopetala	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. magentea	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--

L. juncifolia var. juncifolia	GATTAACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. karooica	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. kombergensis	???????????ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. arbuthnotiae	?ATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. longituba	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. longibracteata	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. margaretea	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. martiniae	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. mathewsii	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. maximiliani	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. mediana	TATTTA-AC--GG-GTGG-------TATTGTTT--TTACA-GCGGAGGCCGTGATTTT--
L. moniliformis	?ATTAACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. muirii	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. multifolia	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. mutabilis	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. namaquensis	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. namibiensis	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. nardousbergensis	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. nervosa	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CTAAAGATACTGATATT--
L. obscura	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. orthopetala	?ATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. paucifolia	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. perryae	GATTAACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. perryae/unifolia	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. polypodantha	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. pusilla	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. pustulata	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. rosea	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. punctata	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. salteri	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. schelpei	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. sp	??
L. sp	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. splendida	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. stayneri	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. thomasiae	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. trichophylla	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. trichophylla subsp. trichophylla	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. undulata	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. unicolor	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. unifolia	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--

L. unifolia/hirta	GATTAACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. valeriae	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. variegata	?ATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. verticillata	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. violacea	?ATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. youngii	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CTAAAGATACTGATATT--
L. zebrina	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
L. zeyheri	GATTAACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
M. depressa	GATTGACTT--ATTATAC-------TCCGGATT-ACGAAA-CCAAAGATACTGATATT--
M. wittebergensis	GATTGACTT--ATTATAC-------TCCGGATT-ACGAAA-CCAAAGATACTGATATT--
V. bracheata	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
V. capensis	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--
W. bifolia	GATTGACTT--ATTATAC-------TCCTGATT-ACGAAA-CCAAAGATACTGATATT--

E. autumnalis	AATATTG-AGCAG-CATTCCGA-GTAACTCCTCAACC-TGGAGTTCCC-GCTGAAGAAGC
E. bicolor	GAGGGTGGAATTCATTTTACAC-GGCGCCTCAAATTG-GAGTTCCCG-GTGAAGAATCAG
E. pole-evansii	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCAA-GAGTTCCCG-CTGAAGAAGCAG
E. vandermerwei	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
G. superba	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. alba	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. flava	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. ameliae	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. anguinea	TTAGCAG-----CCTTCCGAGT-AACTCCTCAACCTG-GAGTTCCCCGCTGAAGAAGCAG
L. attenuata	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. aurioliae	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. bolusii	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. bowkeri	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. bifolia	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. capensis	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. cernua	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. comptonii	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. concordiana	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. congesta	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. contaminata	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. convallarioides	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCCG-GAGTTCCCG-CTGAAGAAGCAG
L. cornymabosa	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. corymbosa	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. dehoopensis	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. doleritica	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. duncanii	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. ensifolia subsp. ensifolia	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG

L. ensifolia var. maughanii	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. fistulosa	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. framesii	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. gillettii	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. haarlemensis	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. hirta	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. inconspicua	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. isopetala	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. magentea	TGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. juncifolia var. juncifolia	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. karooica	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. kombergensis	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. arbuthnotiae	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. longituba	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. longibracteata	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. margaretea	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CGGAAGAAGCAG
L. martiniae	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. mathewsii	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. maximiliani	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. mediana	GCAATTTGGGGGCATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. moniliformis	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. muirii	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. multifolia	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. mutabilis	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. namaquensis	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. namibiensis	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. nardousbergensis	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. nervosa	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. obscura	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. orthopetala	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. paucifolia	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. perryae	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. perryae/unifolia	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. polypodantha	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. pusilla	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. pustulata	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. rosea	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. punctata	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. salteri	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. schelpei	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. sp	??

L. sp	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. splendida	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. stayneri	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. thomasiae	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. trichophylla	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. trichophylla subsp. trichophylla	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GGGTTCCCG-CTGAAGAAGCAG
L. undulata	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. unicolor	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. unifolia	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. unifolia/hirta	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. valeriae	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. variegata	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. verticillata	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. violacea	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. youngii	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. zebrina	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
L. zeyheri	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
M. depressa	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
M. wittebergensis	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
V. bracheata	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
V. capensis	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG
W. bifolia	TTGGCAG-----CATTCCGAGT-AACTCCTCAACCTG-GAGTTCCCG-CTGAAGAAGCAG

E. autumnalis	AGGGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGG
E. bicolor	GGGCTGGGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
E. pole-evansii	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
E. vandermerwei	GGGCTGCGGTAGCTGCCGAATCTTCTAGTGGTACATGGACAACTGTGTGGACCGATGGAC
G. superba	GGGCTGCAGTAGCTGCCGAGTCTTCTACTGGTACATGGACAACTGTGTGGACTGATGGAC
L. angelica	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. alba	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. flava	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. ameliae	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. anguinea	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. attenuata	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. aurioliae	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. bolusii	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. bowkeri	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. bifolia	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. capensis	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. cernua	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. comptonii	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC

L. concordiana	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. congesta	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. contaminata	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. convallarioides	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. cornymabosa	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. corymbosa	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. dehoopensis	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. doleritica	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. duncanii	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. ensifolia subsp. ensifolia	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. ensifolia var. maughanii	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. fistulosa	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. framesii	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. gillettii	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. haarlemensis	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. hirta	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. inconspicua	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. isopetala	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. magentea	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. juncifolia var. juncifolia	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. karooica	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. kombergensis	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. arbuthnotiae	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. longituba	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. longibracteata	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. margaretea	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. martiniae	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. mathewsii	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. maximiliani	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. mediana	GAGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. moniliformis	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. muirii	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. multifolia	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. mutabilis	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. namaquensis	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. namibiensis	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. nardousbergensis	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. nervosa	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. obscura	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. orthopetala	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. paucifolia	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC

L. perryae	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. perryae/unifolia	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. polypodantha	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. pusilla	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. pustulata	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. rosea	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. punctata	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. salteri	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. schelpei	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. sp	??ACCGATGGAC
L. sp	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. splendida	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. stayneri	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. thomasiae	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. trichophylla	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. trichophylla subsp. trichophylla	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. undulata	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. unicolor	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. unifolia	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. unifolia/hirta	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. valeriae	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. variegata	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. verticillata	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. violacea	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. youngii	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. zebrina	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
L. zeyheri	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
M. depressa	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
M. wittebergensis	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
V. bracheata	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
V. capensis	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC
W. bifolia	GGGCTGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC

E. autumnalis	ACTTACCAGTCTTGATCGTTACAAAGGACGATGCTACCACATTGAGGCCGTTGTTGGG-G
E. bicolor	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGG-G
E. pole-evansii	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGG-G
E. vandermerwei	TTACCAGTCTTGATCGTTACAAAGGACGATGTTTAACCACATTGAGGGGATTGTTTTGAG
G. superba	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACAGCATCGAGAAAGTTATTGGG-G
L. angelica	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCTGTTGTTGGA-G
L. alba	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. flava	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G

L. ameliae	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGG-G
L. anguinea	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. attenuata	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCTGTTGTTGGA-G
L. aurioliae	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCTGTTGTTGGA-G
L. bolusii	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCTGTTGTTGGA-G
L. bowkeri	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCTGTTGTTGGA-G
L. bifolia	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. capensis	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. cernua	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. comptonii	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGG-G
L. concordiana	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. congesta	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. contaminata	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. convallarioides	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. cornymabosa	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. corymbosa	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCATATTGAGGCCGTTGTTGGA-G
L. dehoopensis	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCTGTTGTTGGA-G
L. doleritica	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. duncanii	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. ensifolia subsp. ensifolia	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. ensifolia var. maughanii	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. fistulosa	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. framesii	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. gillettii	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. haarlemensis	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCTGTTGTTGGA-G
L. hirta	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. inconspicua	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. isopetala	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGG-G
L. magentea	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. juncifolia var. juncifolia	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. karooica	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. kombergensis	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCTGTTGTTGGA-G
L. arbuthnotiae	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. longituba	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. longibracteata	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. margaretea	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. martiniae	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. mathewsii	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. maximiliani	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. mediana	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. moniliformis	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G

L. muirii	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. multifolia	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. mutabilis	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. namaquensis	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. namibiensis	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. nardousbergensis	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. nervosa	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. obscura	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. orthopetala	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. paucifolia	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. perryae	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. perryae/unifolia	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. polypodantha	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCTGTTGTTGGA-G
L. pusilla	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. pustulata	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. rosea	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCATATTGAGGCCGTTGTTGGA-G
L. punctata	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. salteri	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCATATTGAGGCCGTTGTTGGA-G
L. schelpei	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. sp	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. sp	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. splendida	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. stayneri	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. thomasiae	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. trichophylla	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCTGTTGTTGGA-G
L. trichophylla subsp. trichophylla	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCTGTTGTTGGA-G
L. undulata	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. unicolor	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. unifolia	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. unifolia/hirta	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. valeriae	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. variegata	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. verticillata	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. violacea	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. youngii	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. zebrina	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
L. zeyheri	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
M. depressa	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
M. wittebergensis	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G
V. bracheata	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGG-G
V. capensis	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGG-G

W. bifolia	TTACCAGTCTTGATCGTTACAAAGGACGATGCT--ACCACATTGAGGCCGTTGTTGGA-G

E. autumnalis	AAGAAAATCAATTT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
E. bicolor	AAGAAAATCAATTT--ATTGCTTGGAAGAATGTAGCTTATGACCCAGTTTAGATAACCTT
E. pole-evansii	AAGAAAATCAATTT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
E. vandermerwei	AAGAAAAGGAATTGGAATTTTACGCG---GTGGACTTGATTTTACGCGGTGGACTTGATT
G. superba	AAGATAATCAATAT--ATTGCTTACG---GTGGACTCCTTTAGACGCGGTGGAAG-AATT
L. angelica	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. alba	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. flava	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. ameliae	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. anguinea	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. attenuata	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. aurioliae	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. bolusii	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. bowkeri	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. bifolia	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. capensis	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. cernua	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. comptonii	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. concordiana	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. congesta	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. contaminata	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. convallarioides	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. cornymabosa	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. corymbosa	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. dehoopensis	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. doleritica	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. duncanii	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. ensifolia subsp. ensifolia	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. ensifolia var. maughanii	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. fistulosa	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. framesii	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. gillettii	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. haarlemensis	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. hirta	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. inconspicua	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. isopetala	AAGAAAATCAATTT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. magentea	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. juncifolia var. juncifolia	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. karooica	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT

L. kombergensis	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. arbuthnotiae	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. longituba	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. longibracteata	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. margaretea	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. martiniae	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. mathewsii	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. maximiliani	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. mediana	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. moniliformis	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. muirii	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. multifolia	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. mutabilis	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. namaquensis	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. namibiensis	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. nardousbergensis	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. nervosa	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. obscura	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. orthopetala	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. paucifolia	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. perryae	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. perryae/unifolia	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. polypodantha	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. pusilla	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. pustulata	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. rosea	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. punctata	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. salteri	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. schelpei	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. sp	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. sp	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. splendida	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. stayneri	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. thomasiae	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. trichophylla	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. trichophylla subsp. trichophylla	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. undulata	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. unicolor	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. unifolia	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. unifolia/hirta	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. valeriae	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT

L. variegata	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. verticillata	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. violacea	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. youngii	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. zebrina	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
L. zeyheri	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
M. depressa	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
M. wittebergensis	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
V. bracheata	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
V. capensis	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT
W. bifolia	AAGAAAATCAATAT--ATTGCTT------ATGTAGCTTAT---CC--TTTAGA---CCTT

E. autumnalis	T------TTGAAGAGGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
E. bicolor	TGAGCTGTTGAAGAGGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
E. pole-evansii	T------TTGAAGAGGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
E. vandermerwei	T------TACGCGGTGGACTTGAT-TTTACGCGGTGGACTTGATTTTACACG-GTGGACT
G. superba	T------TACGCGGTGGACATGAT-TTTACGCGGTGGACTTGATTTTACGCG-GTGGACT
L. angelica	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. alba	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. flava	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. ameliae	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. anguinea	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. aurioliae	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. bolusii	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. bowkeri	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. bifolia	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. capensis	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. cernua	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. comptonii	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. concordiana	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. congesta	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. contaminata	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. convallarioides	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. cornymabosa	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. corymbosa	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. dehoopensis	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. doleritica	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. duncanii	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. ensifolia subsp. ensifolia	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. ensifolia var. maughanii	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. fistulosa	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT

L. framesii	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. gillettii	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. haarlemensis	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. hirta	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. inconspicua	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. isopetala	T------TTGAAGAGGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. magentea	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. juncifolia var. juncifolia	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. karooica	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. kombergensis	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. arbuthnotiae	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. longituba	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. longibracteata	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. margaretea	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. martiniae	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. mathewsii	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. maximiliani	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. mediana	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. moniliformis	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. muirii	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. multifolia	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. mutabilis	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. namaquensis	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. namibiensis	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. nardousbergensis	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. nervosa	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGCA-ATGTATT
L. obscura	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. paucifolia	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. perryae	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. perryae/unifolia	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. polypodantha	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. pusilla	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. pustulata	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. rosea	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. punctata	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. salteri	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. schelpei	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. sp	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. sp	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. splendid	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. stayneri	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT

L. thomasiae	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. trichophylla	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. trichophylla subsp. trichophylla	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. undulata	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. unicolor	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. unifolia	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. unifolia/hirta	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. valeriae	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. variegata	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. verticillata	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. violacea	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. youngii	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGCA-ATGTATT
L. zebrine	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
L. zeyheri	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
M. depressa	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
M. wittebergensis	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
V. bracheata	T------TTGAAGAAGGTTCGGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
V. capensis	T------TTGAAGAAGGTTCGGTTACTAACATGTTTACTTCCATTGTGGGTA-ATGTATT
W. bifolia	T------TTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTAGGTA-ATGTATT

E. autumnalis	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTGGGAGGACTCGAATTTCC
E. bicolor	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
E. pole-evansii	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
E. vandermerwei	TGATTTTA---CGCGGTGGACTTGATTTTACGCGGTGGACTTG----------ATTTTAC
G. superba	TGATTTTA---CGCGGTGGACTTGATTTTACGCGGTGGACTTG----------ATTTTAC
L. angelica	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. alba	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. flava	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. ameliae	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. anguinea	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. attenuata	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. aurioliae	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. bolusii	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. bowkeri	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. bifolia	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. capensis	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCT
L. cernua	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCT
L. comptonii	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. concordiana	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. congesta	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. contaminata	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC

L. convallarioides	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. cornymabosa	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. corymbosa	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. dehoopensis	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. doleritica	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. duncanii	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. ensifolia subsp. ensifolia	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. ensifolia var. maughanii	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. fistulosa	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCT
L. framesii	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. gillettii	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. haarlemensis	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. hirta	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. inconspicua	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. isopetala	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAAGATCTG--------CGAATTCCC
L. magentea	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. juncifolia var. juncifolia	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. karooica	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. kombergensis	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. arbuthnotiae	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCT
L. longituba	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. longibracteata	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCT
L. margaretea	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. martiniae	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAAGATCTG--------CGAATTCCC
L. mathewsii	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. maximiliani	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. mediana	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. moniliformis	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. muirii	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCT
L. multifolia	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. mutabilis	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. namaquensis	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. namibiensis	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. nardousbergensis	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. nervosa	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. obscura	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. orthopetala	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. paucifolia	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. perryae	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. perryae/unifolia	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. polypodantha	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC

L. pusilla	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. pustulata	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. rosea	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. punctata	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. salteri	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. schelpei	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. sp	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. sp	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. splendida	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. stayneri	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. thomasiae	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. trichophylla	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. trichophylla subsp. trichophylla	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. undulata	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAAGATCTG--------CGAATTCCC
L. unicolor	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. unifolia	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. unifolia/hirta	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. valeriae	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. variegata	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. verticillata	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. violacea	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. youngii	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. zebrina	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
L. zeyheri	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
M. depressa	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
M. wittebergensis	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
V. bracheata	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
V. capensis	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC
W. bifolia	TGGTTTCAAAGCCCTACGAGCTCTACGTC---TGGAGGATCTG--------CGAATTCCC

E. autumnalis	CCGGTGGACTTGCTTATTCCCGGAAAACTTGATTCTACG--CGGTGGACTTGCCATCCAA
E. bicolor	CC--------TTCTTATTC-C--AAAACTTGATCCAAGGCCCGCCGCA-TTGC-ATCCAA
E. pole-evansii	CC--------TTCTTATTCGC--AAAACTT--TCCAAGGCCCGCCGCACTGGC-ATCCAA
E. vandermerwei	GCGGTGGACTTGATTTTACCCGGTGGACTTGATTTTA-------CGCGGTGG--ACTTGA
G. superba	GCGGTGGACTTGATTTTACGCGGCGGACTTGATTTTA-------CGCGGTGG--ACTTGA
L. angelica	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. alba	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. flava	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. ameliae	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. anguinea	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. attenuata	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA

L. aurioliae	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. bolusii	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. bowkeri	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. bifolia	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. capensis	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. cernua	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. comptonii	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. concordiana	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. congesta	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. contaminata	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. convallarioides	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. cornymabosa	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. corymbosa	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. dehoopensis	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. doleritica	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. duncanii	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. ensifolia subsp. ensifolia	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. ensifolia var. maughanii	CC--------TGCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. fistulosa	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. framesii	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. gillettii	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. haarlemensis	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. hirta	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. inconspicua	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. isopetala	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. magentea	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. juncifolia var. juncifolia	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. karooica	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. kombergensis	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. arbuthnotiae	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. longituba	CC--------TGCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. longibracteata	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. margaretea	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. martiniae	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. mathewsii	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. maximiliani	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. mediana	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCT-TGGC-ATCCAA
L. moniliformis	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. muirii	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. multifolia	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. mutabilis	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA

L. namaquensis	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. namibiensis	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. nardousbergensis	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. nervosa	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. obscura	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. orthopetala	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. paucifolia	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. perryae	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. perryae/unifolia	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. polypodantha	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. pusilla	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. pustulata	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. rosea	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. punctata	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. salteri	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. schelpei	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. sp	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. sp	CC--------TGCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. splendida	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. stayneri	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. thomasiae	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. trichophylla	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. trichophylla subsp. trichophylla	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. undulata	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. unicolor	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. unifolia	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. unifolia/hirta	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. valeriae	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. variegata	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. verticillata	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. violacea	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. youngii	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. zebrina	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
L. zeyheri	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
M. depressa	CC--------TGCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
M. wittebergensis	CC--------TGCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
V. bracheata	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
V. capensis	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
W. bifolia	CC--------TTCTTATTC-C--AAAACTT--TCCAAGGCCCGCCCCA-TGGC-ATCCAA
E. autumnalis	TTTTGAAAGAGATAAA-TTGTACT----------TTTACCCGGTGGACCCCTATT----G

E. bicolour	GTT-GAAAGAGATAAA-TTGAACAGTGAAGGTGATTTACGCGGTCGTCCCCTATTAC--G
E. pole-evansii	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCCTATTTTACG
E. vandermerwei	TTT--TACGCGGTGGACTTGATTT------------TACGCGGTGGACTTGATTTTA-CG
G. superba	TTT--TACGCGGTGGACTTGATTT------------TACGCGGTGGACT???????????
L. angelica	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. alba	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. flava	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. ameliae	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. anguinea	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. attenuata	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. aurioliae	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. bolusii	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. bowkeri	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. bifolia	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. capensis	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. cernua	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. comptonii	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. concordiana	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. congesta	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. contaminata	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. convallarioides	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. cornymabosa	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGCCGTCCCTTATT----G
L. corymbosa	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. dehoopensis	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. doleritica	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. duncanii	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. ensifolia subsp. ensifolia	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. ensifolia var. maughanii	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. fistulosa	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. framesii	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. gillettii	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. haarlemensis	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. hirta	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. inconspicua	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. isopetala	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCTCTATT----G
L. magentea	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. juncifolia var. juncifolia	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. karooica	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. kombergensis	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. arbuthnotiae	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. longituba	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G

L. longibracteata	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. margaretea	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCATTATT----G
L. martiniae	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. mathewsii	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. maximiliani	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. mediana	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. moniliformis	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. muirii	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. multifolia	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGCCGTCCCTTATT----G
L. mutabilis	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. namaquensis	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. namibiensis	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. nardousbergensis	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. nervosa	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. obscura	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. orthopetala	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGGCGTCCCTTATT----G
L. paucifolia	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. perryae	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. perryae/unifolia	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. polypodantha	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. pusilla	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. pustulata	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. rosea	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. punctata	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. salteri	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. schelpei	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. sp	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. sp.	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. splendida	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. stayneri	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. thomasiae	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCATTATT----G
L. trichophylla	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. trichophylla subsp. trichophylla	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. undulata	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. unicolor	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. unifolia	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. unifolia/hirta	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. valeriae	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. variegata	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. verticillata	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. violacea	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G

L. youngii	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. zebrine	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
L. zeyheri	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCTTATT----G
M. depressa	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCCTATT----G
M. wittebergensis	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCCTATT----G
V. bracheata	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCCTATT----G
V. capensis	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCCTATT----G
W. bifolia	GTT-GAAAGAGATAAA-TTGAACA------------AGTACGGTCGTCCCCTGTT----G

E. autumnalis	GGATGTTACGAGGGAGGGAGAAGAAAAAAAGAAAAAGAG
E. bicolor	GGGTGGACTGGGGAAAAAAAAAGGAGGGAAAGAGGAGAA
E. pole-evansii	GGGTGGACTGGGGGAGGGAGAAGGAGAGGAAAAGGAGGA
E. vandermerwei	CGGTGGACCGAAAAGAAAAGGGAAGAAAAGAAGAAGAGA
G. superba	??????????GGGAGAAAGGGGAAGAAAAGAAGAAGAGA
L. angelica	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. alba	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. flava	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. ameliae	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. anguinea	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. attenuata	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. aurioliae	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. bolusii	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. bowkeri	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. bifolia	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. capensis	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. cernua	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. comptonii	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. concordiana	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. congesta	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. contaminata	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. convallarioides	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. cornymabosa	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. corymbosa	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. dehoopensis	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. doleritica	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. duncanii	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. ensifolia subsp. ensifolia	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. ensifolia var. maughanii	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. fistulosa	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. framesii	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. gillettii	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA

L. haarlemensis	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. hirta	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. inconspicua	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. isopetala	GGATGCACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. magentea	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. juncifolia var. juncifolia	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. karooica	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. kombergensis	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. arbuthnotiae	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. longituba	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. longibracteata	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. margaretea	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. martiniae	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. mathewsii	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. maximiliani	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. mediana	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. moniliformis	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. muirii	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. multifolia	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. mutabilis	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. namaquensis	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. namibiensis	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. nardousbergensis	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. nervosa	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. obscura	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. orthopetala	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. paucifolia	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. perryae	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. perryae/unifolia	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. polypodantha	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. pusilla	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. pustulata	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. rosea	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. punctata	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. salteri	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. schelpei	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. sp	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. sp	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. splendida	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. stayneri	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. thomasiae	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA

L. trichophylla	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. trichophylla subsp. trichophylla	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. undulata	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. unicolor	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. unifolia	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. unifolia/hirta	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. valeriae	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. variegata	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. verticillata	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. violacea	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. youngii	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. zebrina	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
L. zeyheri	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
M. depressa	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
M. wittebergensis	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
V. bracheata	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
V. capensis	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA
W. bifolia	GGATGTACTAGGGGAGGGAGAAGGAGGGGAAGAGGAGGA