A taxonomic revision of the southern African endemic genus *Gazania* (Asteraceae) based on morphometric, genetic and phylogeographic data.

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Abstract

Gazania is a small genus of the subtribe Gorteriinae, tribe Arctoteae, that is endemic to southern Africa. The genus was last revised in 1959 by Roessler, who noted that delimitation of the species of *Gazania* can be “extraordinarily difficult”.

Morphometric data was collected to test the reality of the 16 species as delimited by Roessler, who based species boundaries on morphological characters. Only six taxa were found to be morphologically distinct, while the remaining samples showed no species cohesion.

DNA sequence data from two nuclear spacer regions (ITS and ETS) and four chloroplast noncoding regions (the *trnL* and *rpS16* introns, and the *psbA*-*trnH* and *trnL-F* spacers) of 43 samples were utilised to create a species level phylogeny and to investigate correlations between genetically delimited units and morphologically defined taxa. DNA sequence data reveal that seven species (as delimited by Roessler) are morphologically and genetically distinct. The remaining nine of Roessler’s species fall into a morphologically and genetically overlapping continuum that forms an ochlospecies.

Phylogeographic methods (based on an expanded ITS and ETS DNA sequence data set from 169 samples) were employed to further resolve the limits of species, with special focus on the clades within the ochlospecies. These genetically defined clades were correlated with their geographical distributions, and in combination with molecular dating techniques, used to elucidate the recent climatic or environmental factors that may have shaped the phylogeographic structure of the genus.

Phylogeographic patterns and molecular dating reveals that the genus *Gazania* is an example of a South African endemic clade that has undergone episodic cladogenesis in response to fluctuating climatic conditions over the last seven million years. The ochlospecies within *Gazania* is a result of repeated cycles of climate driven isolation in refugia and subsequent expansion and hybridization events during the Pliocene and Pleistocene. Comparisons with phylogeographic studies on other organisms reveal a common pattern indicative of the presence and evolutionary importance of an ancestral refugium in the arid Richtersveld / Namib region of southern Africa.

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Chapter 1.

General introduction

> “The existing treatment for *Gazania* can only be a preliminary revision, and can make no claims to finality.” (Roessler, 1959, pp 100, translated from the original German).

Gazania Gaert. is a small genus of 16 species endemic to Southern Africa. The genus was named in honour of Theodorus Gaza, a 15th-century Italian scholar and translator of the works of Theophrastus, a man often called the “father of taxonomy” due to his works “On the History of Plants” and “On the Causes of Plants” which are considered by some to constitute the most important contributions to botanical science during antiquity and the middle ages.

The genus was last revised in 1959 by Helmut Roessler, although not with any overwhelming certainty, as the opening quote illustrates. The most commonly listed number of species for *Gazania* is 17, but Roessler indicated that the 17th species (*G. thermalis*) is *nomen subnudum*, and disregarded it as a valid species. No subsequent authors have lobbied for a revalidation of this species or offered a species description or type specimen. Roessler based his taxonomy on morphological characters from herbarium specimens, in conjunction with geographical distribution of these samples, and from this he outlined 16 species and ten subspecies.

The delimitation of both the genus *Gazania* itself and the species within it have long been and continue to be problematic. Many of the species in *Gazania*, and in the associated genera of the Gorteriinae (see below for details), have been moved from genus to genus, and many of them have multiple instances of synonymy. The species as accepted by Roessler are laid out in Table 1.1.

Gazania is a member of the tribe Arctoteae, subtribe Gorteriinae. The Gorteriinae also includes seven other genera: *Berkheya*, *Gorteria*, *Cuspida*, *Didelta*, *Heterorachis*, *Cullumia* and *Hirpicium.* Whilst Roessler noted that it is difficult to differentiate between “primitive” and “advanced” characters within a highly advanced family like the Asteraceae, he still used certain morphological features to rank the eight genera of the Gorteriinae from primitive to advanced. A graphical representation of the genera within the Gorteriinae based on Roessler’s description of their relationships, ranked according to their morphological criteria, is presented in Figure 1.1.

Table 1.1: Gazania species and subspecies as accepted by Roessler

Species	**Subspecies**
G. maritima Levyn	
G. rigens L.	*uniflora* (L.f) Roessler
	rigens
	leucolaena (DC.) Roessler
G. pectinata (Thunb.) Spreng	
G. linearis (Thunb.) Druce	*linearis*
	ovalis (Harv.) Roessler
G. ciliaris DC.	
G. caespitosa Bolus	
G. heterochaeta DC.	
G. schenckii O.Hoffm.	
G. leiopoda (DC.) Roessler	
G. othonnites (Thunb.) Less.	
G. jurineifolia DC.	*jurineifolia*
	scabra (DC.) Roessler
G. lichtensteinii Less.	
G. tenuifolia Less.	
G. rigida (Burm.f.) Roessler	
G. serrata DC.	
G. krebsiana Less.	*krebsiana*
	arctotoides (Less.) Roessler
	serrulata (DC.) Roessler

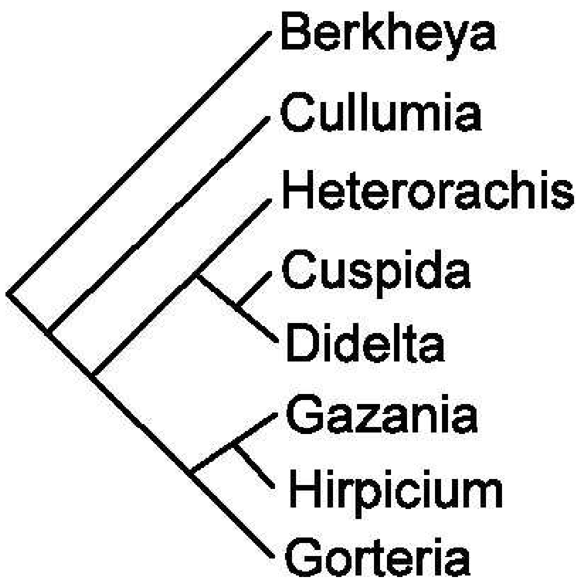


Figure 1.1: Graphical representation of the genera within the Gorteriinae based on Roessler's description of their relationships, ranked according to their morphological criteria.

He considered *Berkheya* as the most primitive genus, with *Cullumia* was ranked as the next most primitive. *Didelta*, *Cuspida* and *Heterorhachis* were grouped together due to the uniformity of their achenes. He likewise groups *Gorteria*, *Hirpicium* and *Gazania* together. He considered *Gazania* as representing the endpoint of development, as the involucre shows the highest degree of fusion, in combination with the presence of "a remarkable capitulum with multicoloured petals, with basal eyespots at the base of the ray florets" (Roessler, 1959: p. 101).

While morphological data suggest that *Gazania* and *Hirpicium* are closely related genera (Roessler, 1959), genetic data suggests that *Gazania* is nested within *Hirpicium* (see Figure 1.2, Funk *et al.*, 2004). More recent molecular work by McKenzie on the placement of Gazania within the Gorteriinae shows the same result (Figure 1.3, McKenzie, unpublished data). The review by Karis (2006) of the genera of Gorteriinae, based on morphological characters, placed *Gazania* as sister to *Gorteria* and *Hirpicium*, rather than nestled within the latter genus (Figure 1.4).

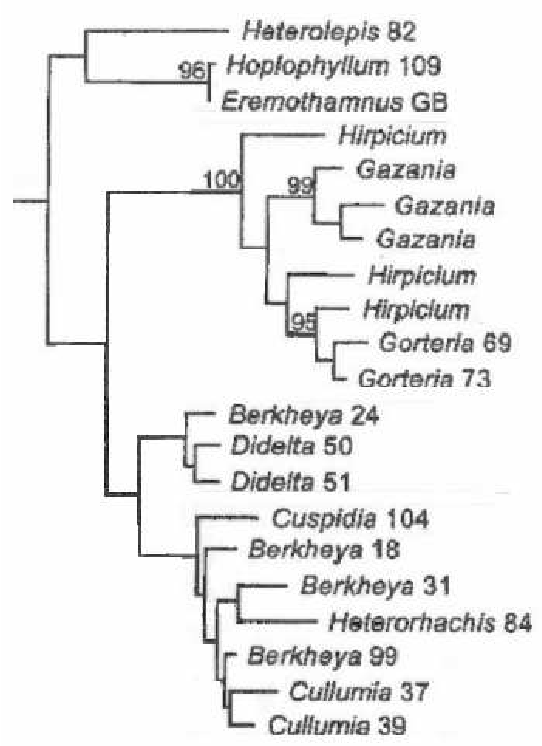


Figure 1.2: Relationships of the genera of the Gorteriinae (from Funk *et al.*, 2004.)

Roessler (1959) described *Gazania* as having two main habits. The presence of a shortened stem, with the leaves crowded into dense rosettes at the base, out of which a leafless unbranched stem arises to bear solitary inflorescences is found in 11 species (see Appendix 1); the other habit (shown by five species, see Appendix 1) is a developed stem, with leaves present more or less evenly along the stem. Roessler commented that the rosette habit was a characteristic of *Gazania* (but also observed in a few *Hirpicium* species) and the developed stem habit was a characteristic of *Hirpicium* (but also observed in a few *Gazania* species).

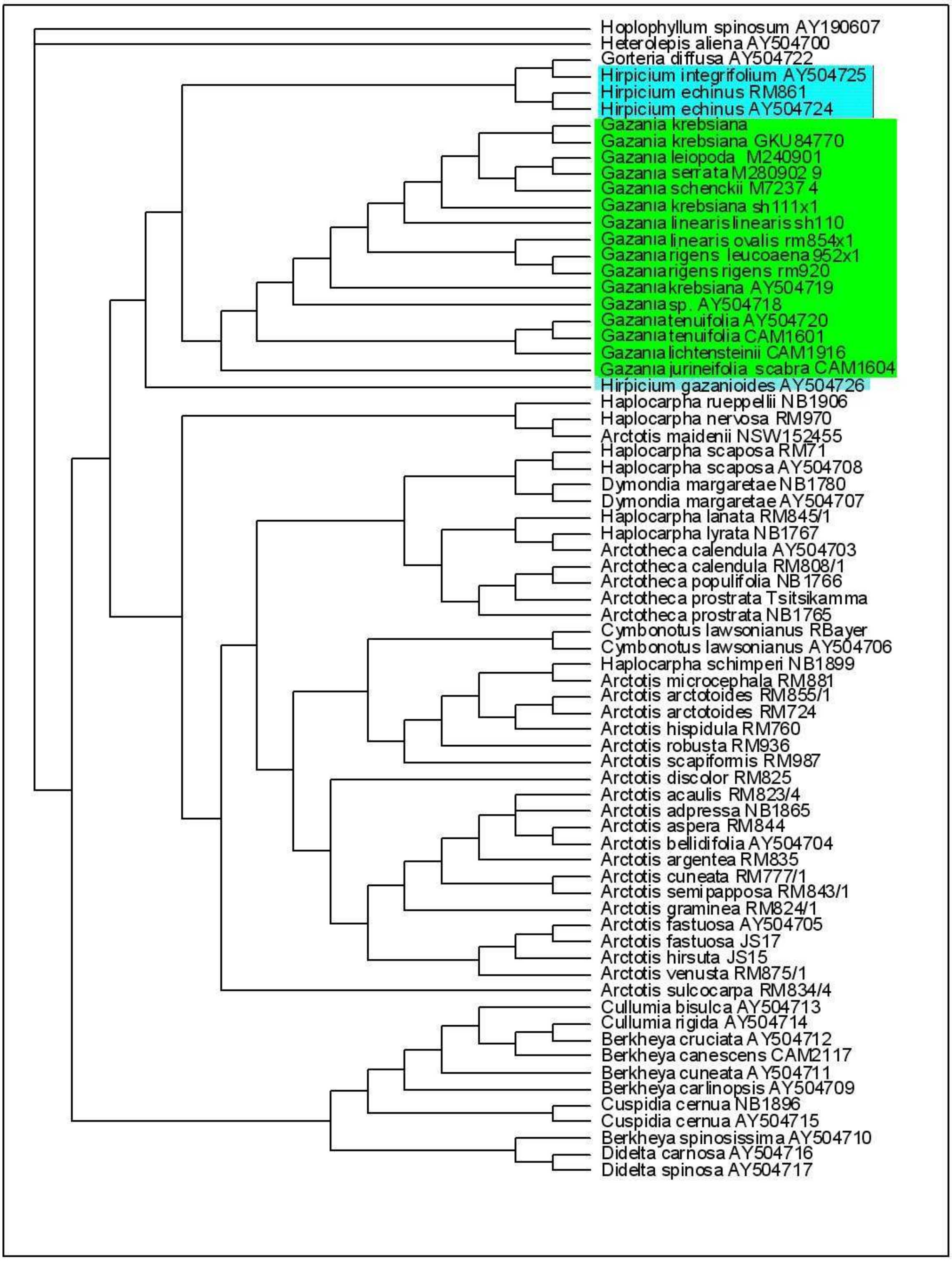


Figure 1.3: Relationships of the genera of the Gorteriinae, based on ITS data from McKenzie, unpublished.

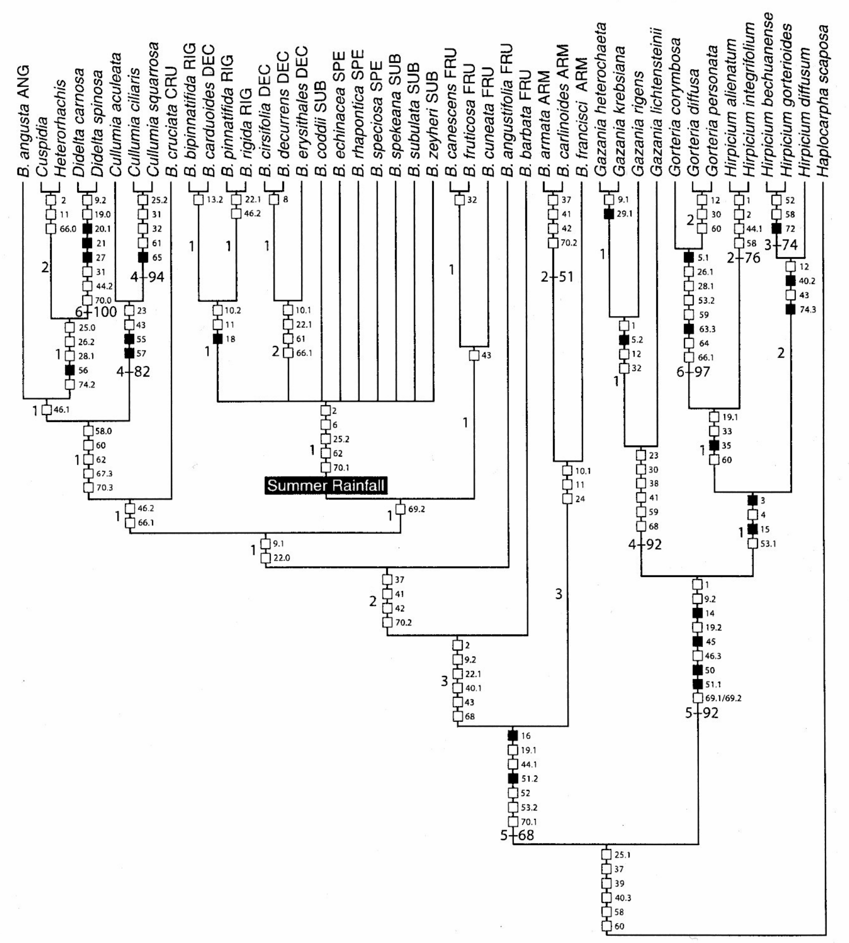


Figure 1.4: Relationships of the genera of the Gorteriinae, based on morphological data (from Karis, 2006, Figure 4).

He separated *Hirpicium* and *Gazania* on the basis of two characters: pappus scales and involucral fusion. The number of rows of pappus scales differentiates the two genera, as *Gazania* has two rows of fully developed pappus scales, while *Hirpicium* has either one row, or one row of full developed scales with a second inner row of smaller scales. He noted that within the genus *Hirpicium* it could be assumed that the species without internal rows of pappus scales are derived in relation to the species with two rows, which is suggested by the occurrence of transition rows that should “certainly be considered as degenerated rows” (Roessler, 1959: p. 101).

Gazania has generalist pollinators (pers. obsv.) and wind dispersed seeds (pers. obsv.). It frequently colonizes disturbed areas, and grows well in poor soils. It has a short period between germination and seedset (under a year).

Aims of this research

All studies to date, be they molecular or morphological, have indicated that *Gazania* is monophyletic. However, within *Gazania*, species delimitations and relationships are not at all clear. Roessler recognised and delimited 16 species in *Gazania*, based on morphology. Some of these species are clearly morphologically and geographically distinct, but some species show overlaps in both morphology and geography. The overall aim of this research is to investigate Roessler's "preliminary revision" (Roessler, 1959) by means of three different approaches to the problem.

1) To use a morphometric data set of *Gazania* samples to test the validity of Roessler's species delimitations.

2) To use DNA sequence data to determine the status and relationships of the taxonomic entities ("species") as delimited by Roessler and the morphometric analysis conducted in Chapter 2.

3) To undertake a phylogeographic study of the genetic entities within *Gazania*.

Chapter 2.

Morphometric species delimitations

> "The abundance of forms regarding systematically rather unimportant (but obvious) characters … with simultaneous uniformity of the habit and the poverty of useful characteristics for type distinction make the development and delimitation of the types extraordinarily difficult."
> (Roessler, 1959, pp 100, translated from the original German).

Aim: To use a morphometric data set of *Gazania* samples to test the validity of Roessler's species delimitations.

Introduction

Morphological data is the major basis of most systematic descriptions and delimitations, and morphological variation in size and shape has physiological, ecological and taxonomic significance (Somers, 1989). Jensen (2003) observes that the majority of systematic studies begin by grouping organisms on the basis of morphological similarity and, once they are so grouped, then the study of relationships among the groups can begin, often by careful examination of variation in morphological features, but increasingly more often by using these morphologically defined groups as the basis for conducting studies of molecular variation.

The advent of modern computing (and the associated increase in the volume of data that can be analyzed) has afforded systematists the chance to statistically test the observed trends in plant morphological variability. Additionally, the availability of high speed electronic computers permits calculations (and statistical methodologies) that previously would have been far too time-consuming to be practical (Mayr, 1965).

Gazania has a two-fold problem, in that the genus possesses a low number of taxonomically informative characters (Roessler, 1959), and that those characters that are potentially useful display a high level of variability within, but not necessarily between, taxonomic entities. A further complication is the observed presence of some phenotypic plasticity in certain characteristics in response to changes in environmental conditions (discussed individually in more detail in the justification for choice of characters in the Methods section). Abdel Khalik *et al.* (2002) note that problems in classification can arise when taxa display a large amount of variability, due to phenotypic plasticity, or when they demonstrate very little variability at all. Further problems occur if the variability that is present lacks any correlation with taxonomic designation.

Morphometrics

There are alternative approaches to the morphometric (phenetic) approach employed here. One such alternative is cladistics, which relies on synapomorphies to define clades. Morphometric data that is continuous in nature creates difficulties in defining binary "present/absent" data necessary to define synapomorphies. There are very few binary characters that could be used to investigate *Gazania*, as most defining characteristics for taxa rely on quantitative measurements of size, rather than presence/absence data. While some may also argue that morphometrics does not allow for the translation of results into meaningful phylogenetic hypotheses (Crowe, 1994), that is not required for this particular investigation. This morphometric study is aimed only at searching for morphological clusters that may or may not correlate with recognized species delimitations.

Even a brief survey of the morphometric literature reveals a large amount of, often heated, debate (see Atchley & Anderson, 1978, for a particularly strident rebuttal to criticism). The debate in the literature covers subjects ranging from the very initial stages of character selection and the measurement of those characters, to the final stages of data analysis (the discussions of the finer details of the methods of morphometric analysis could be most charitably described as contentious).

Morphometrics is defined by Rohlf (1990) as the quantitative description, analyses, and interpretation of shape and shape variation in biology. Bookstein (1982) provides a narrower definition of morphometrics as the assignment of quantities to biological shapes.

The approach now referred to as traditional morphometrics (or multivariate morphometrics) is characterized by the application of multivariate statistical methods to sets of variables (Rohlf & Marcus, 1993). The selected variables usually correspond to various measured distances on an organism; commonly lengths and widths of structures and distances between certain landmarks, as well as angles and ratios (Rohlf & Marcus, 1993). One can then apply cluster-finding procedures to the statistics resulting from the multivariate statistical analysis of data (Oxnard, 1978).

The combined application of various multivariate statistical and clustering methods to morphometric data has been used extensively to tackle both new and old biological problems (Oxnard, 1978). The use of multivariate statistical methods stem from the fact that two (or more) variables taken singly may not separate two groups, but when taken together they may indeed separate the groups (Oxnard, 1978). Multivariate techniques summarize these patterns of morphometric covariation (Somers, 1986) and this provides statistical methods for study of the joint relationships of variables in data that contain intercorrelations (James & McCulloch, 1990). Because several variables can be considered simultaneously, interpretations can be made that are not possible with univariate statistics (James & McCulloch, 1990).

Sources and types of character data

Various measurements can be taken in the pursuit of morphometric data sets. There are two main types of data: quantitative and qualitative. A qualitative character consists of either binary presence or absence of a particular morphological structure/trait (e.g. leaf setae: present or absent), or discrete forms of a character (e.g. leaf shape could be whole, pinnate or lobed). There are two types of quantitative characters: continuous (e.g. leaf length; in which individual measurements are not necessarily integers and potentially form a continuum) or discrete (e.g. ray number, in which any individual measurement is an integer) (Stevens, 1991). Some authors, however, consider the two main types of data to be interchangeable, noting that continuous quantitative characters can be coded and treated as discrete qualitative characters by the delimitation of intervals (e.g. 0 = <5mm, 1 = >5mm), and that most qualitative variation, when examined carefully, will be found to describe an underlying continuum that has been transformed into discrete classes (Stevens, 1991).

Biological shapes have been characterized most often by means of a single measure or other descriptor, or by a very small number of measurements (Oxnard, 1978). A scheme of measured distances is inadequate if it does not permit the reconstruction of the polygon it purports to measure, since information is thereby lost (Bookstein, 1982). The more complicated the shape, the greater the number of measurements necessary to encapsulate the information contained in that shape (Oxnard, 1978).

One can measure the more basic shapes by means of ratios. Figure 2.1.1 illustrates this process with a simple length/width ratio of triangular involucral scales. Both involucral scales are 1 unit of length wide, but A is 6 units long, while B is 1 unit long. The longer scale (A) will have a ratio of “6 units / 1 unit” (i.e. 6), whilst the shorter scale (B) will have a ratio of “1 unit / 1 unit” (1). The lower the ratio, the more obtuse the scale.

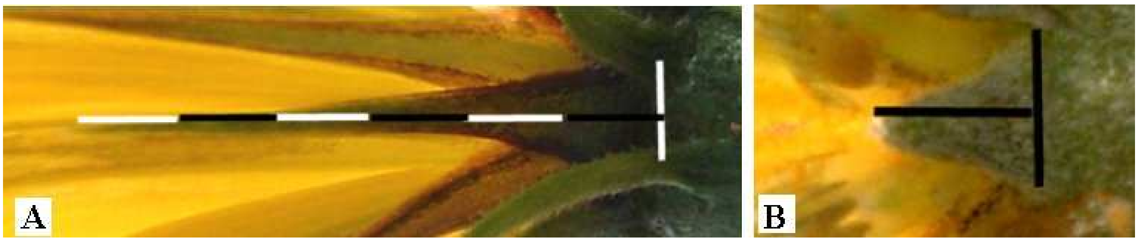


Figure 2.1.1: Comparison of differently shaped involucral scales, overlaid with length units in black and white. All black and white bars are equal in length.

The age of a physical characteristic (e.g. the age of a leaf) can have an effect on the size of the leaf (the older a leaf, the bigger it may be), but not necessarily the shape. Ratios can be useful for comparing shape across size gradients, without letting raw size skew the analysis. Figure 2.1.2 illustrates an example: If length were used as a grouping character, the leaves would group by age rather than species. The use of ratios to encapsulate basic shape (length/width) allows for differentiation based on shape rather than simply length.

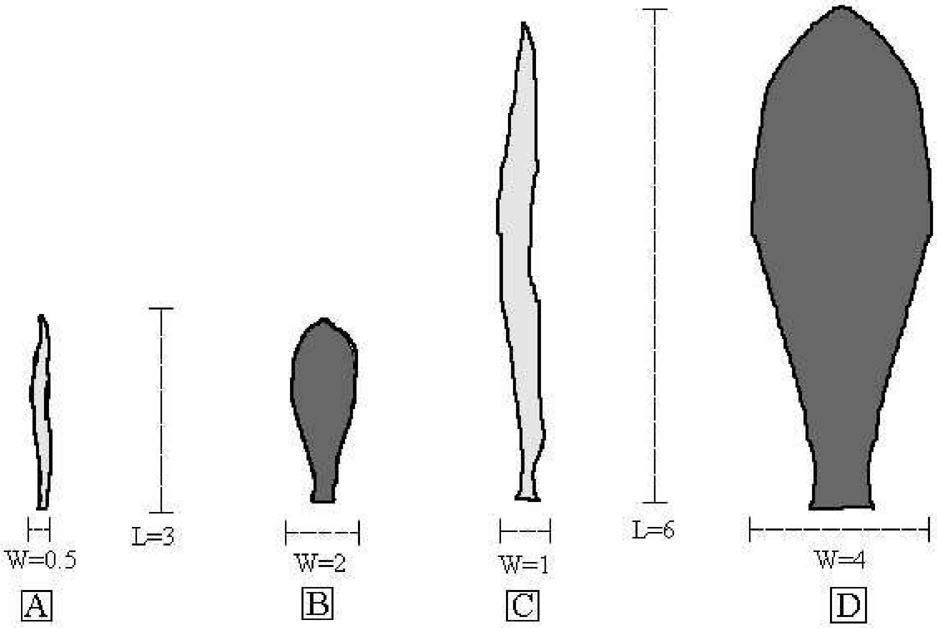


Figure 2.1.2: Use of ratios eliminates size but retains shape. Comparison of four leaves from two species (Species 1 = A,C; Species 2 = B,D). Two leaves are young (A,B) and two old (C,D). The lengths of the younger leaves are the same (L=3), as are the lengths of the older leaves (L=6), but the ratios are different (Species 1: A = 3/0.5 = 6, C = 6/1 = 6; Species 2: B = 3/2 = 1.5, D = 6/4 = 1.5)

Phillips (1983) notes that measurements taken with the use of ratios may be affected by allometric growth. But he notes that this usually only applies in the earliest stages of growth, and by the time the organ is large enough to be measured, allometric growth has stabilized. Phillips (1983) holds that while ratios are inherently correlated with size, there is still a large amount of information about shape within that ratio. As an alternative to ratios, he posits the use of regression analysis. However, this method is computationally intensive. The other problem with regression analysis is the requirement of at least two samples per taxon, to allow for the regression line to be calculated. For some taxa in *Gazania*, this was not possible. Given that there is only an average of 10 samples per taxon, this may not be sufficient to utilize regression analysis properly.

The other alternative to ratios is the use of shape charts. These charts, however, are an attempt to put names to discrete intervals of shapes, whereas in *Gazania* there are no such clear intervals. The shapes of leaves fall along a continuum of variation; categorization of certain leaves into definite shape categories must become subjective when they straddle the uncomfortable interval between two shapes. Actual measurements of ratios allow for the quantification of this continuum of shape variation, rather than the pigeon-holing of samples into the nearest possible fit of shape.

Some analytical methods are sensitive to size effects, and some authors insist that ratios can be a good way to deal with size, and have been useful for some studies (Oxnard, 1978), whilst others indicate that the traditional use of ratios is often criticized (Rohlf, 1990) and that the use of ratios does not always eliminate size from the raw variables (Albrecht, 1978; Phillips, 1983). Hillis (1978) firmly states that “of the many myths about the use of the ratio of two linear measurements perhaps the most widespread is that such ratios are improper in some statistical sense”. He continues by noting that ratios are widely used in taxonomy as measure of shape, and that the statistical difficulties associated with ratios arise because X/Y is not a linear function of X and Y; the difficulties disappear if one transforms ratios using logs (Hillis, 1978). James & McCulloch (1990) agree, stating that ratios must be log transformed.

The inclusion of both ratios and the original measurements that the ratios were calculated could be theorized to lead to double weighting for those characters. Castro *et al.* (2005) however included both size data as well as shape ratios in their data to no ill effect.

Character selection

The major task in selecting characters is to construct measures optimal for particular explanatory purposes (trends, contrasts, comparisons) (Bookstein, 1982). Some authors maintain that as many characters as possible should be used (Presch, 1979), while others insist that the goal in the selection of variable characters is to reduce the volume of data as much as possible, while still retaining the ability to adequately represent the variability (Rohlf, 1990). Scotland *et al.* (2003) support the latter reductionist view, indicating that rigorous and critical anatomical studies of fewer morphological characters is preferable to compiling larger data matrices of increasingly ambiguous and problematic morphological characters.

Combinations of genetic and environmental factors modify growth processes, inducing morphometric variation (Somers, 1986). Good characters are those that are not susceptible to environmental modification, as phenotypic plasticity diminishes a character's taxonomic utility because the environmental contribution to phenotypic variation can obscure genetically based relationships (Davis, 1983). An example of the effects of environment on plant morphology was detected in the analysis of repeat sampling of the same populations of *Lupinus nanus* over several years, which revealed variation due to annual water availability, such that the primary clustering of samples was an annual pattern of variation, rather than taxonomic grouping (Riggins *et al*., 1977). Davis (1983) does, however, indicate that plastic characters (traditionally considered problematic and useless) are not completely useless as, in some cases, some states are limited to fewer than all genotypes, and the characters therefore exhibit some discriminatory information.

Analyses methods

James & McCulloch (1990) rather understate the case when they observe that researchers do not always agree on the best methods of analysis. There are a multitude of methods available for the multivariate analysis of morphometric data and James & McCulloch (1990) provide an overview of some of the various methods, survey their uses in cases in the literature, and list each method’s objectives and limitations. Two of the most widely utilized of those techniques were Principal Component Analysis (PCA) and Cluster Analysis (CA). Each of these methods has certain practical applications and objectives for which they are ideal, but each method has its limitations. Both methods can be utilized for descriptive purposes, i.e. they can suggest causes for patterns, but derived factors and clusters do not necessarily reflect biological factors or clusters in nature (James & McCulloch, 1990). James & McCulloch (1990) limit CA to classification purposes only and PCA to ordination purposes only.

Cluster Analysis

This method places objects in groups according to a similarity measure and then a grouping algorithm (James & McCulloch, 1990). A pairwise similarity matrix is created and used to join the two most similar objects together, then the similarity of this group to all others is calculated, and the closest two groups are again combined until only a single group remains (James & McCulloch, 1990). Although Crompton *et al.* (1990) regard CA as the numerical taxonomic technique most widely used for obtaining groupings, James & McCulloch (1990) caution that CA is most appropriate for categorical rather than continuous data, and may be less efficient that PCA.

Principal Component Analysis

The main purpose of PCA is to describe the total variation in a sample in a few dimensions (Borazan & Babac, 2003). PCA reduces the number of dimensions of a single group of data by producing a smaller number of abstract variables (linear combinations of the original variables, called principal components), such that most of the variation can be summarized by only a few components, so data with many variables can be displayed effectively on a two- or three dimensional graph that uses the components as axes (James & McCulloch, 1990). Not all principal components are needed to summarize the data adequately and, in practice, only the first few components that account for the major patterns of variation need be retained (Borazan & Babac, 2003).

Somers (1986) cautions that PCA is not infallible, since it assumes linearity and multivariate normality of all the variables, and may inefficiently summarize nonlinear patterns. If the distribution of ratios or proportions is reasonably near to normal the analysis can be useful, but without transformations principal components analysis cannot capture nonlinear relationships (James & McCulloch, 1990). PCA is also sensitive to outliers (James & McCulloch, 1990).

Methods

Morphological character selection and data collection

The descriptions of species from Roessler's (1959) review provide a good basis for character selection, as these were the characters that he used to delimit his morphospecies. As such, many of these have been chosen for this morphometric analysis. Appendix 1 contains the character descriptions for each character for each species delimited by Roessler. Data is missing from the table where Roessler gives no details.

Morphometric data was collected for 21 characters from 170 herbarium specimens (both those collected and pressed for this project as well as preexisting herbarium specimens). Although an average number of ten samples per taxa is rather low, the selection of samples was such that a comparison between morphometric and DNA data was made possible. All sample details (including collection localities and herbarium details where appropriate) are listed in Table 2.1.1. Two samples from a putative new species were included as well. Details of characters are given below. Also see Appendix 2 for complete table of morphometric data.

Some characters are inherently difficult to classify quantitatively (e.g. shades of colour). An attempt was made to reduce other characters (e.g. involucral scale shape, leaf shape) that are described by subjective shape descriptive terms (e.g. acuminate, obtuse) to quantitative data values (by means of a ratio). Due to the paucity of measurements that could be taken, the simpler measures were investigated; the simplest way to describe shape quantitatively is to measure length and width and then compare those two measurements as a ratio.

In the case of the involucral scales, the measurement of the length from point of attachment to tip, divided by the width at the point of attachment, provides a numerical estimate of shape. The difference between an acuminate scale (with a ratio of 6:1) and an obtuse scale (with a ratio of 1:1) is clearly illustrated in Figure 2.1.1.

Leaf shape is more difficult to quantify, especially when it comes to including data on pinnate leaves. The basic leaf shape was encapsulated in a length:width ratio. However, as mentioned in the introduction to this chapter, ratios are considered problematic. Shape alone may not be sufficient to discriminate taxa; therefore the actual size of the leaves is included in some data sets to investigate the different effects of actual size versus relative shape ratio on multivariate methods.

Table 2.1.1: List of all samples used in morphometric analyses, including collection locality data.

Sample Name	Species Name	Collection number	Collection site	South	East
Cil1	*ciliaris*	M270805_12	South Africa. Worcester: Tulbagh, below Waterfall near CapeNature office.	33° 20' 31"	19° 06' 53"
Cil2	*ciliaris*	RM1230	South Africa. Cape Town: Paarlberg.	33° 45' 8.3"	18° 57' 5.2"
Cil3	*ciliaris*	RM1382	South Africa. Clan William: Piketberg plateau	32° 48' 41"	18° 42' 40"
Cil4	*ciliaris*	Galpin 4263	Herbarium (GRA)		
Cil5	*ciliaris*	Schlechter 5286	Herbarium (GRA)		
Cil6	*ciliaris*	Schlechter 5286	Herbarium (GRA)		
Cil7	*ciliaris*	SR705	South Africa. Peddie: Fish River, near Port Alfred. Seven seas.	33° 28' 58"	27° 04' 48"
Het1	*heterochaeta*	Schlechter 11318	Herbarium (GRA)		
Het2	*heterochaeta*	Schlechter 11318	Herbarium (GRA)		
Het3	*heterochaeta*	Archibald 2714	Herbarium (GRA)		
Het4	*heterochaeta*	Archibald 2715	Herbarium (GRA)		
Het5	*heterochaeta*	M160901/5G	South Africa. Gamoep: Goegap Nat Res, 4x4 tracks N of Res. Headquarters.	29° 39' 33"	18° 00' 29"
Het6	*heterochaeta*	RM1451	South Africa. Springbok: 5km N Steinkopf, beside N7 highway	29° 14' 04"	17° 45' 20"
Het7	*heterochaeta*	RM1255	South Africa. Worcester: beside R355, North of Karooport.	33° 9' 40.8"	19° 45' 2.8"
Het8	*heterochaeta*	RM1429_1	South Africa. Steytlerville: T2 road Steytlerville - Grootrivierpoort; 5km N Rietfontein turnoff.	33° 22' 30"	24° 22' 30"
Het9	*heterochaeta*	RM1348	South Africa. Springbok: Roadside, 80km east of Port Nolloth	29° 14' 58"	17° 40' 33"
Jur1	*jurineifolia*	CAM1604	Namibia. Witputz: Karas	27° 22' 30"	16° 07' 30"
Jur2	*jurineifolia*	CAM1953	Namibia. Aus: Klein Aus Vista.	26° 37'	16° 22'
Jur3	*jurineifolia*	Gess 01/02/141	Herbarium (GRA)		
Jur4	*jurineifolia*	Barber 638	Herbarium (GRA)		
Jur5	*jurineifolia*	Daly 90	Herbarium (GRA)		
Jur6	*jurineifolia*	Dyer 1014	Herbarium (GRA)		
Jur7	*jurineifolia*	Barber 474	Herbarium (GRA)		
Jur8	*jurineifolia*	Galpin 5564	Herbarium (GRA)		
Jur9	*jurineifolia*	SR682	South Africa. Gamoep: 18km W of Aggeneys (between Springbok & Pofadder)	29° 22' 46"	18° 38' 53"
KrbA1	*krebsiana* subsp *arctotoides*	RM868/1	South Africa. Kenhardt: Rooipan, southeast of Lime Acres.	29° 47'	21° 56'
KrbA10	*krebsiana* subsp *arctotoides*	RM831_2	South Africa. Oudtshoorn: south of Oudtshoorn on N12 highway.	33° 35'	22° 11'
KrbA12	*krebsiana* subsp *arctotoides*	RM860_1	South Africa. Steynburg: south of Joubertsberge	31° 45' 19"	25° 04' 53"
KrbA2	*krebsiana* subsp *arctotoides*	RM770_2	South Africa. Willowmore: Prince Alfred's Pass.	33° 45'	23° 08'
KrbA4	*krebsiana* subsp *arctotoides*	M071001/3GP	South Africa. Queenstown: Stormberg Plateau, Penhoek Pass, rest place 3km North of pass.	31° 25' 33"	26° 41' 29"
KrbA5	*krebsiana* subsp *arctotoides*	RM903	South Africa. Graaff-Rienet: southwest of Aberdeen on N9 highway.	32° 31'	24° 00'

KrbA6	*krebsiana* subsp *arctotoides*	RM904	South Africa. Graaff-Rienet: between Graaff-Reinet and Adendorp on R75 road.	32° 15'	24° 33'
KrbA8	*krebsiana* subsp *arctotoides*	RM862_1	South Africa. Worcester: east of Potmasburg, West Cape, Dassiehoek	33° 50'	19° 30'
KrbA9	*krebsiana* subsp *arctotoides*	RM876_1	South Africa. Aliwal North: Bloemfontein	30° 19'	26° 48'
KrbK10	*krebsiana* subsp *krebsiana*	NB1465	South Africa. Steytlerville: Graaff-Rienet. Farm Welgmoed. Track to Nardousberg plateaux.	32° 47'	24° 32'
KrbK11	*krebsiana* subsp *krebsiana*	M261001/2	South Africa. Queenstown: Stormberg, Penhoek Pass.	31° 15' 34"	26° 44' 51"
KrbK12	*krebsiana* subsp *krebsiana*	M071001/1G	South Africa. Port Elizabeth: Coega salt works.	33° 46' 35"	25° 40' 05"
KrbK13	*krebsiana* subsp *krebsiana*	M071001/3GL	South Africa. Queenstown: Stormberg Plateau, Penhoek Pass, rest place 3km North of the pass.	31° 25' 33"	26° 41' 29"
KrbK14	*krebsiana* subsp *krebsiana*	M230803/8	South Africa. Port Shepstone: Umtamvuna Nature Reserve, Beacon hill.	30° 48'	30* 11'
KrbK16	*krebsiana* subsp *krebsiana*	RM874	South Africa. Kimberley: SE of Kimberley on N8 highway.	28° 47'	24° 47'
KrbK17	*krebsiana* subsp *krebsiana*	RM929	South Africa. Witbank: Middelburg, Agter-Renosterberg, near Uitsig hut, Transkaroo hiking trail.	25° 43'	29° 25'
KrbK18	*krebsiana* subsp *krebsiana*	RM968	South Africa. Matatiele: Carlisle's Hoek, beside road to Tiffindell Ski resort.	30° 40'	28° 03'
KrbK19	*krebsiana* subsp *krebsiana*	RM962	South Africa. Queenstown: NE of Queenstown on R359 road.	31° 49'	26° 55'
KrbK2	*krebsiana* subsp *krebsiana*	RM949	South Africa. Humansdorp: Eskom substation 500m north of N2 on R330 to Hankey.	34° 08' 38*	24° 10' 41"
KrbK20	*krebsiana* subsp *krebsiana*	RM960	South Africa. Fort Beaufort: SW of Seymour, junction R67 & road to Katberg Pass.	32° 35'	26° 44'
KrbK22	*krebsiana* subsp *krebsiana*	RM856	South Africa. Willowmore: Bloukrans River.	33° 58'	23° 39'
KrbK23	*krebsiana* subsp *krebsiana*	RM906	South Africa. Fort Beaufort: south of Bedford.	32° 41'	26° 05'
KrbK24	*krebsiana* subsp *krebsiana*	RM852_1	South Africa. Grahamstown: south of Bathurst	33° 30' 43"	26° 49' 44"
KrbK25	*krebsiana* subsp *krebsiana*	RM713_3	South Africa. Port Elizabeth: Coega.	33° 46’	25° 40’
KrbK26	*krebsiana* subsp *krebsiana*	SR564	South Africa. Port Edward: Umtamvuna Nature Rserve.	31° 04'	30° 11'
KrbK27	*krebsiana* subsp *krebsiana*	SR520	South Africa. Underberg: Estcourt.	29° 02’ 35"	29° 52’ 19"
KrbK28	*krebsiana* subsp *krebsiana*	SR480	South Africa. Grahamstown: Fort Brown, resolution hatchery.	33° 09' 53"	26° 37' 18"
KrbK3	*krebsiana* subsp *krebsiana*	SH110	South Africa. Grahamstown: 100m from Great Fish River Bridge.	33° 29'	26° 55'
KrbK4	*krebsiana* subsp *krebsiana*	SH112	South Africa. Stutterheim: Road out of Kaiskammahoek.	32° 49'	27° 11'
KrbK5	*krebsiana* subsp *krebsiana*	SH111	South Africa. Peddie: 10km East Peddie.	33° 12'	27° 07'
KrbK7	*krebsiana* subsp *krebsiana*	RM992_2	South Africa. Lady Frere: Baster Voetpad. Near Elliot. Roadside bank.	31° 19'	27° 57'
KrbK8	*krebsiana* subsp *krebsiana*	M210902_1	South Africa. Fort Beaufort: N of Fort Brown, road to Fort Beaufort.	32° 55' 43"	26° 37' 28"
KrbK9	*krebsiana* subsp *krebsiana*	RM804_2	South Africa. Grahamstown: Riebeek East, 'Willowfontein' farm.	33° 12'	26° 09'
KrbS1	*krebsiana* subsp *serrulata*	RM1150	South Africa. Colesberg: Free State, Gariep Dam, day visitor area.	30° 36' 14"	25° 29' 24"
KrbS2	*krebsiana* subsp *serrulata*	RM1137	South Africa. Bloemfontein: Bayswater area, junction of N1 + R400 roads.	29° 10'	26° 13'
KrbS3	*krebsiana* subsp *serrulata*	RM866	South Africa. Griekwastad: north of Danielskuil	28° 10' 50"	23° 32' 11"
KrbS4	*krebsiana* subsp *serrulata*	RM863_1	South Africa. Olifantshoek: southeast of Beeshoek	27° 45'	22° 37'
KrbS5	*krebsiana* subsp *serrulata*	RM877_1	South Africa. Aliwal North: north of Rouxville.	30° 25’	26° 49’
KrbS6	*krebsiana* subsp *serrulata*	RM965	South Africa. Lady Frere: 13km SW Elliot on R56 road.	31° 19'	27° 57'

Leio1	*leiopoda*	RM1320	South Africa. Hondeklipbaai: Kamiesberg.	30° 11' 16"	17° 59' 21"
Leio10	*leiopoda*	RM1309	South Africa. Kamiesberg: Roadside.	30° 24' 38"	18° 3' 9"
Leio11	*leiopoda*	RM1466	South Africa. Hondeklipbaai: Namakarroo National Park, W of Kamieskroon.	30° 05' 47"	17° 35' 03"
Leio2	*leiopoda*	M200901/22G	South Africa. Hondeklipbaai: Kamieskroon, Arakop Farm.	30° 05' 31"	17° 54' 33"
Leio3	*leiopoda*	M230901/7G	South Africa. Vanrhynsdorp: Knersvlakte, Vanrhynsdorp, Quaggaskop Farm.	31° 24' 46"	18° 38' 33"
Leio4	*leiopoda*	M240901/19	South Africa. Calvinia: Nieuwoudtville, near turnoff to Rondekop.	31° 23' 23"	19° 11' 00"
Leio5	*leiopoda*	M210901/22	South Africa. Hondelipbaai: Kamieskroon, Arakop Farm, edge of dirt road.	30° 05' 31"	17° 54' 33"
Leio6	*leiopoda*	M160704/5	South Africa. Hondeklipbaai: Namaqualand, Kamieskroon, on N7.	30° 14' 15"	17° 53' 43"
Leio7	*leiopoda*	RM1291	South Africa. Hondeklipbaai: roadside.	30° 18' 37"	17° 53' 37"
Leio8	*leiopoda*	M250901/34	South Africa. Vanrhynsdorp: road from Vredendal to Strandfontein, Papendorp turnoff.	31° 42' 06"	18° 13' 32"
Leio9	*leiopoda*	RM1063	South Africa. Vanrynsdorp: SW of Lutzville, R362 between Papendorp & Lutzville.	31° 33'	18° 21'
Lict1	*lichtensteinii*	M7249/15	South Africa. Springbok: Kamieskroon, at bridge of N7 over Haasrivier	29° 59' 312"	17° 52' 31"
Lict10	*lichtensteinii*	RM1323	South Africa. Kamiesberg: Road north east of Kamieskroon.	30° 7' 44"	18° 13' 40"
Lict11	*lichtensteinii*	Schlechter 4501	Herbarium (GRA)		
Lict3	*lichtensteinii*	M150704/10	South Africa. Vioolsdrif: N7, between Steinkopf and Vioolsdrif.	28° 57' 24"	17° 46' 17
Lict4	*lichtensteinii*	M020803/8	South Africa.Merweville: Leeuw-Gamka, Shell petrol station	32° 47' 13"	21° 59' 00"
Lict5	*lichtensteinii*	M060605_22	South Africa. Gamoep: Namaqualand, Aggeneys, Kangas farm, gate on N14	29° 30' 10"	18° 18' 48"
Lict6	*lichtensteinii*	RM1249	South Africa. Wuppertal: beside R355 road near Tankwa Karoo National Park.	32° 10' 30"	19° 42' 47"
Lict8	*lichtensteinii*	RM1265	South Africa. Calvinia: flats South of Botterkloof Pass.	31° 56' 59"	19° 14' 34"
Linlin1	*linearis* subsp *linearis*	RM1013	South Africa. Port St Johns: North of Mbotyi river mouth.	31° 26'	29° 43'
Linlin10	*linearis* subsp *linearis*	RM794_2	South Africa. Stutterheim: south of King William's Town on N2 highway.	32° 52'	27° 23'
Linlin13	*linearis* subsp *linearis*	RM787_1	South Africa. Umtata: between Umtata and Umlambo Mputi on N2 highway.	31° 59'	28° 40'
Linlin15	*linearis* subsp *linearis*	RM916_1	South Africa. Fort Beaufort: Katberg Pass	32° 26' 46"	26° 38' 26"
Linlin2	*linearis* subsp *linearis*	RM1061	South Africa. Capetown: Clanwilliam. Possible garden escape growing wild and profusely.	32° 11' 45"	18° 54' 32"
Linlin21	*linearis* subsp *linearis*	RM885_1	South Africa. Fort Beaufort: Tor Doone, Hogsback.	32° 34’	26° 56’
Linlin23	*linearis* subsp *linearis*	RM789	South Africa. Umtata: between Umtata and Umlambo Mputi on N2 highway.	31° 35'	28° 47'
Linlin24	*linearis* subsp *linearis*	RM951_1	South Africa. Humansdorp: St Francis bay, R330 road, St Francis Bay village turnoff.	34° 11'	24° 50'
Linlin25	*linearis* subsp *linearis*	RM1182	South Africa. Humansdorp: on N2, Seekooi river.	34° 02’	24* 46’
Linlin26	*linearis* subsp *linearis*	SR571	South Africa. Port Shepstone: Port Shepstone. Roadside.	30° 44'	30° 27'
Linlin27	*linearis* subsp *linearis*	SR523	South Africa. Humansdorp: Maitlands, road between Seaview and Maitlands River.	34° 00'	25° 41'
Linlin28	*linearis* subsp *linearis*	SH131	South Africa. Stutterheim: Road between Hogsback and Cathcart, 7km out.	32° 33'	27° 04'
Linlin29	*linearis* subsp *linearis*	SH132	South Africa. Stutterheim: Road between Hogsback and Cathcart, 14km out.	32° 22'	27° 07'
Linlin3	*linearis* subsp *linearis*	RM1010	South Africa. Calvinia: Mzimpunzi river mouth, Pondoland.	31° 19'	29° 56'

Linlin4	*linearis* subsp *linearis*	SH113	South Africa. Stutterheim: 10km out of Stutterheim.	32° 34'	27° 25'
Linlin5	*linearis* subsp *linearis*	RM1092	South Africa. Port St Johns: Coffee Bay, Bumvu river mouth.	31° 58'	29° 09'
Linlin6	*linearis* subsp *linearis*	RM1103	South Africa. Port Edward: Mkambati Nature Reserve, N of the Msikaba River Mouth.	31° 01' 24"	30° 13' 48"
Linlin9	*linearis* subsp *linearis*	RM780	South Africa. Fort Beaufort: between East London and Cintsa turnoff on N2 highway.	32° 53'	28° 04'
LinO1	*linearis* subsp *ovalis*	RM854	South Africa. Grahamstown: north of Bathurst.	33° 29'	26° 49'
LinO10	*linearis* subsp *ovalis*	Britten 2691	Herbarium (GRA)		
LinO2	*linearis* subsp *ovalis*	M041001_2G	South Africa. Grahamstown: Thornycroft, road between Alexandria and Port Elizabeth.	33° 36' 42"	26° 01' 43"
LinO3	*linearis* subsp *ovalis*	ND_haven	South Africa. Butterworth: The Haven, Transkei.	32° 14'	28° 54'
LinO4	*linearis* subsp *ovalis*	Potts 220	Herbarium (GRA)		
LinO5	*linearis* subsp *ovalis*	Galpin 2953	Herbarium (GRA)		
LinO6	*linearis* subsp *ovalis*	Daly 717	Herbarium (GRA)		
LinO7	*linearis* subsp *ovalis*	White 70	Herbarium (GRA)		
LinO8	*linearis* subsp *ovalis*	Britten 5239	Herbarium (GRA)		
LinO9	*linearis* subsp *ovalis*	Britten 2691	Herbarium (GRA)		
Marit	*maritima*	RM1038	South Africa. Bredasdorp: Cape Agulhas, about 2km E of actual cape, on shoreline.	34° 48' 48"	20° 02' 48"
Oth	*othonnites*	RM1306	South Africa. Springbok: Kleinzee, Molyneux trail	29° 41' 27"	17° 05' 40"
Pct1	*pectinata*	M120903/5	South Africa. Clan William: Western Cape Province, Piketberg, Sauer, Uitvlug turnoff.	32° 50' 17"	18° 33' 14"
Pct2	*pectinata*	M260901/2G	South Africa. Clanwilliam: Cederberg, Pakhuis pass.	32° 08' 11"	18° 58' 15"
Pct3	*pectinata*	M180904/5	South Africa. Bredasdorp: De Hoop Nature Reserve., Koppie Alleen.	34° 28 ' 41"	20° 30' 39"
Pct4	*pectinata*	RM1044_3	South Africa. Caledon: Agulhas peninsula, Bredasdorpberge.	34° 29' 47'	19° 53' 39"
Pct5	*pectinata*	RM1044_1	South Africa. Caledon: Agulhas peninsula, Bredasdorpberge.	34° 29' 47"	19° 53' 39"
Pct6	*pectinata*	M250901_37	South Africa. Vanrhynsdorp: Strandfontein, on road to Doringbaai.	31° 45' 18"	18° 14' 02"
Pct7	*pectinata*	Rogers 11067a	Herbarium (GRA)		
Pct8	*pectinata*	RM1390	South Africa. Caledon: Franschoek Pass, summit of pass.	33° 54' 27"	19° 09' 19"
Rigid1	*rigida*	RM1210	South Africa. Bredasdorp: 14.5km North of Bredasdorp on R319 road.	34° 25' 50"	20° 7' 22"
Rigid12	*rigida*	M110805_10	South Africa. Bredasdorp: De Hoop Nature Reserve, Potberg, Melkosheuwel.	34° 22' 50"	20° 29' 16"
Rigid13	*rigida*	RM1270	South Africa. Wuppertal: North of base of Pakhuis Pass.	32° 03' 37"	19° 10' 10"
Rigid14	*rigida*	RM1254	South Africa. Wuppertal: base of Katbakkies Pass, Swartruggens.	32° 52' 58"	19° 44' 27"
Rigid3	*rigida*	M280902/9	South Africa. Oudtshoorn: Oudtshoorn, turn off to Zebra	33° 45' 45"	22° 20' 07"
Rigid4	*rigida*	M100903/4	South Africa. Cape Town: Darling, Tienie Versveld Flower Reserve.	33° 20' 07"	18° 16' 16"
Rigid5	*rigida*	M100904/4	South Africa. Beaufort West: Uniondale, bridge over Keurboomsrivier.	33° 45' 39"	22° 57' 44"
Rigid6	*rigida*	RM1044_2	South Africa. Caledon: Agulhas peninsula, Bredasdorpberge. Ex-pine plantation.	34° 29' 47"	19° 53' 39"
Rigid7	*rigida*	M120805_80	South Africa. Sutherland: De Hoop Nature Reserve, Potberg, NE of the Potberg gate.	34° 22' 10"	20° 31' 32"

Rigid8	*rigida*	Rogers 2889	Herbarium (GRA)		
Rigid9	*rigida*	JacotGuillarmard 7662	Herbarium (GRA)		
Rigs10	*rigens*	RM782_2	South Africa. Port St Johns: Second Beach.	31° 37'	29° 32'
Rigs11	*rigens*	RM772_2	South Africa. Knysna: Plettenberg Bay.	34° 02'	23° 22'
Rigs16	*rigens*	RM919	South Africa. Grahamstown: SE of Cannon Rocks.	33° 44'	26° 33'
Rigs17	*rigens*	RM920	South Africa. Grahamstown: SE of Cannon Rocks.	33° 44'	26° 33'
Rigs19	*rigens*	SR625	South Africa. Skoenmakerskop: Cape Riecefe (Between PE and seaview).	34° 00'	25° 39'
Rigs2	*rigens*	M7298/2	South Africa. Humansdorp: St Francis Bay, bridge over Kromme river, tidal salt marsh.	34° 08' 15"	24° 48' 28"
Rigs20	*rigens*	SR581	South Africa. Grahamstown: Kowie river.	33° 36'	26° 53'
Rigs21	*rigens*	SR 575	South Africa. Stanger: Durban, Blue Lagoon.	29° 48'	31° 02'
Rigs22	*rigens*	SR 574	South Africa. Port Shepstone: Umkomaas, Warner Beach, Baggies Beach, 10km N Durban.	30° 04'	30° 52'
Rigs23	*rigens*	SR463	South Africa. Stanger: Tugela River mouth	29° 13'	31° 30'
Rigs3	*rigens*	M7293/1	South Africa. Humansdorp: Jeffereys Bay, beach south of Kabeljouws River mouth.	34° 00' 53"	24° 55' 42"
Rigs4	*rigens*	M070704/1	South Africa. Simonstown: Miller's Point.	34° 13' 57.8"	18° 28' 32"
Rigs5	*rigens*	M7257/2	South Africa. Riversdale: Gouritzmond, coast, parking lot, leeward slope dune.	34° 21' 01"	21° 53' 00"
Rigs6	*rigens*	RM952_1	South Africa. Humansdorp: Cape St Francis, in sand rocky shoreline	34° 12’	24° 50’
Rigs7	*rigens*	RM952_3	South Africa. Humansdorp: Cape St Francis, in sandon rocky shoreline	34° 12’	24° 50’
Rigs9	*rigens*	RM783	South Africa. Port St Johns: Third Beach.	31° 37'	29° 32'
Serr1	*serrata*	RM1216	South Africa. Caledon: 1km SW of Caledon on R320 road.	34° 16' 24"	19° 26' 09"
Serr2	*serrata*	RM1260	South Africa. Worcester: Calvinia.	33° 30' 21"	19° 44' 23"
Serr3	*serrata*	M250904/15	South Africa. Simonstown: Helderberg strand, R44 between Nautilus and Octopus streets	34° 08' 31"	18° 51' 06"
Serr4	*serrata*	RM821_1	South Africa. Worcester: Robertson aerodrome.	33° 48'	19° 53'
Serr6	*serrata*	RM812	South Africa. Worcester: Dassiehoek Nature Reserve.	33° 50’	19° 30’
Serr7	*serrata*	RM1245	South Africa. Worcester: Skurweberg.	33° 14' 11"	19° 17' 42"
Serr8	*serrata*	RM1280	South Africa. Calvinia: 5km East of Nieuwoudtville.	31° 23'	19° 06'
Serr9	*serrata*	RM1374	South Africa. Clanwilliam: Piketberg, near top of Versveld Pass.	32° 50' 59"	18° 44' 02"
sp. nov1	*species nova*	M040906_33	South Africa. Hondeklipbaai: Hondeklipbaai, coast at police station	30° 19' 22"	17° 16' 21"
sp. nov2	*species nova*	MSG7237/4	South Africa. Port Nolloth: South of McDougalls Bay. Strandveld.	29° 17' 39"	16° 52' 45"
sp. nov3	*species nova*	M050905_02	South Africa, Springbok: Kleinzee, Rooikoppies	29° 43' 52"	17° 03' 40"
Ten1	*tenuifolia*	M7230/2	South Africa, Springbok: Goegap Nature Reserve, Bleshoek	29° 41' 31"	17° 58' 46"
Ten2	*tenuifolia*	M7219_10	South Africa. Gamoep: Goegap Nature Reserve, SE of Carolusberg.	29° 39' 23"	18° 00' 32"
Ten3	*tenuifolia*	RM1352	South Africa. Springbok: 40km east of Port Nolloth	29° 17' 56"	17° 12' 21"
Ten4	*tenuifolia*	CAM1601	Namibia. Witputz: Arras	27° 22' 30"	16° 7' 30"

Ten5	*tenuifolia*	Schlechter 8109	Herbarium (GRA)		
Ten6	*tenuifolia*	Esterhuysen 5984	Herbarium (GRA)		
Ten7	*tenuifolia*	Esterhuysen 5985	Herbarium (GRA)		
Ten8	*tenuifolia*	Esterhuysen 5986	Herbarium (GRA)		
Ten9	*tenuifolia*	Esterhuysen 5987	Herbarium (GRA)		
Ten10	*tenuifolia*	Schlechter 8109	Herbarium (GRA)		

Collector abbreviations: RM = Robert McKenzie, M = Laco Mucina, MSG = Mucina & Santos Guerra, CAM = Colleen Mannheimer, SR = Syd Ramdhani, ND = Nico Devos.

A list of characters, an explanation of each character, a description of how each character was quantified/qualified and the possible characters states follows:

Qualitative characters:

Binary characters:

1) Habit:

0 = Leaves alternate, capitula scapose.

1 = Leaves rosulate, capitula pedunculate.

2) Involucre furry/setose:

0 – no

1 – yes

Multistate characters:

3) Presence of parietal scales on involucre:

Not all the tips of the fused involucral scales are inserted at the terminal edge of the involucre, some are parietal.

0 = No scales

1 = Some few single scales

2 = Multiple rows of scales

4) Base of involucre truncated/annulated:

See Figure 2.2.1 for illustration of each state.

0 – No

1 – annulated

2 – subinserted

3 – truncate

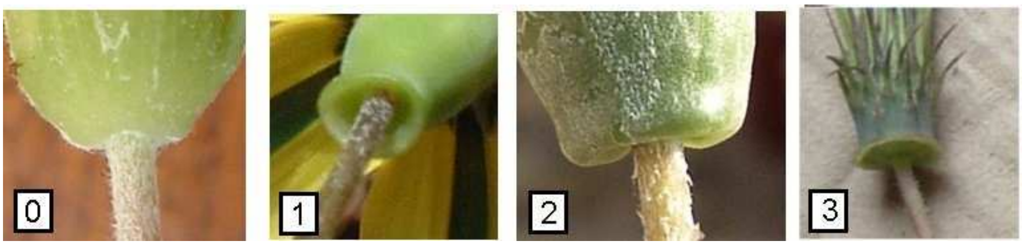


Figure 2.2.1: Involucral base states in *Gazania*: 0 = no modification, 1 = annulated, 2 = subinserted, 3 = truncate.

5) Adaxial leaf indumentum:

Some leaves are very scabrid to touch and others have only a light coat of hairs.

0 – smooth
1 – lightly setose/ciliate
2 – densely roughly setose/ciliate

6) Leaf margin ciliate/smooth:

0 = smooth
1 = ciliate at terminal upper half
2 = ciliate at basal lower half
3 = ciliate along entire edge.

7) Leaf dissectedness:

1 – all leaves on plant entire, no division
2 – all leaves on plant lobed
3 – all leaves on plant pinnatisect (deeply incised)
4 – some leaves on plant whole, some leaves on plant lobed
5 – some leaves on plant whole, some leaves on plant pinnatisect
6 – lobed, pinnatisect and whole all present on plant
7 – minute lobes present all along edges of leaves

Quantitative characters:

8) Outer involucral scale length (mm):

Length from point of attachment to tip.

9) Outer involucral scale width (mm):

Width of scale at point of attachment.

10) Inner involucral scale length (mm):

Length from point of attachment to tip.

11) Inner involucral scale width (mm):

Width of scale at point of attachment.

12) Involucre length (mm):
Length from point of stem attachment to start of terminal scales.

13) Width of involucre at terminal edge (mm):
Width of the involucre at terminal edge where terminal scales are inserted.

14) Leaf length (mm):
Average length of three longest adult leaves on plant.

15) Leaf width (mm):
Average width at widest part of three longest adult leaves on plant.

16) Involucre scape/peduncle length (mm):
Measured from last major leaf, to point of attachment to involucre (solitary linear bracts were ignored as a starting point for the measurement).

Ratio characters:
17) Outer involucral scale:
Length / Width.

18) Inner involucral scale:
Length / Width.

19) Outer involucral scale length/Inner involucral scale length:
Some species are noted for having inner scales longer than the other scales.

20) Involucre length/width

21) Leaf length/width

Discarded characters

Roessler (1959) included “the width of the capitula with the ligules expanded” as a character in his species delimitations. The length of ray floret ligules were investigated for potential data signal during the data collection process. However, the length of ray floret ligules is subject to water availability (water stress results in smaller inflorescences; pers. obs. on greenhouse plants) and also shows little useful signal.

Roessler (1959) noted that certain species have only divided leaves or only whole leaves, thus leaf dissectedness was investigated. However, the inclusion of leaf dissectedness (whole, lobed or pinnate) as an informative character is debatable. The difference between leaves that are whole, pinnate or lobed can either be species specific (certain species are always pinnate; others are commonly, but not always, whole) or environmentally responsive (excess water can either result in more pinnate leaves in rigens, or more whole leaves in some commonly pinnate western cape species, pers. obs.).

Roessler (1959) listed ray spot patterns in his species descriptions, but the extraordinary variability of ray spot patterns precluded any easy delimitation of character states. Likewise, the large variety of spot patterns, colours and colour combinations that occur within species likewise advised against using this character. Samples of the same subspecies co-occurring within centimeters of each other have been observed to have different spot patterns (pers. obs. & R. McKenzie, pers. comm.).

Roessler (1959) included comments on comparative length of terminal pinnules relative to side pinnules. However, the length of the pinnules (or only the terminal pinnule) was found to be highly variable, not only within species, but also on individual plants, making it very difficult to determine with any accuracy. The lack of pinnules in some samples also made this a dubious character.

Many taxonomists consider colour characters dubious, since colour characters are considered unstable, the measurement is dependent on the colour vision of the observer, and is very hard to quantify (Chandler & Crisp, 1998). In addition, the change in colour that herbarium specimens may undergo over time makes ray colour a very difficult character to judge for *Gazania* specimens.

Analysis of herbarium versus live specimens

The pressing of herbarium samples does not affect the leaves in terms of length and width, nor does it appear to affect involucral scale characters. However, the pressing of herbarium specimens can change the width of the involucre slightly (as the cylindrical involucre becomes rather more two-dimensional). Since all the herbarium specimens are pressed, the measurements are directly comparable with each other, but probably not directly with living material.

Data sets

To compare the effects of ratio data versus raw size data on various analytical methods three data sets were constructed. All three data sets contained the binary and qualitative characters 1-7.

1) “RAW”, which contains characters 8-16, i.e. all the raw size data of the qualitative characters but no ratio characters.
2) “RAT”, which contains character 17-21, i.e. all the ratio characters but none of the raw size data characters.
3) “TOTAL”, which contains both raw size and ratio characters, i.e. characters 8-21.

Data analysis

All data analyses were conducted in NTSYS-pc version 2.02k (Applied Biostatistics, Inc.).

Normalization of data

Certain analyses require that continuous variables be normally distributed. When a variable is not normally distributed a transformation, such as taking the log of the variable, eliminates the undesirable characteristic and improves the symmetry about the mean and the approximation to a normal distribution to provide more natural expressions of the characteristics being studied (Borazan & Babac, 2003). Test of normality were conducted in STATISTICA 6.1 (StatSoft, Inc), using the Lilliefors test (Lilliefors, 1967) of normality, where a significant result ($p<0.05$) indicates that data is not normally distributed. All quantitative data were converted to their log values prior to PCA analysis.

Albrecht (1978) noted that analysis (specifically PCA) of raw data which contains both size and shape components of variation should yield different results than an analysis of this same data after elimination of the size variation by some appropriate scaling procedure. The data sets were standardized to eliminate the distorting effects of different scales of measurement on the output results (Cupido, 2003; Borazan & Babac, 2003), using the STAND function. As the data was mixed (binary, qualitative, and quantitative/ratio, depending on the data set) the SIMINT function (with the Manhattan distance option) was used to compute a variety of similarity and dissimilarity coefficients for interval measure (quantitative) data, generating a correlation matrix. The most commonly used distance function is the Euclidean distance, but this is also the simplest and may be dependent on scales (Atchley *et al.*, 1982). The Manhattan distance is rather used when the data set contained mixed (metric and binary) data (Cupido, 2003). The Manhattan distance method is the most effective measure for continuous variables (Pimentel, 1981; Crisp & Weston, 1993), and its stepwise form of measurement suits the assumed hierarchical nature of taxonomic data (Chandler & Crisp, 1998).

Cluster Analysis

The Clustering analysis utilized the SAHN (Sequential Agglomerative Hierarchical Nested Cluster Analysis) function. James & McCulloch (1990) note that it has become conventional in systematics to use the UPGMA (unweighted pair-group method using averages), which distributes the objects into a reasonable number of groups by calculating differences between clusters as the average of all the point-to-point distances between a point in one cluster and a point in the other. The resulting phenogram was plotted using the TREEPLOT function in NTSYS.

The COPH function takes a hierarchical system of clusters and produces a symmetrical matrix of "cophenetic" (ultrametric) similarity or dissimilarity values, which can be used to test for the goodness of fit of a clustering to a set of data. The MXCOMP function takes two symmetric similarity or dissimilarity matrices and plots one matrix against the other element by element, and also computes the product-moment correlation, r, and the Mantel test statistic, Z, (Mantel, 1967) to measure the degree of relationship between the two matrices. The correlation can be used as a measure of goodness of fit for a cluster analysis (the subjective interpretation is roughly $r > 0.9$ indicates a very good fit, $r < 0.7$ indicates a very poor fit).

Principle Component Analysis

The principal components of a matrix are computed by its eigenvalues and eigenvectors, which describe the relationship between operational taxonomic units (Borazan & Babac, 2003). The EIGEN function was used to extract the first three PCA axes from the correlation matrix, along with the eigen vectors and values. The PROJ function was used to project objects onto PCA axes and the 2D PLOT option was used to produce scatterplots of the first three PCA axes. Colours were inserted into the plot circles using PaintShopPro version 4.12 (JASC, Inc).

Results

Tests of normality

The results of the Lilliefors test of normality on all continuous variables are presented in Table 2.3.1 below. The significant p-values for several variables indicate that those variables are not normally distributed, and that logging the data was therefore necessary. Non-normal data does not affect CA, but the logging of data was necessary for PCA.

Table 2.3.1: Table of Lilliefors test of normality p-values for all continuous size variables. Asterisks indicate significant values.

Variable	**P-value**
Outer Involucral scale length	p<0.01*
Outer Involucral scale width	p<0.15
Inner Involucral scale length	p<0.01*
Inner Involucral scale width	p<0.15
Involucre length	p>0.2
Involucre width	p>0.2
Leaf Length	p<0.01*
Leaf Width	p<0.01*
Stem Length	p<0.01*

Cluster Analysis

The dendrograms from Cluster Analysis of the RAW, RAT and TOTAL data sets are presented in Figures 2.3.1 to 2.3.12. Two species (*G. tenuifolia* and *G. lichtensteinii*) are clearly clustered together in all three analyses regardless as to whether size data or ratio data are used (Figures 2.3.2, 2.3.6 and 2.3.10). Two taxa (*G. rigens* and *G. linearis* subsp *ovalis*) always cluster together in their own branches, but are also always interspersed with one or two additional samples from other species (Figures 2.3.2, 2.3.3, 2.3.6, 2.3.8, 2.3.10 and 2.3.11). Most *G. heterochaeta* samples cluster clearly together, while one or two samples were scattered through the phenogram (Figures 2.3.3, 2.3.8 and 2.3.11). The same holds for most *G. jurineifolia* samples, which cluster together in the same branch, but are sometimes interspersed with some few samples from other taxa (Figures 2.3.3, 2.3.8 and 2.3.11). The remaining taxa samples do not show any clear groupings and are interspersed with each other. Although there are a few small *G. krebsiana* and *G. linearis* clusters (Figures 2.3.8, 2.3.10 and 2.3.11), these clusters do not include all examples of the species and are not retrieved in all three data set analyses.

Figure 2.3.2 contains a cluster (named “A” on the dendrogram) that is composed of a mix of samples from several taxa*: G. linearis* subsp *ovalis, G. linearis* subsp *linearis, G. pectinata* and *G. ciliaris*.

All of these species are characterised by extremely long and thin acuminate involucral scales. The use of raw size data, rather than shape data from ratios, is the most likely reason that these samples are clustering together.

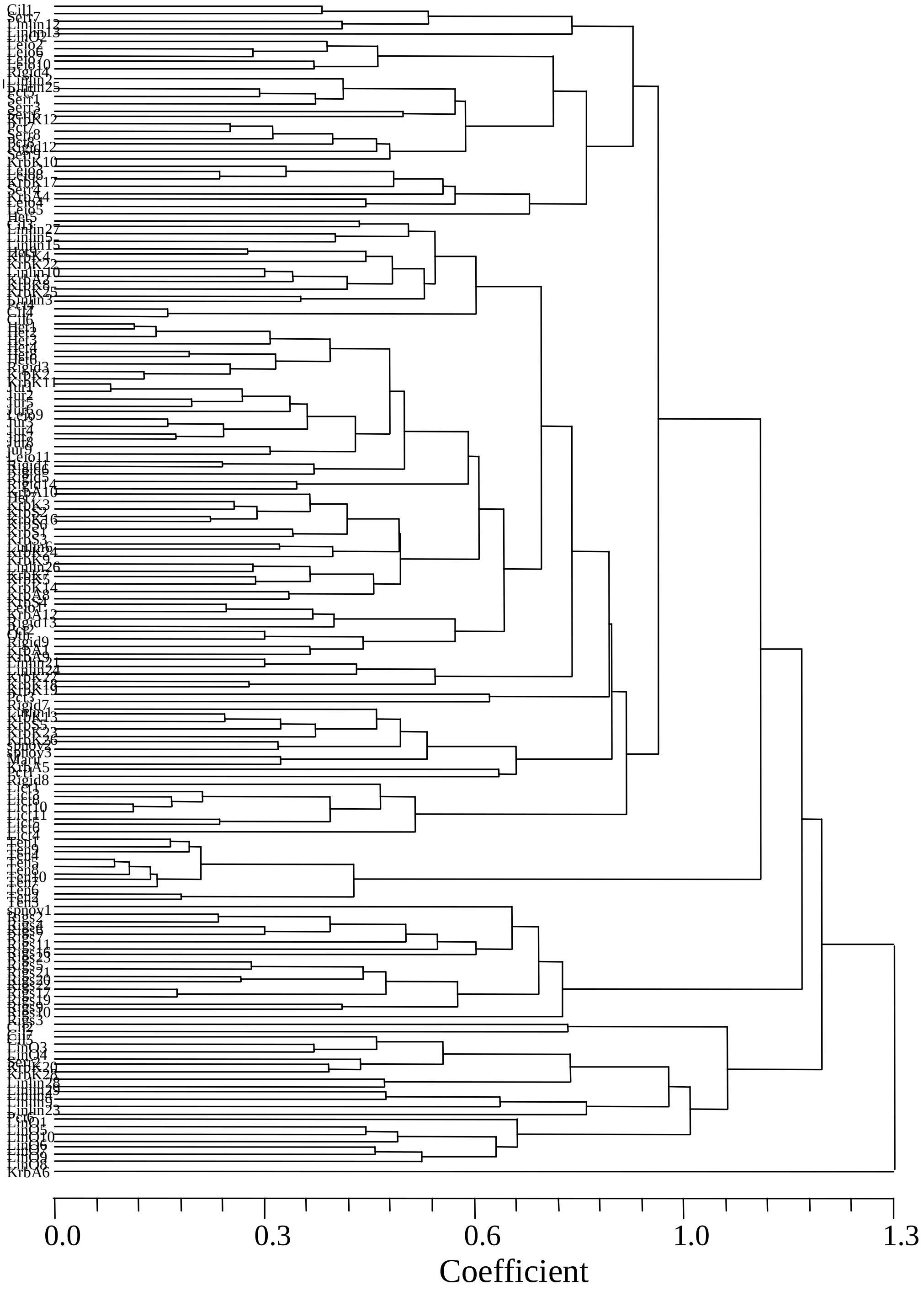


Figure 2.3.1: Cluster Analysis phenogram of RAW data (standardized, Manhattan distance, UPGMA, r=0.67). Detailed expansion of branches is provided in next three figures.

Figure 2.3.2: Lowest third of Cluster Analysis phenogram of RAW size data (full phenogram in Figure 2.3.1). Triangles indicate monospecific branches. “A” marks cluster discussed in detail in text.

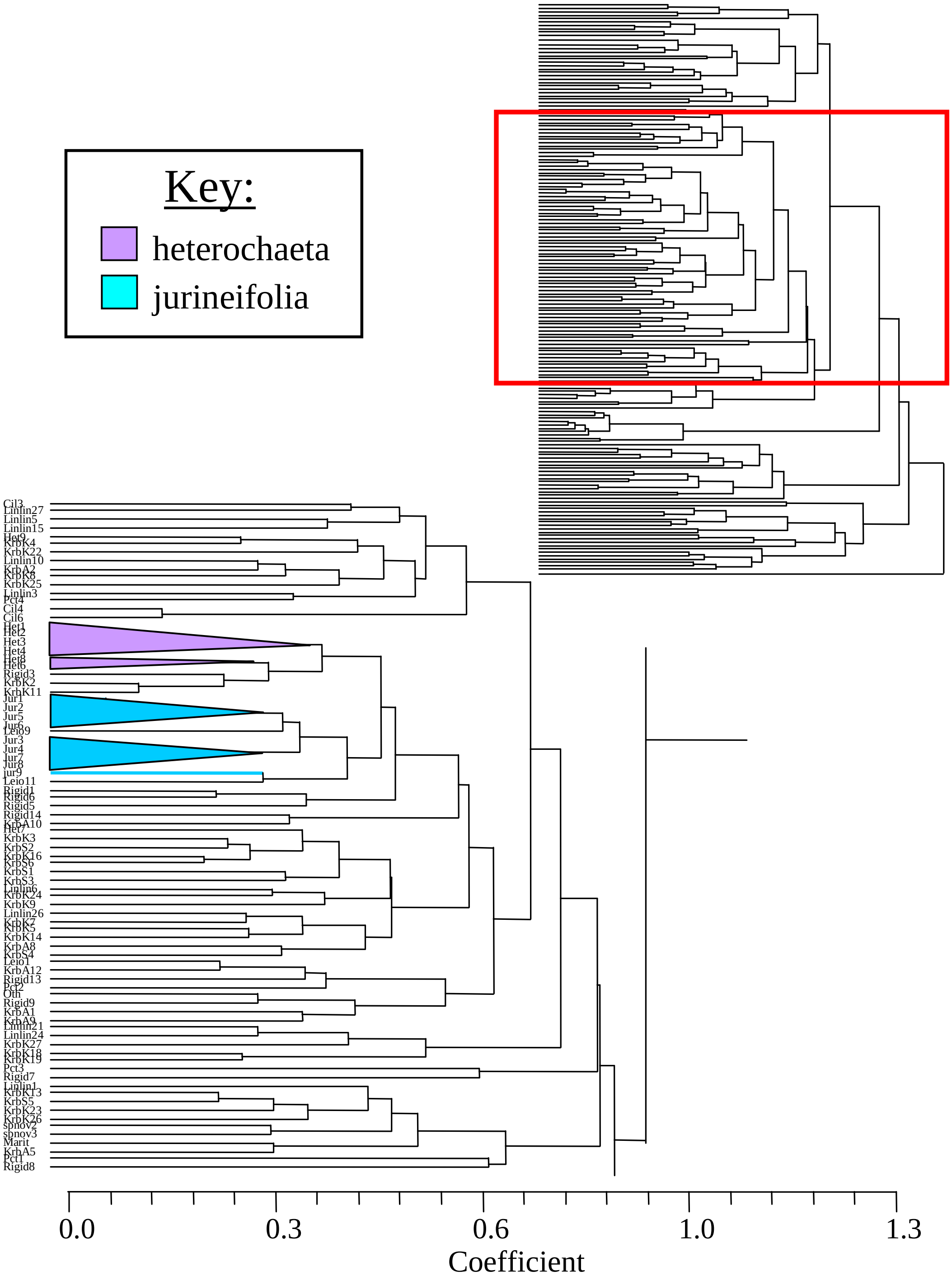


Figure 2.3.3: Middle third of Cluster Analysis phenogram of RAW size data (full phenogram in Figure 2.3.1). Triangles indicate monospecific branches.

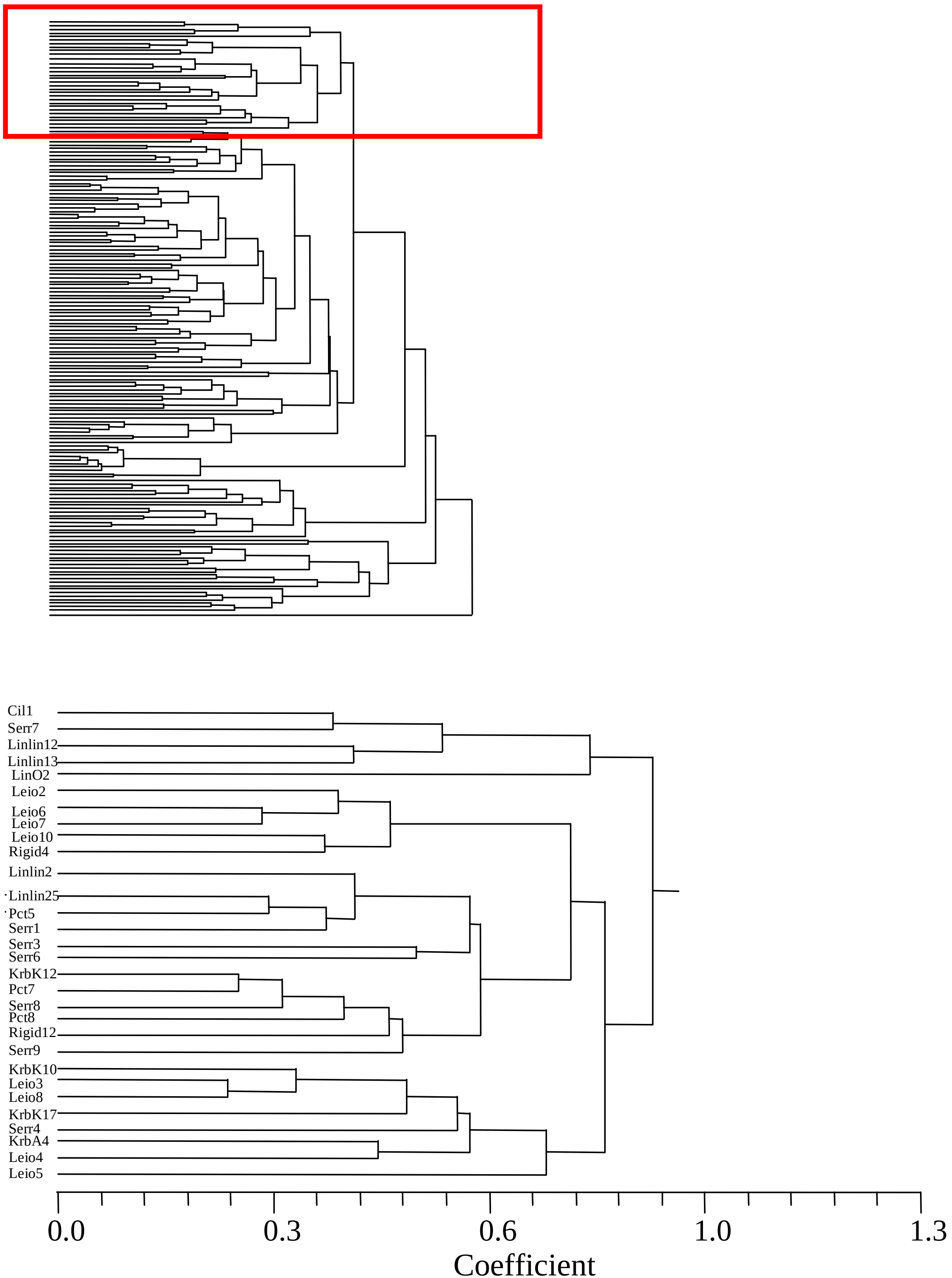


Figure 2.3.4: Top third of Cluster Analysis phenogram of RAW size data (full phenogram in Figure 2.3.1).

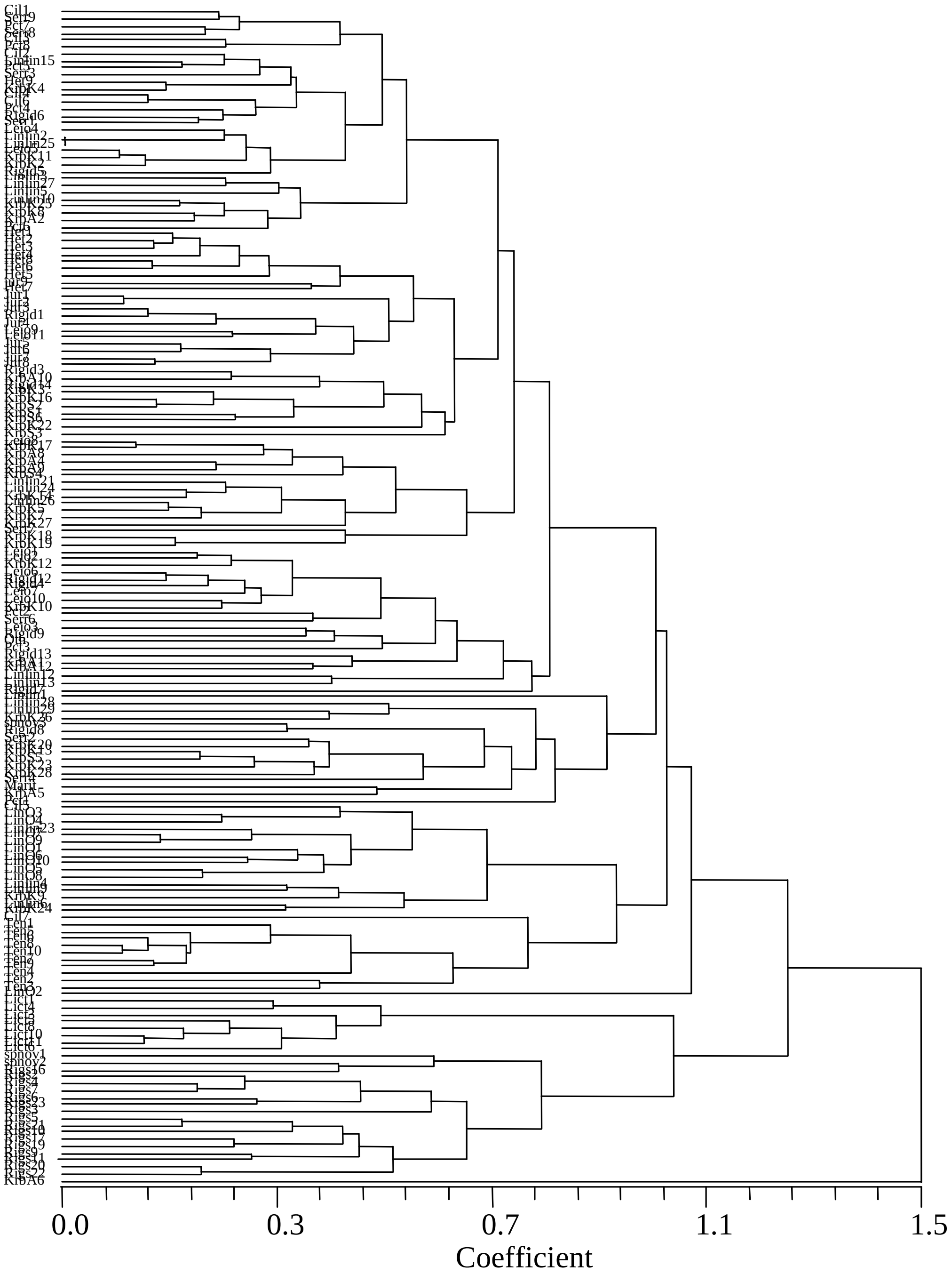


Figure 2.3.5: Cluster Analysis phenogram of RAT data (standardized, Manhattan distance, UPGMA, r=0.72). Detailed expansion of branches is provided in following three figures.

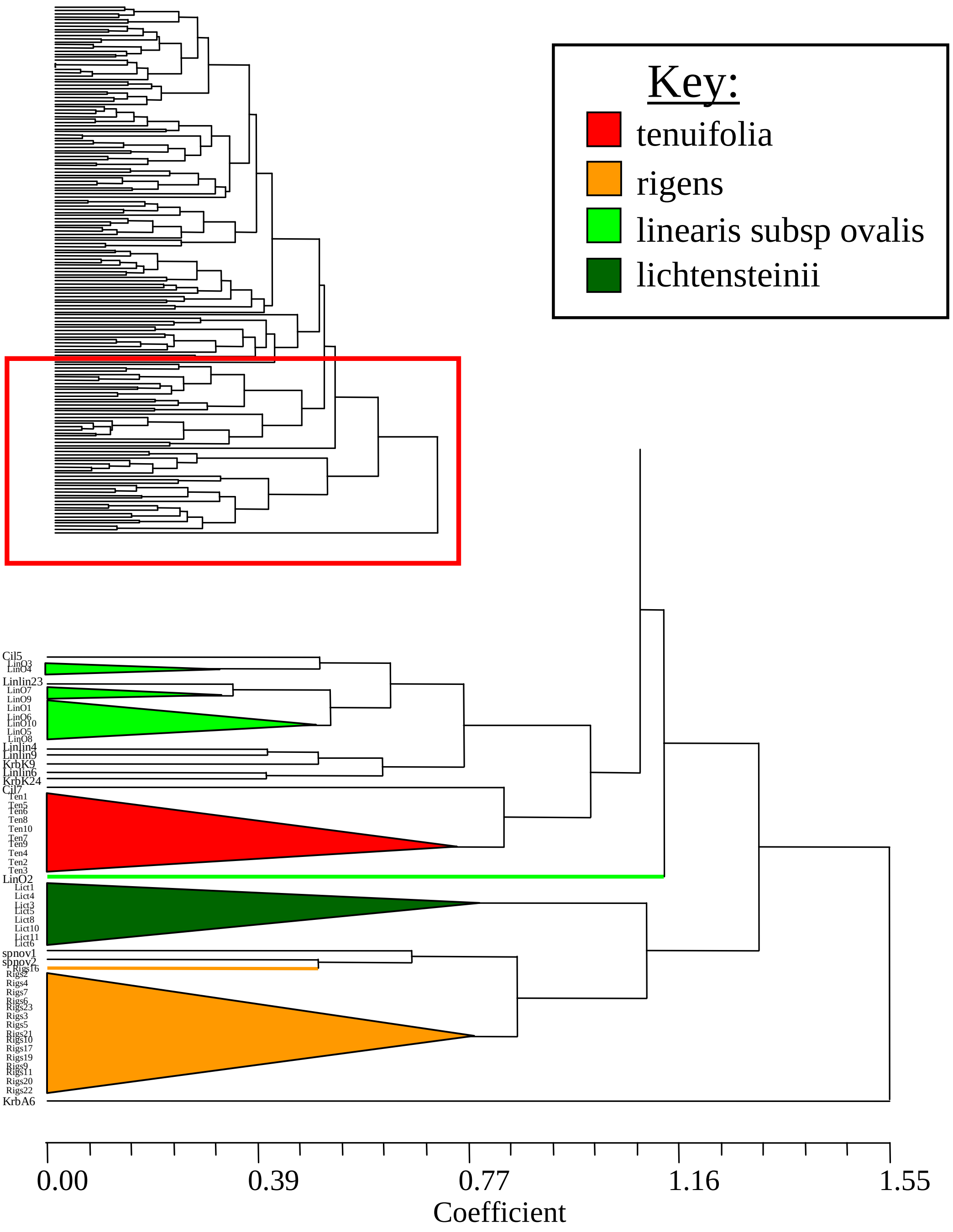


Figure 2.3.6: Lowest third of Cluster Analysis phenogram of RAT size data (full phenogram in Figure 2.3.5). Triangles indicate monospecific branches.

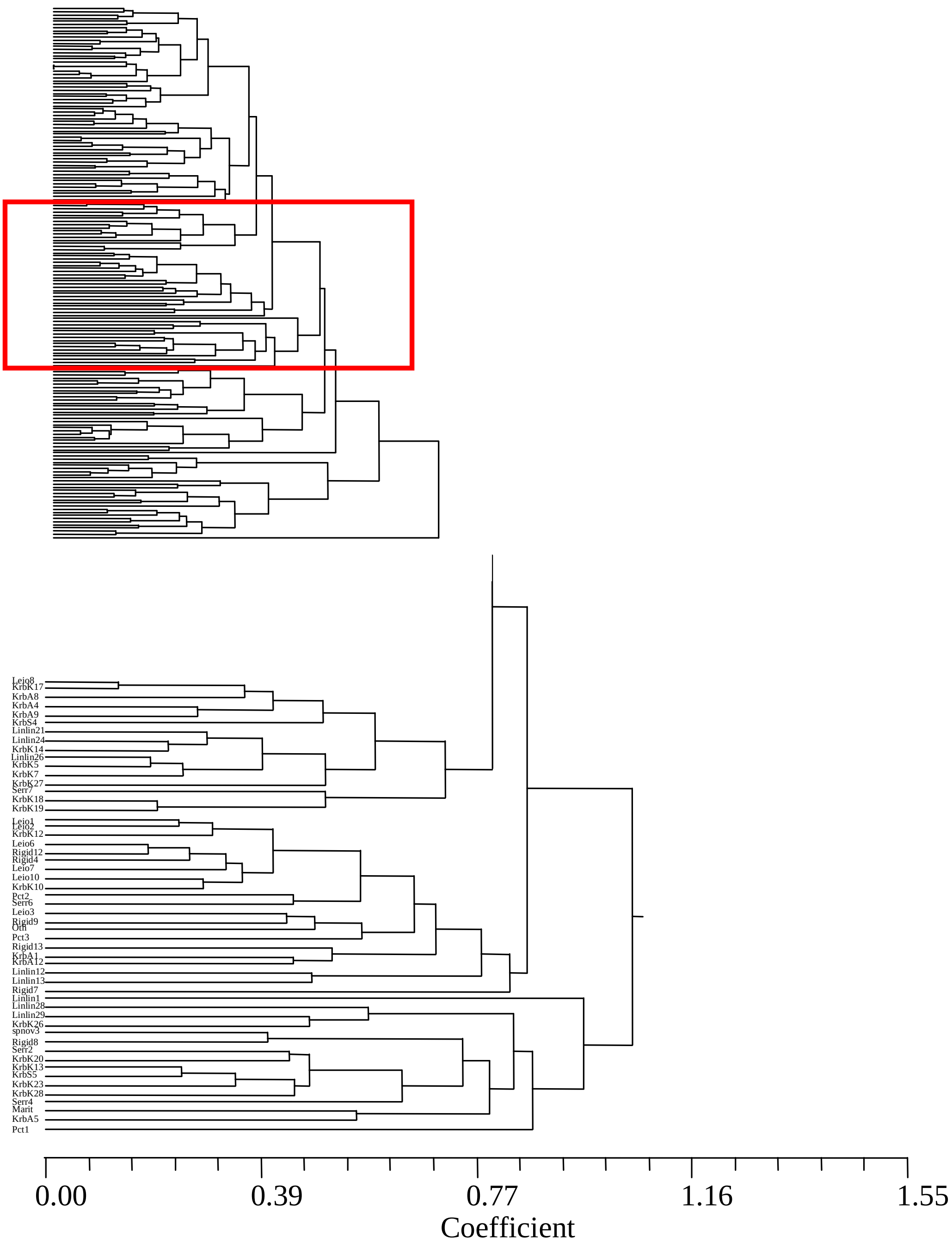


Figure 2.3.7: Middle third of Cluster Analysis phenogram of RAT size data (full phenogram in Figure 2.3.5).

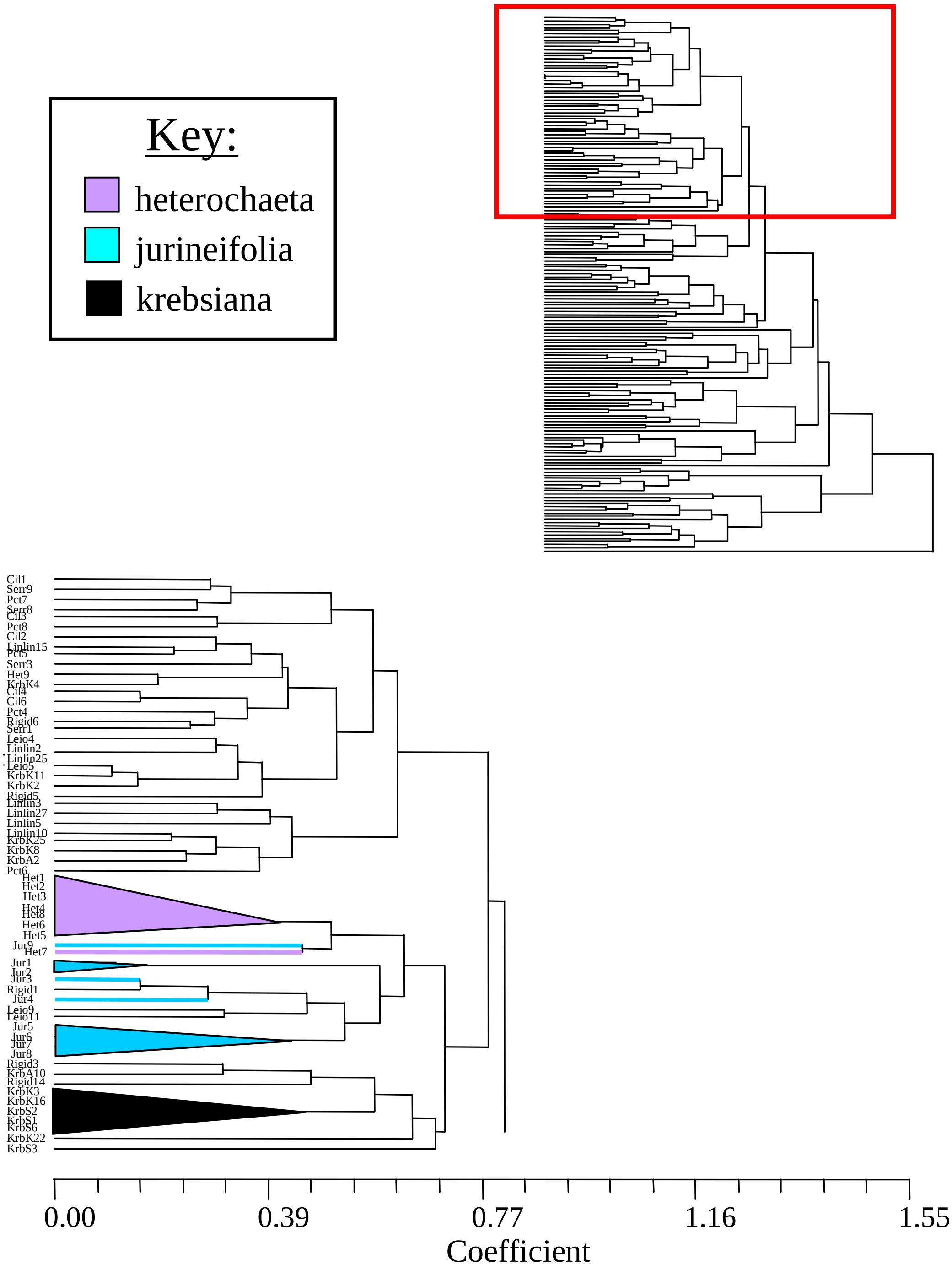


Figure 2.3.8: Top third of Cluster Analysis phenogram of RAT size data (full phenogram in Figure 2.3.5). Triangles indicate monospecific branches.

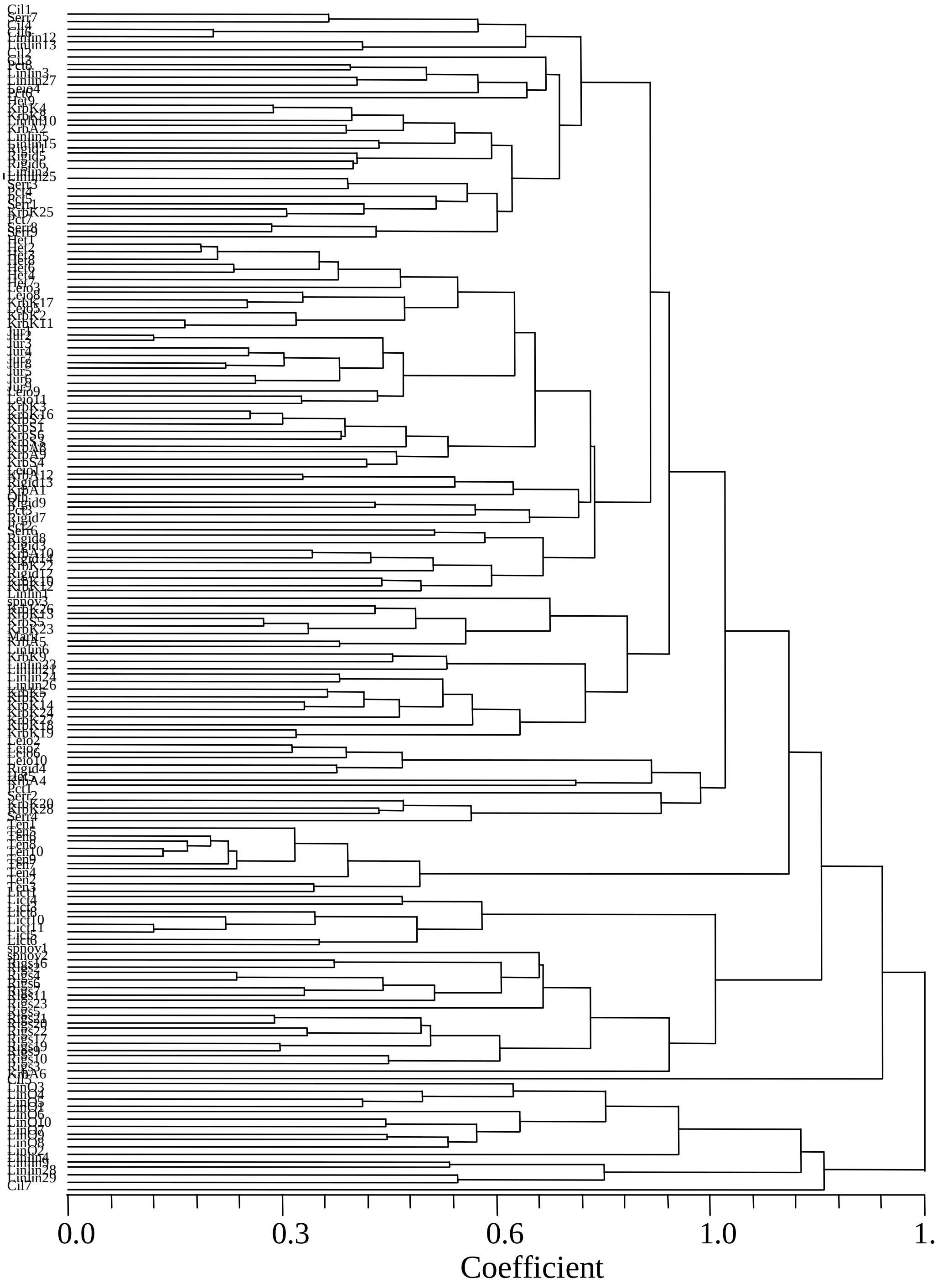


Figure 2.3.9: Cluster Analysis phenogram of TOTAL data (standardized, Manhattan distance, UPGMA, r=0.68). Detailed expansion of branches is provided in next three figures.

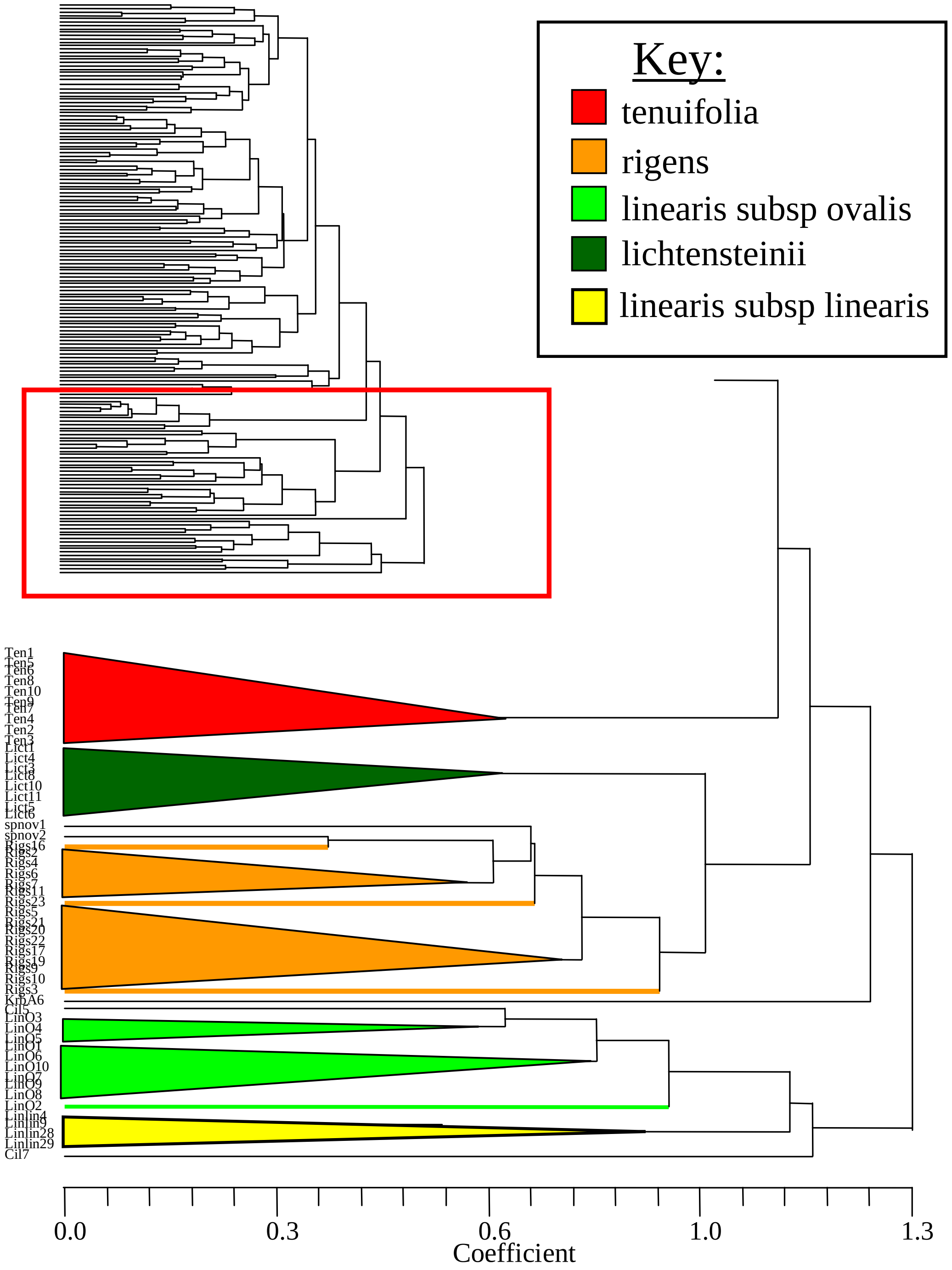


Figure 2.3.10: Lowest third of Cluster Analysis phenogram of TOTAL data (full phenogram in Figure 2.3.9). Triangles indicate monospecific branches.

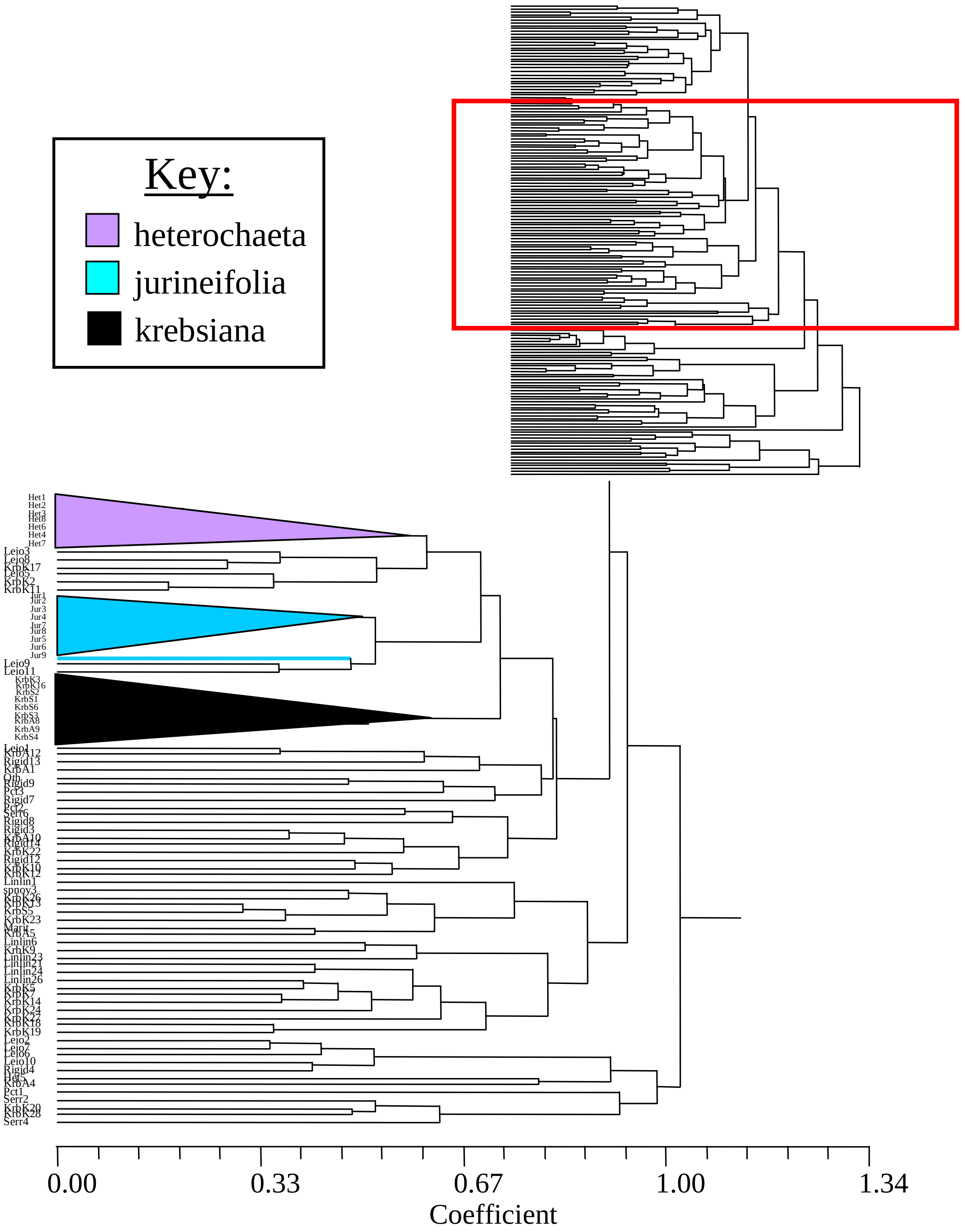


Figure 2.3.11: Middle third of Cluster Analysis phenogram of TOTAL data (full phenogram in Figure 2.3.9). Triangles indicate monospecific branches.

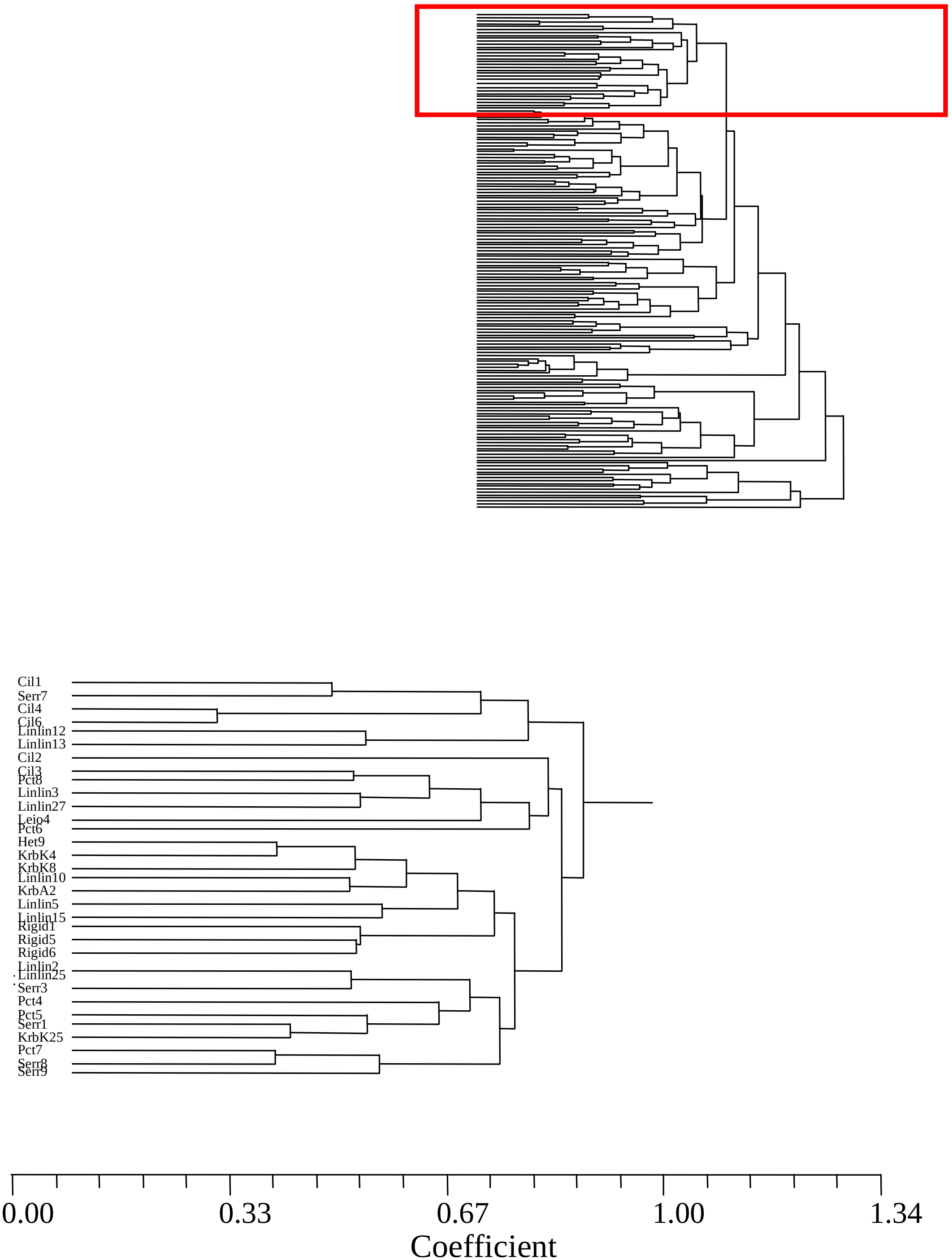


Figure 2.3.12: Top third of Cluster Analysis phenogram of TOTAL data (full phenogram in Figure 2.3.9).

The matrix goodness of fit test produced an r = 0.67 for the RAW data, 0.72 for the RAT data and 0.68 for the TOTAL data, all of which could be regarded as a “very poor” fit. The Mantel test resulted in p = 1 for all three data sets, likewise indicating a poor fit.

Despite the poor fit to the data, samples of six taxa are consistently clustered together. These six are:

1) *G. jurineifolia*,
2) *G. lichtensteinii*,
3) *G. linearis* subsp *ovalis*,
4) *G. rigens*,
5) *G. heterochaeta*, and
6) *G. tenuifolia*.

The samples of the remaining 10 species do not show any grouping.

Principle Component Analysis

Figures 2.3.13 to 2.3.15 are the scatter plots of the first three PCA axes of the RAW data set. The relative impact of each variable on each axis is presented in Tables 2.3.2 to 2.3.7, along with the percentage variability each axis accounts for. For the RAW data set, the first axis accounts for only 26% of the variability observed (and the next two axes both for significantly less than that).

The first and second axes (Figure 2.3.13) show one clearly discrete plot of *G. tenuifolia* samples (labeled “1”), along with two less clearly separate clusters (“2” and “3”). Cluster 2 consists of all the samples of *G. rigens, G. lichtensteinii*, as well as one sample each of *G. maritima, G. sp. nov*. and *G. krebsiana.* Cluster 3 consists of the remainder of all other samples.

The first and third axes (Figure 2.3.14) show no clearly discrete clusters. The second and third axes (Figure 2.3.15) show three small clusters that are separate from the rest of the samples. However, these are not single-species specific clusters. Cluster 1 consists of some samples of *G. lichtensteinii*, *G. rigens, G. sp. nov.*, and *G. krebsiana*, while Cluster 2 consists of samples of *G. rigens, G. maritima* and *G. krebsiana*. Cluster 3 consists of samples of *G. tenuifolia, G. linearis* subsp *linearis*, *G. ciliaris* and *G. krebsiana*.

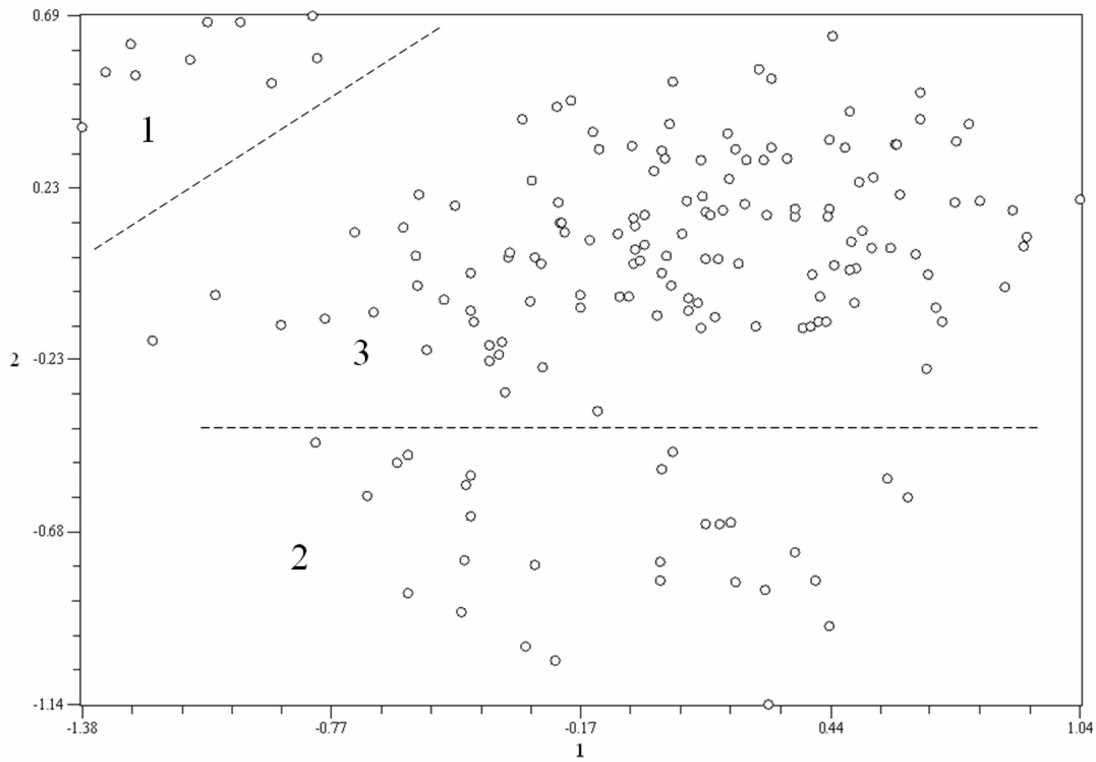


Figure 2.3.13: Scatterplot of first and second PCA axes of RAW data set. Dashed lines separate numbered clusters (details of cluster composition discussed in text).

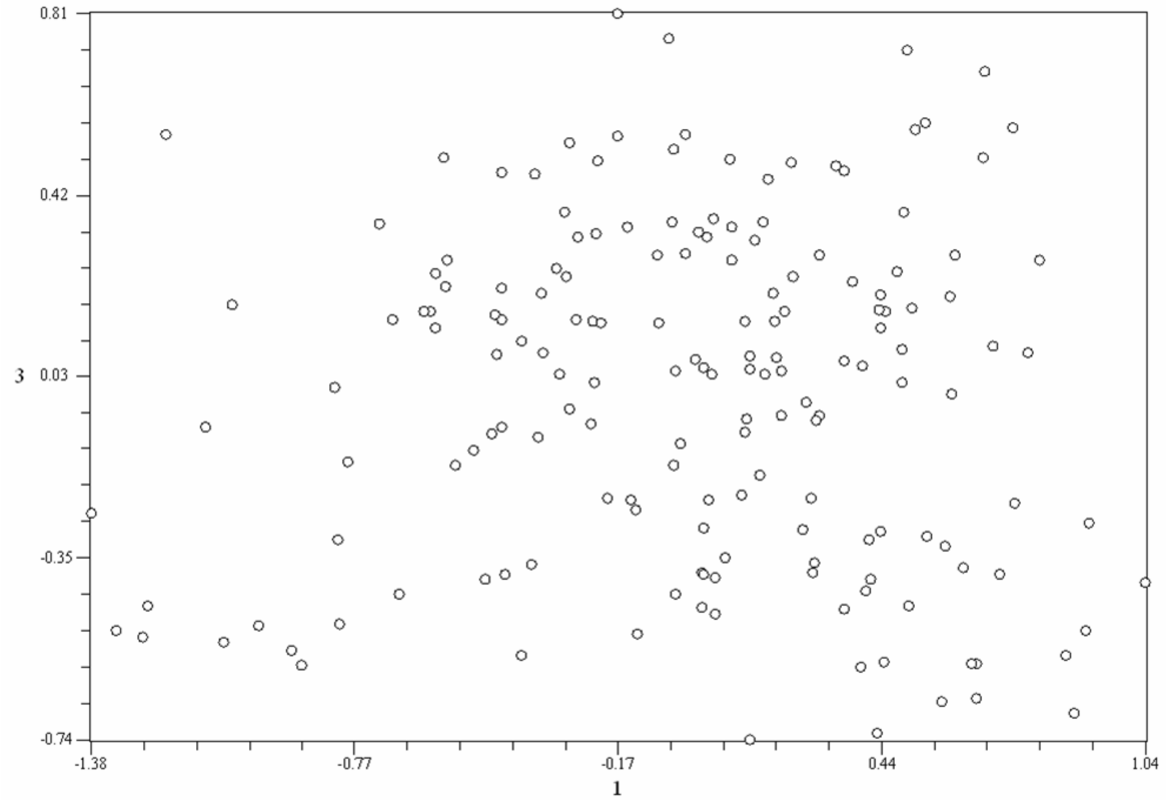


Figure 2.3.14: Scatterplot of first and third PCA axes of RAW data set. No clearly separate clusters are visible.

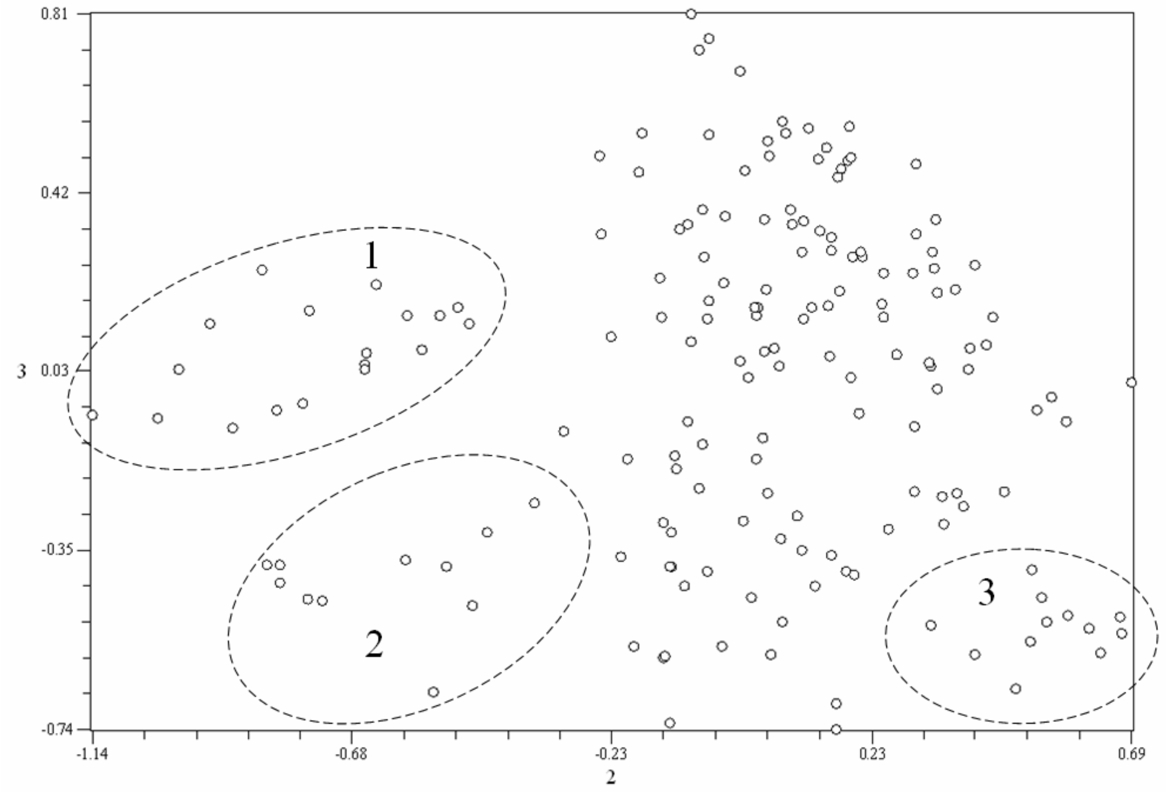


Figure 2.3.15: Scatterplot of second and third PCA axes of RAW data set. Circled and numbered clusters are discussed in detail in text.

Table 2.3.2: RAW data: Impact of each character on each PCA axis (most significant contributors highlighted in bold red) and total % variability accounted for by each PCA axis.

Character	**Axis1**	**Axis2**	**Axis3**
Habit	0.0484	0.7862	0.1503
InvSet	0.0559	-0.1737	0.3564
ParScl	-0.0776	0.3901	-0.4069
InvBase	-0.3034	0.3611	-0.3851
LfIndu	0.0894	0.2801	0.7703
LfMarg	-0.0021	0.5406	0.5412
LfDiss	-0.0826	0.4662	0.4411
OIL	0.723	0.3033	-0.3302
OIW	0.624	-0.4496	0.1656
IIL	0.6337	0.2582	-0.4154
IIW	0.5377	-0.1221	0.2743
InvL	0.7602	-0.163	0.2537
InvW	0.7935	0.0077	0.1636
LfLgth	0.6817	0.278	-0.1579
LfWdth	0.5469	-0.4753	-0.0412
StmLgth	0.6661	0.4168	-0.2225
% Variab.	25.8	15	13

Figures 2.3.16 to 2.3.18 are the scatter plots of the first three PCA axes of the RAT data set. As for the RAW data set, there are no discrete separate clusters apparent in the scatterplots. The first two axes accounts for only 21% and 18% of the observed variability.

Figures 2.3.19 to 2.3.21 are the scatter plots of the first three PCA axes of the TOTAL data set. Figure 2.3.19 shows some separation of the *G. tenuifolia* samples (above the dashed line), but little other cluster separation is visible. Figure 2.3.20 shows no clear cluster separation. Figure 2.3.21 shows three clusters. Cluster 1 consists of all the samples of G. *lichtensteinii*, G. *linearis* subsp *ovalis* and *G. rigens*, as well as some samples of *G. heterochaeta* and *G. sp. nov.*. Cluster 3 consists of *G. tenuifolia* samples, and Cluster 2 consists of the remaining samples. The first axis only accounts for just 22% of the variability observed in the data.

All three data sets achieve much the same level of results, indicating that, in *Gazania* at least, neither shape ratios nor actual size data can provide a better method for the separation of morphologically overlapping species.

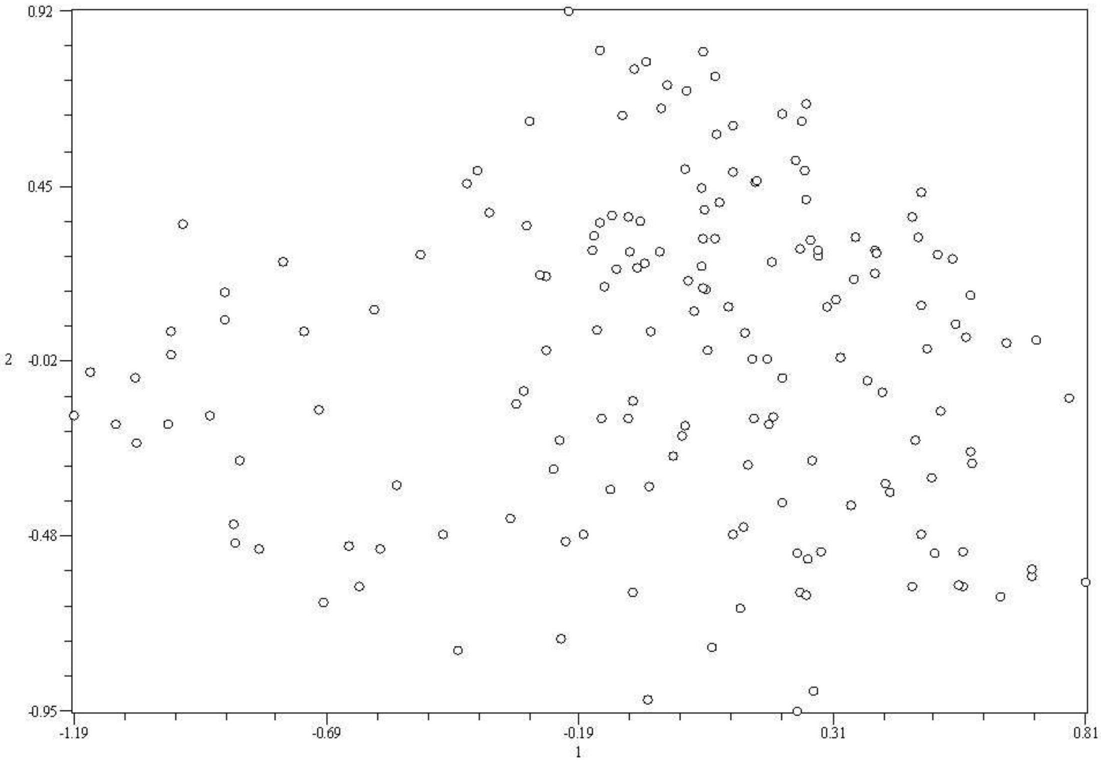


Figure 2.3.16: Scatterplot of first and second PCA axes of RAT data set. No clearly separate clusters are visible.

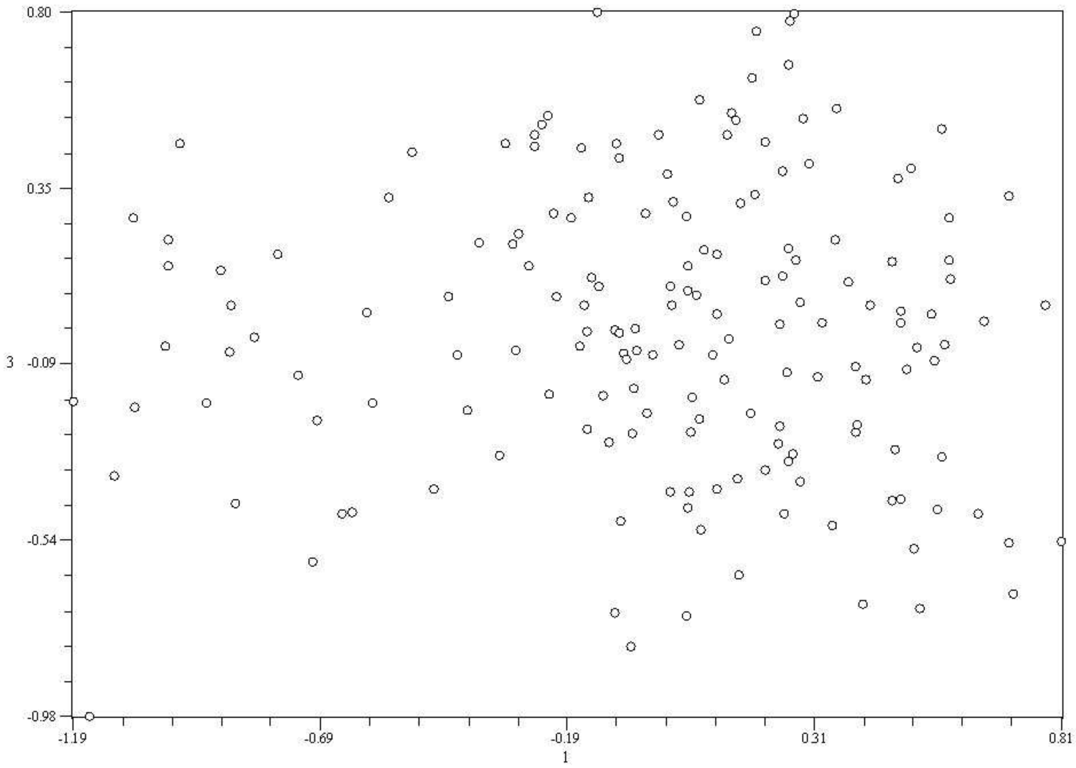


Figure 2.3.17: Scatterplot of first and third PCA axes of RAT data set. No clearly separate clusters are visible.

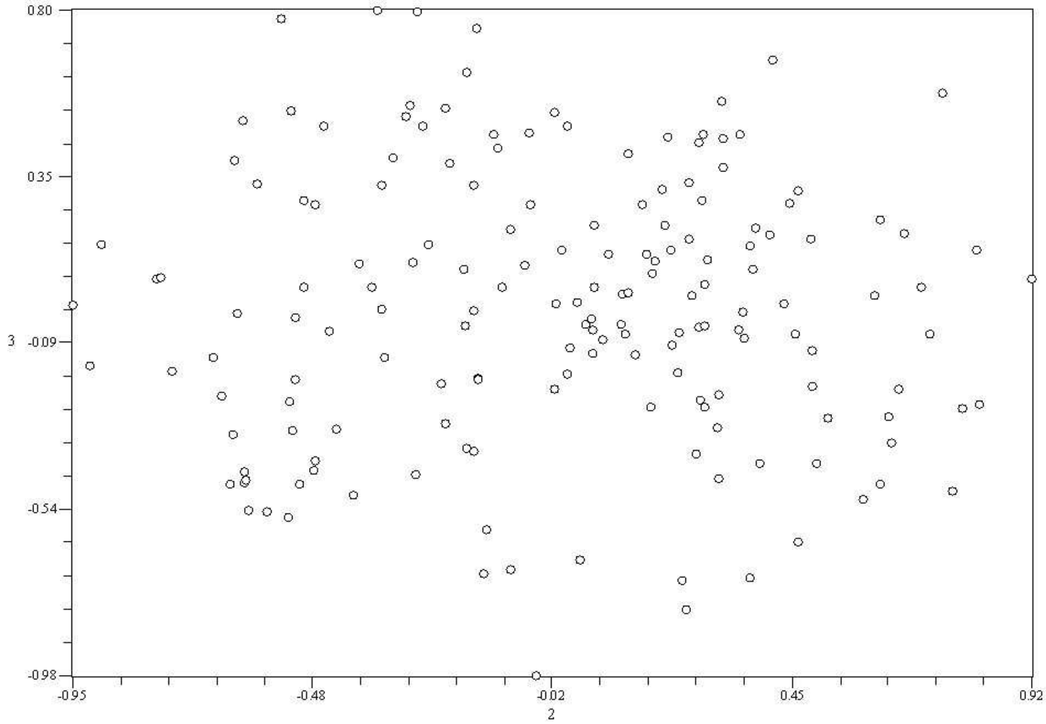


Figure 2.3.18: Scatterplot of second and third PCA axes of RAT data set. No clearly separate clusters are visible.

Table 2.3.3: RAT data: Impact of each character on each PCA axis (most significant contributors highlighted in bold red) and total % variability accounted for by each PCA axis.

Character	Axis1	Axis2	Axis3
Habit	0.7708	0.2323	0.1274
InvSet	-0.1604	0.2931	-0.3743
ParScl	0.3935	-0.4465	-0.5607
InvBase	0.341	-0.3343	-0.1013
LfIndu	0.2314	0.761	-0.0978
LfMarg	0.4706	0.5571	0.0362
LfDiss	0.394	0.4224	-0.5357
LogOIRAT	0.7135	-0.374	0.2858
LogIIRAT	0.3954	-0.653	-0.0433
LogOI/II	0.2692	0.1959	0.5228
LogInvRAT	-0.2254	0.0632	0.6252
LogLFRAT	0.6175	0.0639	0.2055
% Variab.	20.8	17.8	13

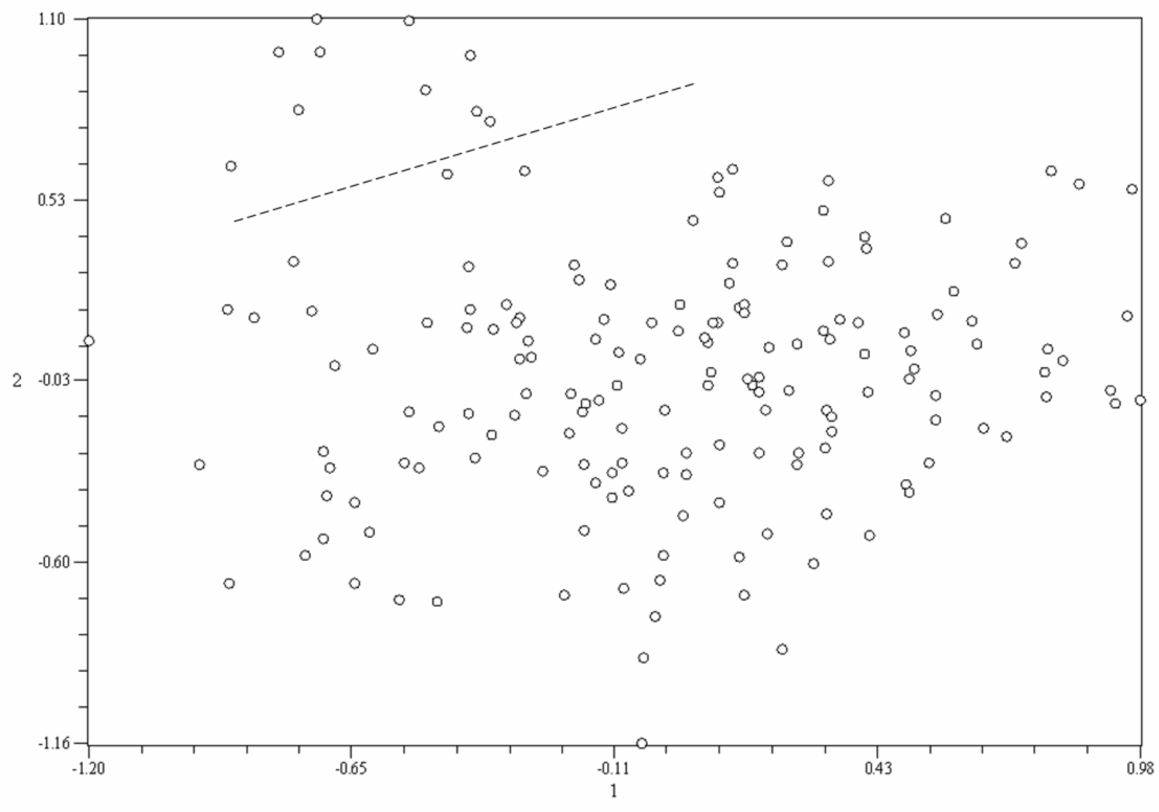


Figure 2.3.19: Scatterplot of first and second PCA axes of TOTAL data set. Dashed line separates *G. tenuifolia* samples (above line) from remaining samples.

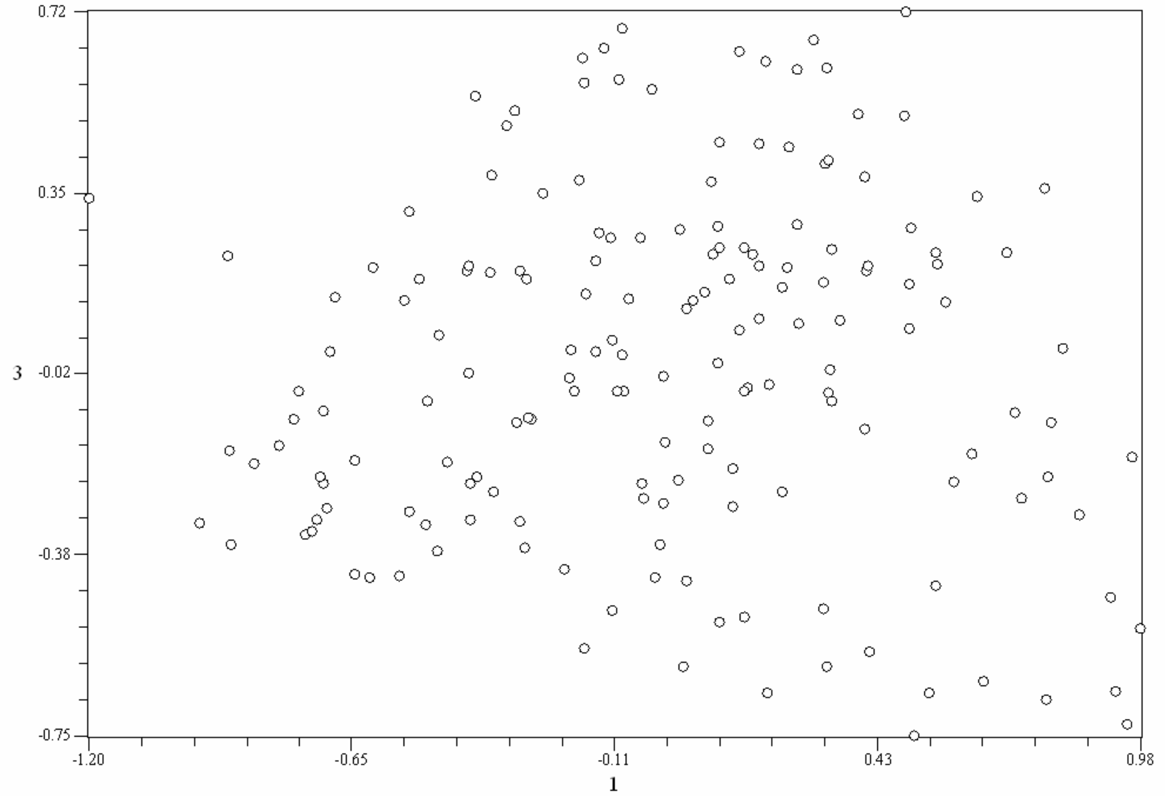


Figure 2.3.20: Scatterplot of first and third PCA axes of TOTAL data set. No clearly separate clusters are visible.

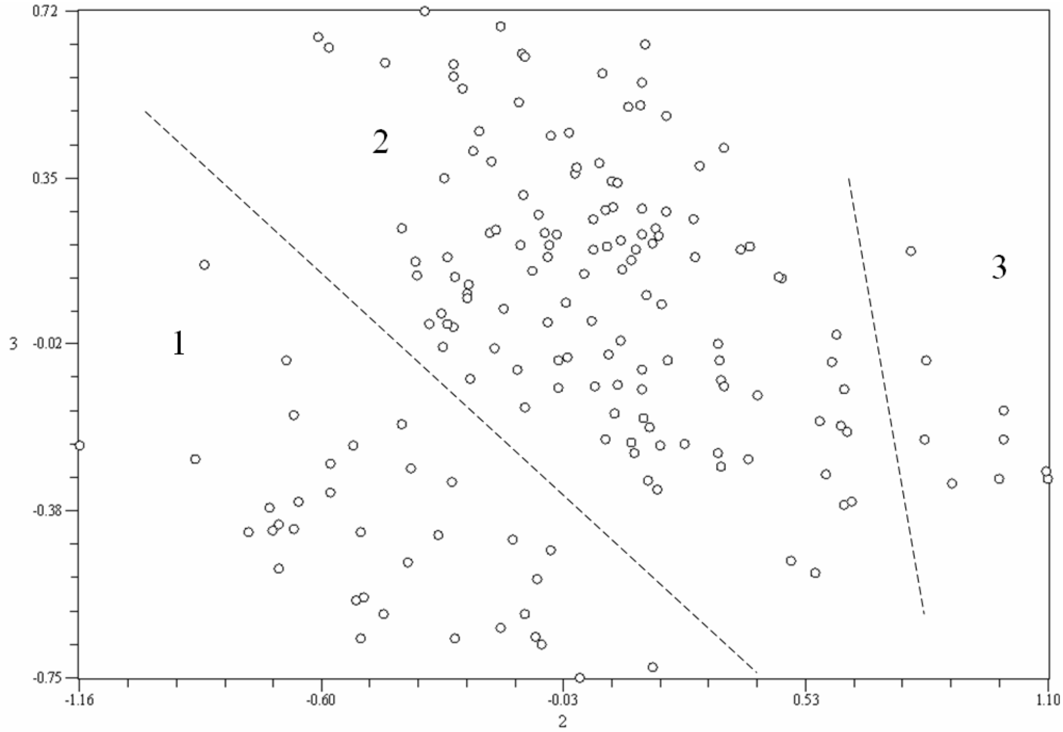


Figure 2.3.21: Scatterplot of second and third PCA axes of TOTAL data set. Dashed line separate three numbered clusters (details of cluster composition discussed in text).

Table 2.3.4: TOTAL data: Impact of each character on each PCA axis (most significant contributors highlighted in bold red) and total % variability accounted for by each PCA axis.

Character	**Axis1**	**Axis2**	**Axis3**
Habit	0.2476	0.5537	0.4819
InvSet	-0.0336	-0.2496	0.2514
ParScl	0.1323	0.4197	-0.264
InvBase	-0.123	0.4623	-0.1491
LfIndu	0.025	-0.1005	0.6925
LfMarg	0.0498	0.1964	0.5316
LfDiss	-0.02	0.1608	0.488
OIL	0.8761	0.1627	-0.1119
OIW	0.3808	-0.7232	0.0329
IIL	0.7527	0.1267	-0.419
IIW	0.3539	-0.492	0.2553
InvL	0.5816	-0.4781	0.1743
InvW	0.7254	-0.4114	0.158
LfLgth	0.7376	0.0877	0.2005
LfWdth	0.3503	-0.6457	-0.3568
StmLgth	0.7564	0.1791	0.0879
LogOIRAT	0.5318	0.6648	-0.1261
LogIIRAT	0.4781	0.45	-0.5691
LogOI/II	0.2955	0.0713	0.3688
LogInvRAT	-0.4184	0.1064	-0.0492
LogLFRAT	0.191	0.6326	0.453
% Variab.	22	17	12

Six species data set

In an effort to investigate the six most commonly clustered species retrieved in the CA dendrograms, the TOTAL data set was subdivided, and a smaller data set was constructed, consisting of only the six most commonly retrieved species clusters from the CA. A PCA was conducted on this smaller data set to see if the six CA species clusters could be distinguished by PCA.

Figures 2.3.22 to 2.3.24 are the scatterplots for the first three PCA axes for the TOTAL data set, containing only the six most commonly retrieved CA species. With the first two axes (Figure 2.3.22) the only species that shows true separation from all the others is *G. tenuifolia*. With the first and third axes (Figure 2.3.23), three separate clusters can be seen, one composed of *G. tenuifolia* samples, one composed of a mix of *G. lichtensteinii, G. jurineifolia* and *G. heterochaeta* samples and a third cluster composed of *G. linearis* subsp *ovalis* and *G. rig*ens samples.

With the second and third axes (Figure 2.3.24), G. *lichtensteinii* becomes a distinct cluster. The cluster to the bottom right of the plot contains all the *G. tenuifolia*, *G. rigens* and G. *linearis* subsp *ovalis* samples, and the cluster at the top again shows no separation between *G. heterochaeta* and *G. jurineifolia* is seen.

Ray colour was added as a 22nd character (in binary format: 1 = white, 0 = not white) to investigate if this could separate *G. jurineifolia* from *G. heterochaeta* (*G. jurineifolia* has white rays, while all the other species of *Gazania* have yellow, orange or red rays). Figures 2.3.25 to 2.3.27 are the scatterplots of the TOTAL data set, now including the additional ray colour character. Figure 2.3.25 now shows species clustering of *G. tenuifolia*, *G. linearis* subsp *ovalis* and *G. jurineifolia*. Figure 2.3.26 of the first and third axes shows an almost clear separation of all six species, although there is some slight overlap between some of the clusters it is only a narrow margin, rather than a more pronounced intermingling of samples.

Overall, while not all of the species produce clearly separate clusters on the scatterplots, there are definite trends visible. Certain species tend towards a certain region of the scatterplots, but there is too much overlap in morphological character variation to permit full separation of these species clusters from other similar species clusters. In the remaining species (those that showed no clear clustering on the CA dendrograms) the situation is even worse.

PCA of remaining species

Figures 3.2.28 to 3.2.30 illustrate the PCA analyses of the TOTAL data set containing those samples that showed no clustering in the CA dendrograms. No distinct clusters are visible.

Eigen values

None of the axes from any of the analyses containing all species was found to quantify more than 25% of the variability between the groups. The highest eigen values were found in the PCA of the six species data set, where the first axis quantified 31% of the variability (still a very low percentage).

Uninformative characters

The only characters that were never significant contributors to eigenvectors were “inner involucre scale width” and “outer involucral scale length/inner involucral scale length”. All other characters were significant contributors to at least one analysis’ first three axes.

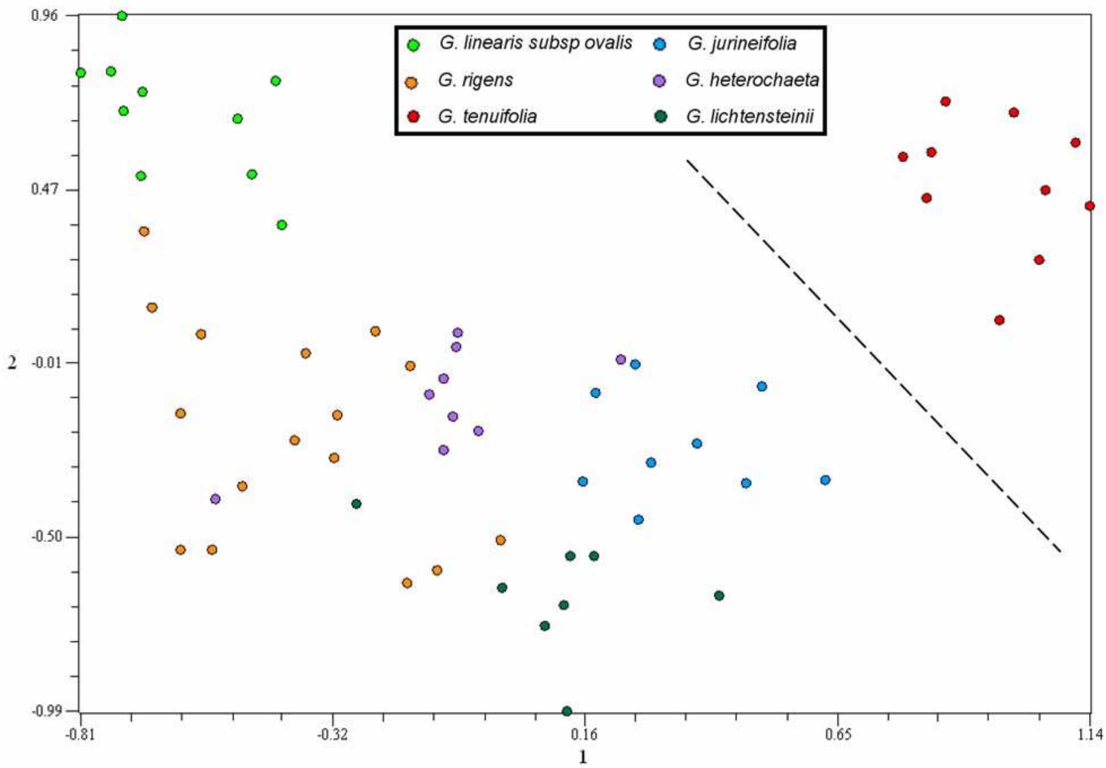


Figure 2.3.22: Scatterplot of first and second PCA axes of TOTAL data set, only containing six species that showed best clustering in CA analysis. Dashed line indicates clearly distinct cluster separation.

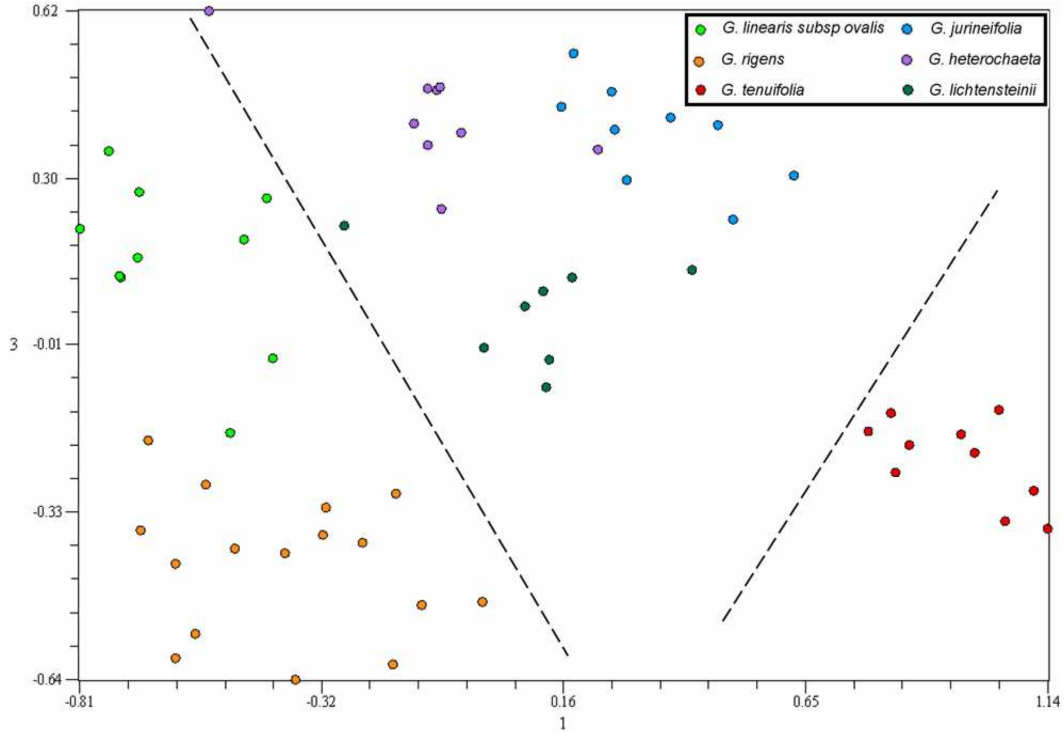


Figure 2.3.23: Scatterplot of first and third PCA axes of TOTAL data set, only containing six species that showed best clustering in CA analysis. Dashed lines indicate clearly distinct cluster separation.

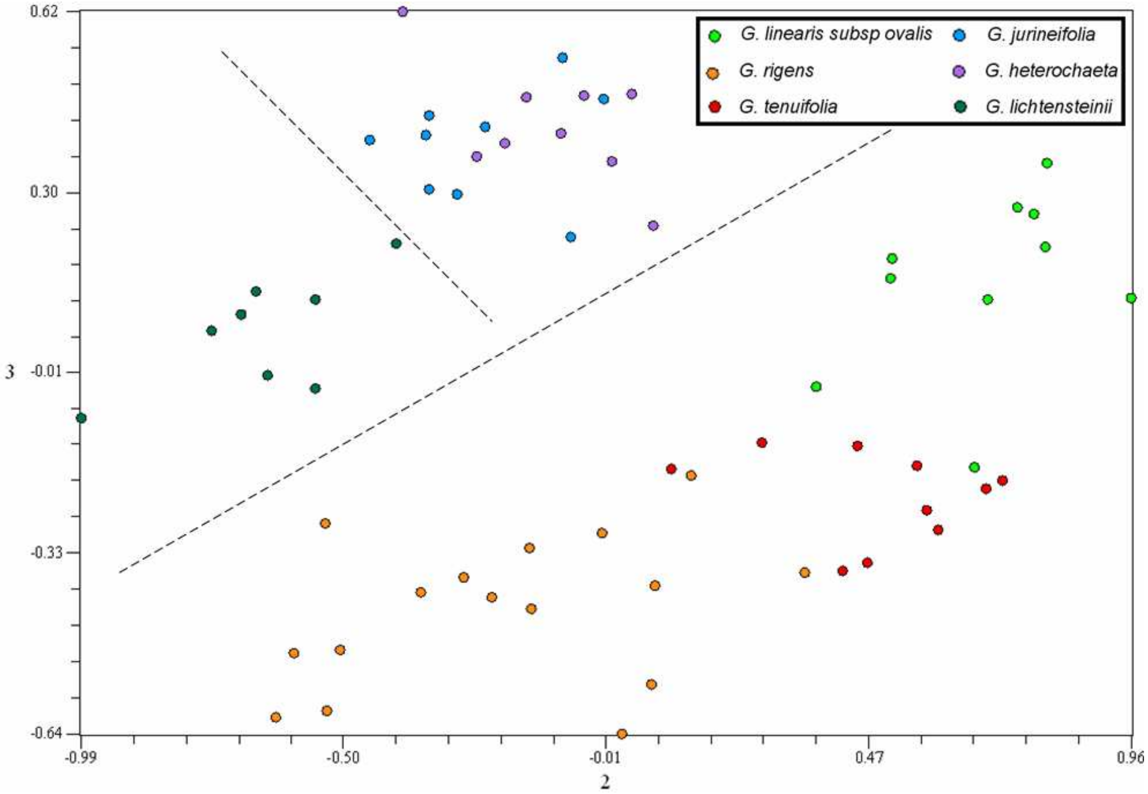


Figure 2.3.24: Scatterplot of second and third PCA axes of TOTAL data set, only containing six species that showed best clustering in CA analysis. Dashed line separates species clusters.

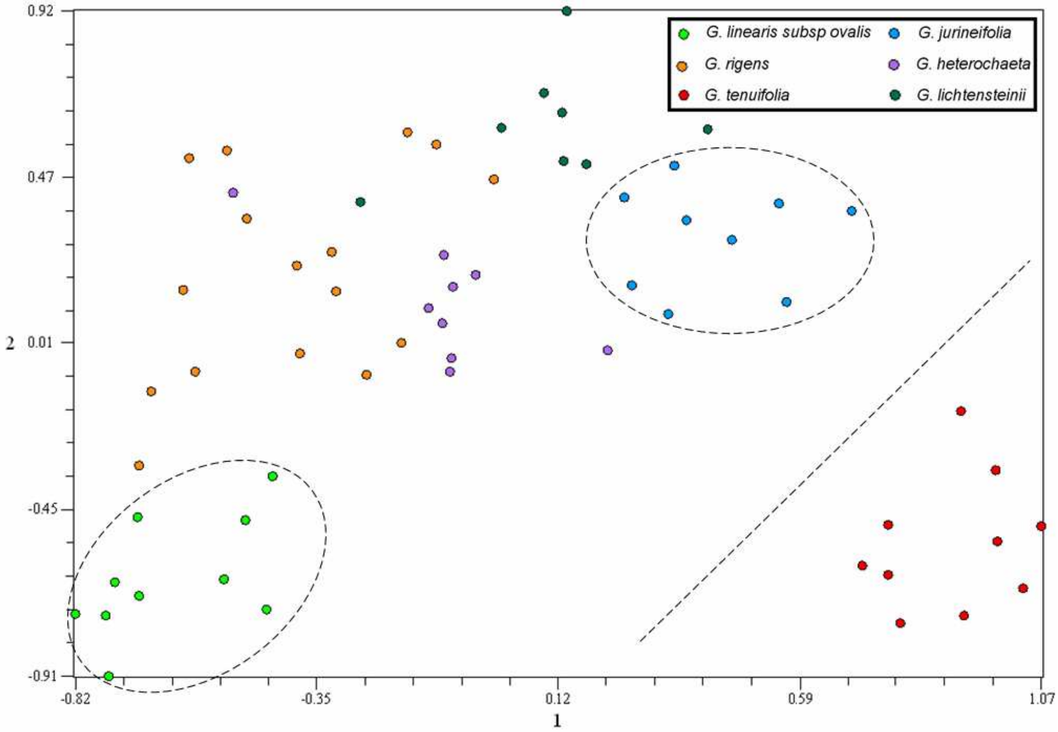


Figure 2.3.25: Scatterplot of first and second PCA axes of TOTAL data set (now including Ray Colour as an additional binary character), only containing six species that showed best clustering in CA analysis. Dashed lines and ovals indicates species clusters.

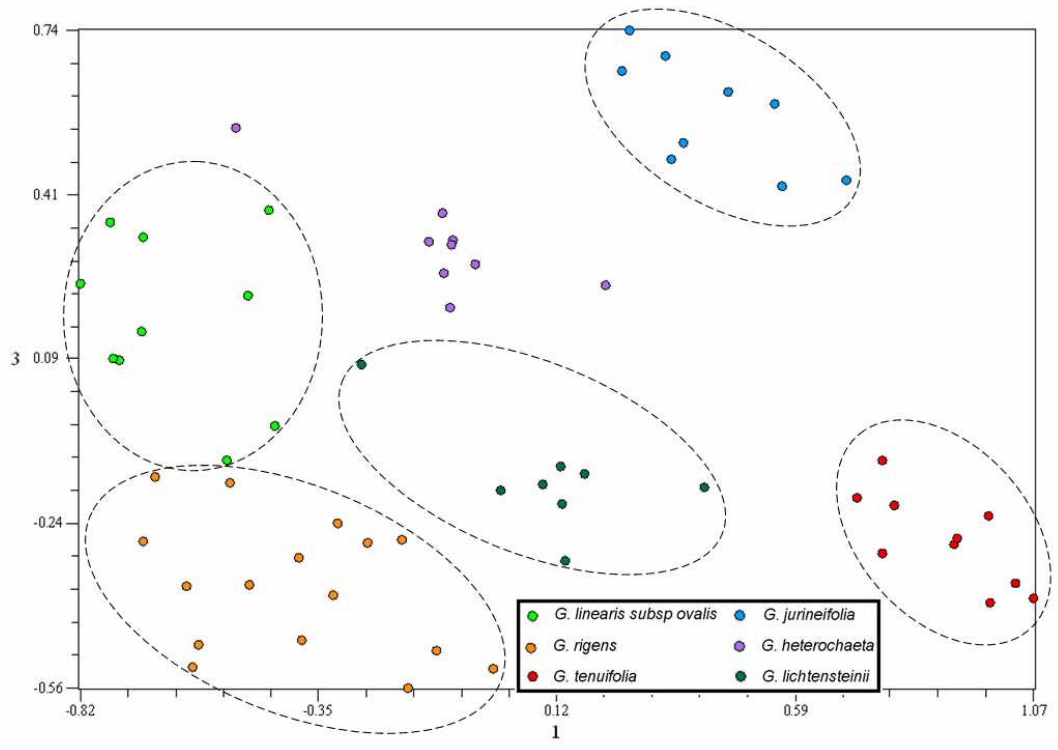


Figure 2.3.26: Scatterplot of first and third PCA axes of TOTAL data set (now including Ray Colour as an additional binary character), only containing six species that showed best clustering in CA analysis. Dashed ovals indicate species clusters.

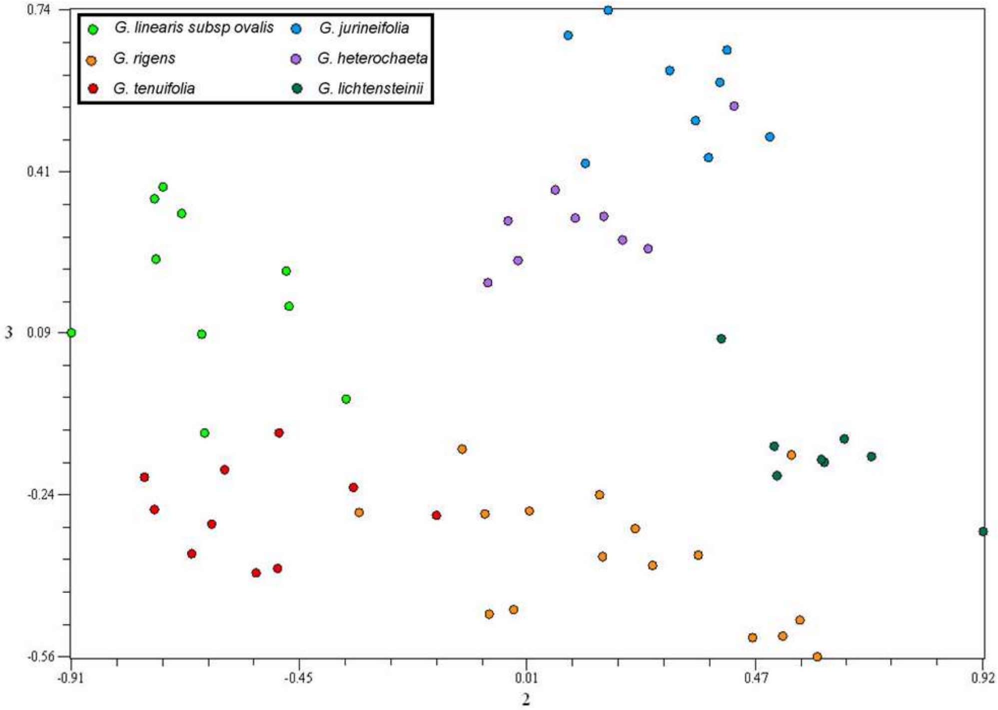


Figure 2.3.27: Scatterplot of second and third PCA axes of TOTAL data set (now including Ray Colour as an additional binary character), only containing six species that showed best clustering in CA analysis.

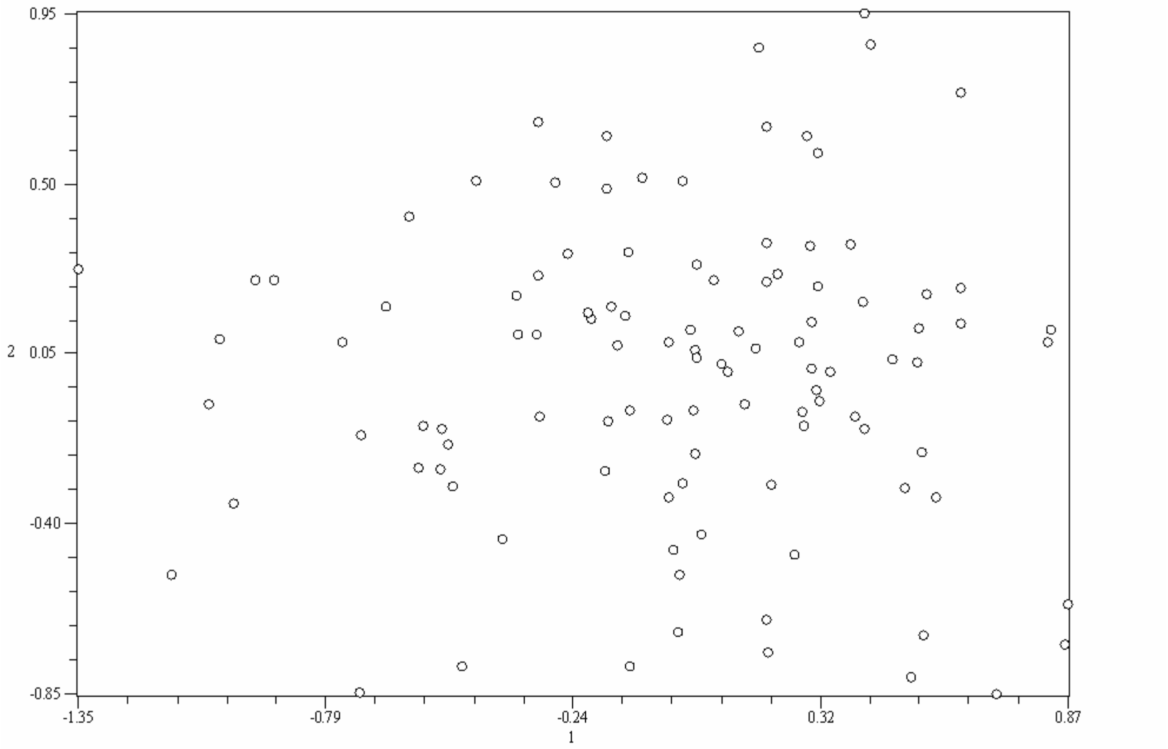


Figure 2.3.28: Scatterplot of first and second PCA axes of TOTAL data set, excluding six species that showed best clustering in CA analysis. No clearly separate clusters are visible.

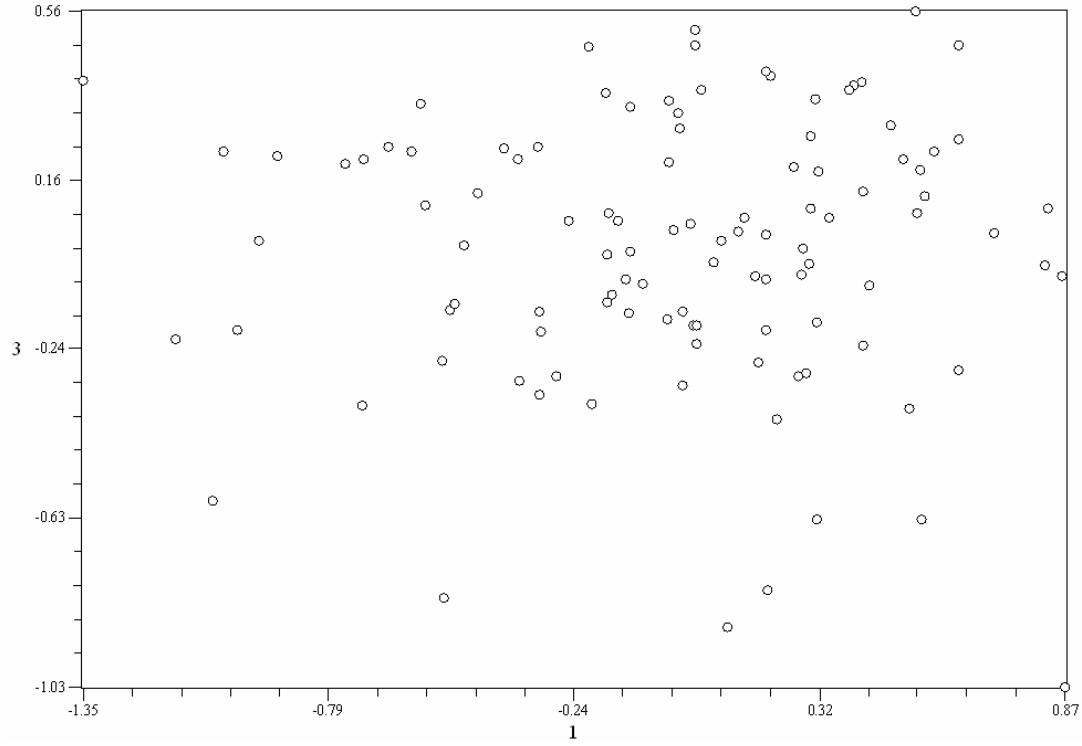


Figure 2.3.29: Scatterplot of first and third PCA axes of TOTAL data set, excluding six species that showed best clustering in CA analysis. No clearly separate clusters are visible.

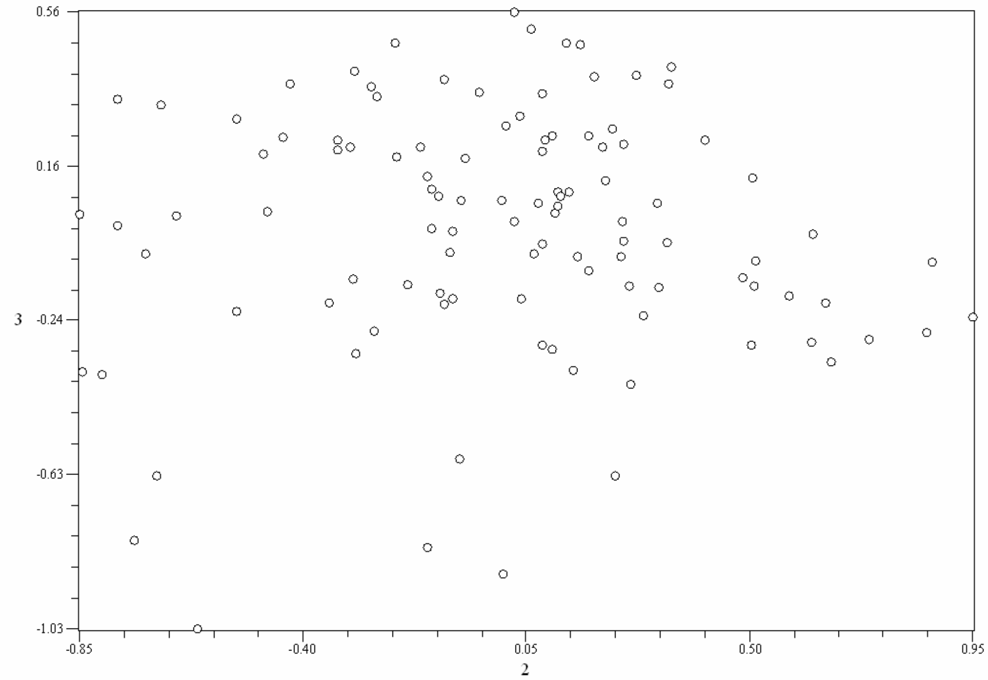


Figure 2.3.30: Scatterplot of second and third PCA axes of TOTAL data set, excluding six species that showed best clustering in CA analysis. No clearly separate clusters are visible.

Table 2.3.5: TOTAL data (selected six species from CA): Impact of each character on each PCA axis (most significant contributors highlighted in bold red) and total % variability accounted for by each PCA axis.

Character	**Axis1**	**Axis2**	**Axis3**
Habit	0.3334	0.5869	0.614
Invset	-0.1266	-0.133	-0.5247
ParScl	0.3662	0.6692	-0.4762
InvBase	0.527	0.4949	-0.1024
LfSet	0.243	-0.3389	0.6742
LfMarg	0.4323	0.0052	0.7941
LfDiss	0.6025	0.2017	0.359
OIL	-0.6994	0.5643	-0.0062
OIW	-0.8031	-0.3647	0.0701
IIL	-0.5762	0.6702	0.2941
IIW	-0.5107	-0.466	0.2862
InvL	-0.88	-0.1179	0.1877
InvW	-0.794	0.1763	0.1712
LfLgth	-0.6439	0.5276	-0.028
LfWdth	-0.9511	-0.0536	0.073
StmLgth	-0.4876	0.6566	0.0815
LogOIRAT	0.0366	0.8585	-0.0674
LogIIRAT	-0.2205	0.8753	0.0977
LogOI/II	-0.2506	-0.0712	-0.4007
LogInvRAT	0.1411	-0.3688	-0.0326
LogLFRAT	0.6871	0.4818	-0.1136
% Variab.	31	24	12

Table 2.3.6: TOTAL data (selected six species from CA, now including Ray Colour as additional binary character): Impact of each character on each PCA axis (most significant contributors highlighted in bold red) and total % variability accounted for by each PCA axis.

Character	**Axis1**	**Axis2**	**Axis3**
PetCol	0.3274	0.2603	0.6581
Habit	0.3354	-0.5648	0.6444
InvSet	-0.1351	0.1201	-0.4194
ParScl	0.3221	-0.7024	-0.3835
InvBase	0.4875	-0.5372	-0.1692
LfIndu	0.2892	0.3667	0.6696
LfMarg	0.4532	0.0039	0.6675
LfDiss	0.6154	-0.2006	0.4232
OIL	-0.7199	-0.5262	0.0865
OIW	-0.7719	0.417	0.162
IIL	-0.5938	-0.6275	0.3268
IIW	-0.474	0.5074	0.2964
InvL	-0.8751	0.1576	0.1354
InvW	-0.7782	-0.1119	0.3417
LfLgth	-0.6629	-0.4926	0.0573
LfWdth	-0.9512	0.0939	0.0553
StmLgth	-0.5232	-0.6394	0.0652
LogOIRAT	-0.0103	-0.868	-0.0595
LogIIRAT	-0.2579	-0.861	0.1212
LogOI/II	-0.2569	0.0698	-0.3094
LogInvRAT	0.1247	0.3233	-0.3229
LogLFRAT	0.6722	-0.5047	-0.0244
% Variab.	30	23	13

Table 2.3.7: TOTAL data (excluding six species from CA): Impact of each character on each PCA axis (most significant contributors highlighted in bold red) and total % variability accounted for by each PCA axis.

Character	Axis1	Axis2	Axis3
Habit	0.2353	0.1312	0.0664
InvSet	-0.0225	0.5224	-0.0839
ParScl	0.4246	-0.0542	0.1035
InvBase	-0.0846	-0.2	-0.2284
LfIndu	0.2435	0.4599	0.2993
LfMarg	0.2599	0.2847	0.5984
LfDiss	0.277	0.4832	0.0672
OIL	0.7844	-0.4406	0.2032
OIW	0.3686	0.4299	-0.4296
IIL	0.7192	-0.4549	-0.052
IIW	0.5071	0.4017	-0.1126
InvL	0.5153	0.3959	0.1335
InvW	0.7668	0.4458	-0.1389
LfLgth	0.6419	-0.0417	-0.1609
LfWdth	0.1705	0.3105	0.5687
StmLgth	0.7249	-0.1059	-0.1879
LogOIRAT	0.4672	-0.6756	0.4617
LogIIRAT	0.338	-0.7479	0.0318
LogOI/II	0.2355	-0.0548	0.4237
LogInvRAT	-0.603	-0.2825	0.2696
LogLFRAT	0.3481	-0.3058	-0.6256
% Variab.	22	16	8

Discussion

Rieseberg *et al.* (1991) note that the number of morphological characters suitable for phylogenetic and systematic analyses is often very low, that morphological characters are often functionally or developmentally correlated, that much morphological variation is nonheritable (environmental), and that morphological characters often converge when exposed to similar selective pressures. Schilling & Panero (1996) also note that the potential for homoplasy in such analyses is enhanced by the fact that groups close enough genetically to produce hybrids when crossed will necessarily tend to have similar morphological potentials. Roessler (1959) considered hybridization to be one of the problems that confused the taxonomy of the genus *Gazania*. The presence of hybrid herbaria collections that display novel combinations of characters that point to obvious incidences of hybridization also add weight to this possibility (Roessler, 1959; pers. obsv.). The actual extent of hybrization that occurs naturally within *Gazania* has, however, not been investigated here, and this must render all discussion of such processes as speculative.

The Morphological Species Concept relies on species being recognizable by discontinuities in morphological characters. The results of these analyses bear out Roessler’s comment that there are a few well-delimited, easily recognisable species. His list included *G. rigens*, *G. othonnites*, *G. lichtensteinii* and *G. tenuifolia*. The CA highlighted *G. rigens, G. lichtensteinii, G. tenuifolia, G. jurineifolia*, *G. heterochaeta*, and *G. linearis* subsp *ovalis* as distinct species. However, it should be noted that not all the *G. heterochaeta* samples grouped together in the CA results.

PCA analysis of all the samples in each data set resulted in no clear clusters being visible on scatterplots of the first three axes of each analysis. Some researchers indicate that PCA should not be used for “multiple sample” situations where there are several groups, due to a tendency to confound within- and between-group sources of variation (James & McCulloch, 1990).

The PCA of a smaller subset of six taxa, as highlighted by CA, revealed that *G. tenuifolia* is a morphometrically distinct species, clustering tightly and separately from other samples. For the other five taxa, there were rarely entirely discrete clusters, but rather general trends of certain species occurring in certain areas of the scatterplots, but with insufficient morphological discontinuity to make clusters properly distinct from each other. It is only with the addition of flower colour as an extra character to aid in the separation of *G. heterochaeta* and *G. jurineifolia* that species clusters become more distinct. Figure 2.3.26 is the only PCA figure to illustrate six separate species clusters, although there is still some marginal overlap between *G. rigens* and *G. linearis* subsp *ovalis*.

Non-distinct taxa

The remaining species, when subjected to PCA, show no pattern of separation or clustering at all. Roessler (1959) stated that amongst the remaining taxa that are not distinctly different, relationships are so close and characteristics overlap to such a degree that a clear separation becomes impossible. The lack of clear signal in the morphometric analyses bears out his observation. Although the extremes of two or more taxa may be distinct when they are compared with each other, there may be so many intermediates that obvious lines of demarcation between states are unclear (Stevens, 1991).

This is a typical problem faced by systematists: the need to determine where, if at all, groups occur within a more or less continuous range of variation (Kores *et al*., 1993). The problems seen in *Gazania* are quite common in plant systematics. A similar example exists in the *Viola alba* complex (Violaceae), where the taxa express high variability on the regional, local, and the individual scale (Marcussen, 2003). As with *Gazania*, this variation has brought about the description of large numbers of taxa of various taxonomic rank and distribution (Marcussen, 2003).

Another example exists in the *Euphorbia esula* group (Crompton *et al.*, 1990) where, again, several taxa were so similar that no clear separation into species groups could be accomplished. *Quercus* is notorious for interspecific hybridization, such that species tend to form a morphological continuum instead of separate or clear clustering (Borazan & Babac, 2003). In Borazan & Babac’s (2003) study, PCA analyses could not clearly separate the four taxa belonging to the subgenus under scrutiny. *Lupinus nanus* (Leguminosae) offers another similar result, where no groups corresponding to infraspecific taxa could be distinguished by any single character or by a combination of characters (Riggins *et al.*, 1977). Specimens of any sample could not be identified with certainty and the range of variation in each sample is so extreme that consistent assignment is virtually impossible (Riggins *et al.*, 1977).

Apart from natural variation in *Gazania*, the possibility of contamination from "naturalized" garden escapes cannot be discounted. The presence of large (apparently naturally occurring) populations of anomalous large pink-flowered *Gazania* (possessing character combinations that do not naturally appear in any wild type species) on the south western coast (R. McKenzie, pers. comm.) highlights this issue.

Comparative data signal between ratios and size data

The raw size data and the ratio shape data both generated similar results, and inclusion of both ratio and size data in the same data set did produce better groupings. Ratio data appears to cause more scattering of samples and less separation between some groupings than raw size data. The tightest species clusters in CA were produced by the TOTAL data set.

Comparative analysis methods for morphometric analysis

Henderson (2006) notes that some authors (such as James & McCulloch, 1990) consider that PCA should not be used for multiple samples (a restriction which would entirely eliminate its usefulness in systematics); but he also notes that this opinion is not shared by others (e.g. Humphries *et al.*, 1981; Boyd, 2002; Chandler & Crisp, 1998). Chandler & Crisp (1998) successfully used PCA on a large data set of 150 samples which contained both quantitative and qualitative characters.

CA and PCA are exploratory methods, in that they require no *a priori* knowledge of species groupings, but rather search for groupings within a collection of samples (Henderson, 2006). These most commonly utilized morphometric data analysis methods have produced the same result: some few species (and one subspecies) are distinct, the remaining species overlap in morphological traits to such an extent that no clear disjunction exists. Although some authors indicate that PCA's method of reexpressing a large number of original variables into two or three new uncorrelated variables (such that they retain most of the original variation) can be used to uncover unexpected relationships (Ackerfield & Wen, 2002), there is little difference from the species cohesion achieved with CA.

Conclusion

Under the MSC, there are six distinct taxa within *Gazania* that correlate with Roessler's (1959) taxa. These are:

1) *G. jurineifolia*,
2) *G. lichtensteinii*,
3) *G. linearis* subsp *ovalis*,
4) *G. rigens*,
5) *G. heterochaeta*, and
6) *G. tenuifolia*.

The remaining species show no clear morphological separation. While morphometrics is recognized as a valuable component of what systematists do (Jensen, 2003), there are other sources of data to investigate phylogeny. To this end, a DNA phylogeny is necessary to investigate the status of Roessler’s species.

Chapter 3.

Molecular systematics of *Gazania* at the species level

> "The genus … comprises a number of well-delimited and recognisable species. Between the remaining taxa, such close relationships and overlaps of characteristics exist that a clear separation becomes impossible." (Roessler, 1959, pp 100, translated from the original German).

Aim: To use DNA sequence data to determine the status and relationships of the taxonomic entities ("species") as delimited by Roessler and the morphometric analysis conducted in Chapter 2.

Introduction

There are a number of different species concepts in used in biology today (22 at last count by Mayden, 1997). The different ways species arise and are described is crucially linked to the comprehension of biodiversity and evolution (de Meeus, 2003). For systematists, the question of "by what criteria shall species taxa be identified" lies at the heart of the species concept debate (Hey *et al.*, 2003). Historically, and until the recent development of molecular tools, taxonomic groups (species) have been identified using morphological criteria alone ("morphospecies"). This has left uncertainty in some cases as to the validity, and support, of groups delineated using these criteria (Hendry *et al.*, 2000).

While morphological data has traditionally been used to delimit species and continues to be widely used today, recent studies have used DNA sequence data to test these morphology-based taxonomies (Wiens *et al.*, 2002). One of the species concepts that has come into use with DNA sequence data is that of the Phylogenetic Species concept (PSC). While various formulations of the PSC have been advanced (e.g. Wheeler & Platnick, 2000; Mishler & Theriot, 2000), all agree that species recognition should emphasize criteria of phylogenetic relationship (descent) and not reproductive relationships (as endorsed by the Biological Species Concept; Avise, 2000).

The PSC defines a species as "… the smallest aggregation of populations (sexual) or lineages (asexual) diagnosable by a unique combination of character states in comparable individuals" (Nixon & Wheeler, 1990). The question of the demarcation used to define an entity as a species or a subspecies (i.e. how much genetic divergence defines a species) based on the PSC is difficult to answer (Wheeler & Platnick, 2000). Hey *et al.* (2003) note that whatever the decision taken regarding demarcations, one must also recognize that the decision may be an oversimplification demanded by the practical concerns of the research.

DNA sequence data as a tool for reviewing existing taxonomy

With the advent of DNA sequencing technology came access to additional sources of data for testing and revising the taxonomy of existing systematic and species delimitations. For plants, these sources are the three genomes present in the plant cell: nuclear, chloroplast and mitochondrial. Traditional morphometric analysis can only generate and use a relatively small set of characters, whilst DNA sequence data can generate thousands of potentially informative characters. When hundreds (or even thousands) of molecular characteristics are assayed among various organisms, any widespread and intricate similarities present in these macromolecules are highly unlikely to have arisen by convergent evolution and thus must reflect true phylogenetic descent (Avise, 2004).

The proven track record of DNA sequence data as a valuable tool for phylogeny reconstruction and species delimitation (e.g. studies by Bayer *et al.*, 1996; Jeandroz *et al.*, 1997; Manos *et al.*, 1999; Peterson *et al*., 2004) makes it an ideal alternative means to explore the validity of the six discrete morphological entities uncovered using “traditional” morphological methods in Chapter 2, as well as Roessler’s (1959) 16 species. It is, likewise, a means to investigate further the other less discrete, overlapping taxa that were unable to be satisfactorily separated by means of morphometric analysis.

When choosing loci for phylogenetic inference, the first step is to determine sequence variability over a small sample of taxa; as a matter of practicality, regions that present difficulty in either amplification or sequencing are often eliminated in this preliminary step (Mort *et al*., 2007). There are many genes in several different regions of the plant genome that can be used, but for the purposes of this project, the nuclear ITS and ETS regions, and several chloroplast regions were selected following preliminary screening trials of multiple noncoding regions. Because ITS and ETS mutates faster than chloroplast DNA (Albach & Chase, 2004), at low level taxonomic studies, where the level of divergence between target taxa may be very low, a fast-changing set of characters would provide more information than a slower or invariant character set. The ITS and ETS have proven useful at low taxonomic levels, as their rapid evolution makes them useful in phylogenetic studies where little or no variation in chloroplast genes is found (Jeandroz *et al.*, 1997).

The choice of chloroplast regions may be made either on length or number of parsimony informative characters. Mort *et al.* (2007) note, however, that the absolute number of parsimony informative characters is not entirely predictive of ability to resolve nodes with support, and that there may be no significant correlation between the number of aligned characters and the number of parsimony informative characters. Phylogenetic utility of any particular region may vary significantly among lineages, and two important measures of utility are resolution (loci that resolve many relationships but exhibit homoplasy are more useful than those that provide neither resolution nor conflict) and the degree to which data provide support for resolved clades (Mort *et al.*, 2007). It should also be noted that a region that provides the most characters (and the most parsimony informative characters in some groups) may not be especially useful in supporting nodes in general (Mort *et al.*, 2007).

The nuclear genome: Multicopy nuclear markers (ITS and ETS)

Eukaryote nuclear ribosomal DNA (nrDNA) is commonly utilized and consists of tandem repeat units, with each unit containing 18S, 5.8S and 26S nrDNA (Hung *et al.*, 2004). The 18S and 26S nrDNA code for the small and large ribosomal subunits respectively (Soltis & Soltis, 1998). These repeat units are organized into arrays, with each array containing hundreds to thousands of identical to near-identical repeats (Wendel *et al.*, 1995). These nrDNA arrays are typically located in the nucleolar organizing region (NOR), of which there may be several present on several different chromosomes (Soltis & Soltis, 1998; Muir *et al*., 2001). Intragenomic nrDNA diversity is generally low (Buckler *et al.*, 1997), these repeats having become homogenised by evolutionary forces (e.g. unequal crossing-over, gene conversion) that are collectively referred to as concerted evolution (Wendel *et al.*, 1995). Regardless of small differences being reported between nrDNA families located in different chromosomal positions, in a phylogenetic context the nrDNA has been treated as a single-copy gene (Muir *et al.*, 2001).

The Internal Transcribed Spacers (ITS) and the External Transcribed Spacers (ETS) are part of this nrDNA. Figure 3.1.1 illustrates their proximity to each other and the other portions of the nrDNA tandem repeats. The ITS1 region lies between the 18S and 5.8S genes while the ITS2 region lies between the 5.8S and 26S genes. The ETS and the Nontranscribed Spacer (NTS) make up the Intergenic Spacer (IGS) that joins the repeats of 26S and 18S.

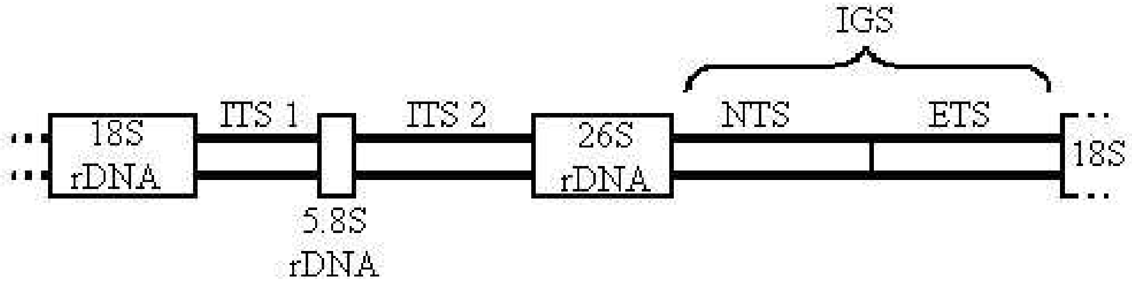


Figure 3.1.1: Diagrammatic representation of the nrDNA regions. ITS = Internal Transcribed Spacer, ETS = External Transcribed Spacer, NTS = Nontranscribed Spacer, IGS = Intergenic Spacer. Boxes indicate functional rDNA genes.

It should be noted that because the ETS is part of the same transcription unit as the ITS region, it cannot be regarded as an independent line of phylogenetic evidence for comparison with ITS results (e.g. for identifying factors such as lineage sorting or hybridization that may have lead to deviation between rDNA tree and species tree; Baldwin & Markos, 1998). There are some instances where ITS alone has been used for phylogenetic reconstruction, or biogeographic studies (e.g. the Bellarosa *et al.* (2005) study on *Quercus* spp. did not use any other gene region than ITS), and although mention is made of ETS, this is not generally considered a separate gene system for these purposes.

The effectiveness of concerted evolution on the ITS region in most plants makes it the primary choice for phylogenetic reconstruction at lower taxonomic levels (Campbell *et al.*, 2005). However, this process of homogenization proceeds faster within chromosomes than it does among chromosomes, leading to the possibility of differing copies being located on different chromosomes (O’Kane *et al.*, 1996). If concerted evolution is slower than speciation, then a single individual will contain divergent paralogues (Buckler *et al.*, 1997). Intra- and inter-individual variation for nrDNA types has been found in several plant species, with up to five copies found among and within individuals of two species of *Picea* (O’Kane *et al.*, 1996). Unidentified paralogous relationships and infrequent recombination between paralogues can result in erroneous species phylogenies (Buckler *et al.*, 1997).

There is also some ambiguity as to how concerted evolution generally operates in the ETS (Linder *et al.*, 2000). Because the ETS is part of the 18S-26S nrDNA repeat, it is often assumed that concerted evolution will homogenize it in the same way that it does the ITS, but the presence of a small number of large (130 bp) tandem repeats at the 5’ end of the ETS may hinder or alter the rate of concerted evolution as the repeats in the NTS appear to do (Linder *et al.*, 2000).

The ITS region in angiosperms can range in size from 565 to 700 bp (Liston *et al.*, 1996). The IGS varies considerably in length, from 1 to 8 kb (Soltis & Soltis, 1998), but the entire IGS in *Gazania* is recorded as having a length of 1.3 kb (Linder *et al.*, 2000). Usually, rather than amplifying the entire IGS or ETS, a highly variable region of around 600-700 bp near the 18S end is utilized (e.g. Bena *et al*., 1998; Clevinger & Panero, 2000; Linder *et al*., 2000).

The use of the ITS region is not without its critics. Alvarez & Wendel (2003) firmly recommend that ITS should not be routinely used phylogenetic analyses, and recommend using single-copy nuclear loci instead. They cite several genetic processes that can confound accurate phylogenetic reconstruction, including: array duplication events, pseudogenes, and incomplete homogenization of sequences in different arrays (Alvarez & Wendel, 2003). The ITS region is also accused of being prone to high levels of homoplasy (possibly due to fast evolution of the ITS region), and this can mask the phylogenetic signal (Alvarez & Wendel, 2003). Additionally the presence of reticulation may obscure the phylogenetic signal (Alvarez & Wendel, 2003).

The chloroplast genome

Organelle genomes provide ideal markers for phylogeny reconstruction because their sequences record the history of a lineage uncomplicated by recombination (Harrison, 1991). The chloroplast (cp) genome offers many advantages for phylogenetic reconstruction, including the fact that the genome is small (Soltis & Soltis, 1998). Further advantages include the fact that the cpDNA genes are all linked with each other, and thus the plastid genome behaves as a single recombination unit; all the parts of the genome should have the same pedigree within species (and the same phylogenetic history among species) and should therefore contain the same phylogenetic signal in all DNA regions (Graham *et al*., 1998; Albach & Chase, 2004).

There are three functional categories of DNA in the cp genome: (i) non-coding regions that do not code for transfer RNA, ribosomal RNA or proteins; (ii) coding genes (rRNA and proteins); and (iii) chloroplast introns (Clegg *et al*., 1995). The cpDNA genome is extremely condensed compared to nrDNA and most of the noncoding DNA in the chloroplast genome is found in very short segments separating functional genes (Clegg *et al*., 1995). It also accumulates nucleotide substitutions relatively slowly (Palmer, 1987) and has a lower rate of intraspecific mutation than nuclear DNA (Palmer & Zamir, 1982; Clegg *et al*., 1984a; Clegg *et al*., 1984b; Perl-Treves & Galun, 1985) which has made the chloroplast genome an ideal focus for studies of plant evolutionary history (Clegg *et al*., 1995).

Because the cp genome is free from recombination, and inherited as a single unit, cpDNA sequences from different regions can readily be combined (Soltis & Soltis, 1998). The presence of different genealogical histories can be ruled out if there is any incongruence between cpDNA data sets, so any incongruence can be ascribed to differing functional constraints, as rates and modes of evolution are known to differ substantially in different parts of the cp genome (Graham *et al.*, 1998; Albach & Chase, 2004). If these processes are sufficiently strong, they may be a source of any tangible differences in trees that are inferred from separate parts of the cp genome (Graham *et al.*, 1998). Sequencing a second plastid marker is thus necessary to support the hypothesis that the results from the first plastid marker represent the phylogenetic signal of the plastic genome, despite relatively few potentially informative characters (Albach & Chase, 2004).

Different portions of the cp genome evolve at different rates, and at different rates across different lineages (Small *et al.*, 2005). A direct consequence of this is that the phylogenetic utility of different noncoding cpDNA regions within a given taxonomic group can vary tremendously (Shaw *et al.*, 2005). In principle, cpDNA sequencing should involve the selection of a sequence whose substitution rate is appropriate to the phylogenetic problem at hand (Olmstead & Palmer, 1994). To this end, a number of regions were screened to determine if they could provide the necessary intrageneric, specific and intraspecific variability among the species of *Gazania*.

Shaw *et al.* (2005) compiled a list of 21 variable and informative noncoding cpDNA regions sampled across all of the major lineages of flowering plants. From this, a selection of primers could be chosen for trial. Of all the lineages amplified, the clade that *Gazania* falls into had a very low level of cpDNA variability across all the regions tested. The region with the highest percentage variability for the Eupatorium clade (which *Gazania* falls into) was the *psb*A-*trn*H region (also referred to by some authors as the *trn*H-*psb*A region, and titled in full *trn*H^{GUG}-*psb*A by Shaw *et al.*, 2005). The next highest variable region for the Eupatorium clade was the *trn*C^{GCA}-*ycf*6-*psb*M region, and the other most variable regions across all angiosperms were *trn*S-*trnf*M, *trn*T-*trn*L, *rp*S16 and *trn*L-*trn*L-*trn*F. These six regions were therefore investigated for potential utility in a subset of *Gazania* samples, and a subset of three of these regions was selected (Appendix 3 for details of screening procedure). The final choice of cpDNA data sets was composed of sequences from the *psb*A-*trn*H, *rp*S16 and *trn*LF regions.

The *psb*A-*trn*H region has been used in phylogenetic studies at the intrageneric level (Olmstead & Palmer, 1994; Gielly *et al*., 1996; Sang *et al*., 1997; Kim *et al*, 1999; Chandler *et al*., 2001) as well as at the intraspecific level (Hamilton, 1999; Holdregger and Abbott, 2003).

The *rp*S16 is not as widely used as other cpDNA regions, but is typically more informative than the *trn*LF region (Shaw *et al*., 2005). It has proven useful at the genus level, in *Gunnera* (Wanntorp *et al*., 2001; Wanntorp & Wanntorp, 2003), *Cymopterus* (Downie *et al*., 2002) and *Alectryon* (Edwards & Gadek, 2001) and has also been used successfully at species level in *Silene aegaea* (Popp & Oxelman, 2001).

The *trn*LF region is comprised of the Group I intron that interrupts the *trnL* gene, and the intergenic spacer between the t*rn*L and *trn*F genes (Shaw *et al*, 2005). This region one of the most commonly used non-coding regions of cpDNA in phylogenetic studies (Sang *et al.*, 1997; and papers listed therein). The *trn*L intron and *trn*L-*trn*F spacer regions are easily co-amplified together using the “c” and “f” primers of Taberlet *et al*. (1991) and are often used as a single region (Shaw *et al*., 2005). Due to the near-universal nature of the primers and their early publication, these regions have become the most widely used noncoding cpDNA sequences in plant systematics (Shaw *et al*., 2005). The *trn*LF region has been used at many levels of phylogenetic study, including the intrageneric and species level (Olmstead & Palmer, 1994; Mes and t’Hart, 1994; Gielly *et al*., 1996; Sang *et al.*, 1997; Chandler *et al*., 2001).

Methods

Study samples

43 samples were collected from all 16 species and ten subspecies of *Gazania*, details of which are presented in Table 3.2.1. Two samples per taxa were used to investigate the monophyly of each taxon. All specimens were identified by using Roessler's key to *Gazania* (Roessler, 1959), to enable the testing of the validity of the current species recognized by Roessler. Three outgroup samples, one each from close sister genera *Berkheya, Hirpicium* and *Gorteria*, were also included. One sample of a putative new species (*G. sp. nov.*) is also included. This specimen was collected by L. Mucina (Univ. Stellenbosch) and is considered by him to be a new species (this is not a final designation, pending the collection of further samples and further investigation). Both the *G. othonnites* and the *G. sp. nov*. samples have grey (glaucous) leaves with a certain amount of fleshy succulence, although they show very different leaf morphology in other aspects (the *G. othonnites* sample has equal numbers of entire and pinnate leaves that are glaborous, while the *G. sp. nov*. sample has entire, roughly hispid leaves). Both samples come from the same geographical area (around Springbok in the Northern Cape).

DNA was extracted from all samples using a CTAB DNA extraction protocol (Doyle & Doyle, 1987). Multiple samples of each species and subspecies were used where possible to test for species monophyly. Although cloning of nrDNA samples would counteract the possible effects of multiple ITS/ETS paralogues, the budget required for cloning of all sequences is beyond the reach of this research project.

PCR amplification and sequencing

The PCR reagents and their volumes are presented in Table 3.2.2. Primers, annealing temperatures and number of cycles necessary to ensure clean product for each region are presented in Table 3.2.3.

Table 3.2.2: Table of PCR reagents, all units in microlitres.

	10x buffer	dNTPs	Primer1	Primer2	DNA	$MgCl_2$	BioTaq	H_2O
nrDNA	5	2	2	2	2	1	0.25	34
cpDNA	"	"	"	"	"	4	"	31

10x = 10x Bioline NH4 Dilution Buffer ($MgCl_2$ free); BioTaq = Bioline Taq Polymerase;
DNA = DNA template; H_2O = distilled PCR-quality water
$MgCl_2$ = 50 mM solution of $MgCl_2$ provided with enzyme and 10x buffer.

For some samples a DNA dilution of 1:20 or 1:100 in dH_2O was necessary to counteract the effects of putative contaminants that prevented successful PCR amplification at full DNA concentration. PCR amplifications were conducted either on a ThermoHybaid PCRSprint Temperature Cycling System or a Corbett Research PC-960G Microplate Gradient Thermal Cycler. The following standard conditions were used (although annealing temperature varied as per Table 3.2.3): 95°C for 1 min, 52°C for 1 min and 72°C for 3 minutes, repeated between 30 and 40 cycles, with a 10 minute 72ºC extension period at the end of the PCR program.

PCR product was run on 1% agarose gels, which consisted of 0.5g agarose in 50ml TBE buffer (10.8g Tris(hydroxymethyl)aminomethane, 5.5g Boric acid and 0.93g EDTA made up to 1L with distilled water). Each gel contained 20µl ethidium bromide (0.5µg/ml) and the PCR products bands were visualised using a UV transilluminator. A clean clear bright band was taken as a positive result. Any smearing indicated an unsatisfactory PCR result, and PCR conditions were altered as necessary to reduce smearing (e.g. a reduction in number of cycles; a reduction in quantity of primers used in the PCR reaction).

The PCR product was cleaned using the PROMEGA Wizard SV Gel and PCR purification kit and resuspended in 30µl of dH_2O. The final product was checked for purity and concentration by running 1µl of the product, with 5µl water and 5µl of a loading buffer (Bromophenol blue and xylene cyanol in glycerol) on a 1% Agarose gel that contained 15µl of ethidium bromide (0.5µg/ml) and visualised by means of a UV transilluminator. Cleaned PCR product was sequenced using ABI prism BigDye Terminator v3.1 Ready Reaction Cycle sequencing kit (Applied Biosystematics) according to manufacturer’s instructions with the primers listed as sequencing primers in Table 3.2.3.

Primer development for ITS and ETS amplification and sequencing

Figure 3.2.1 illustrates the starting positions and directionality of primers used to amplify and sequence in the ITS region. Boundaries of ITS1, ITS2 and the 5.8S regions were determined by comparison with published sequences of Asteraceae ITS (Goertzen *et al.*, 2003).

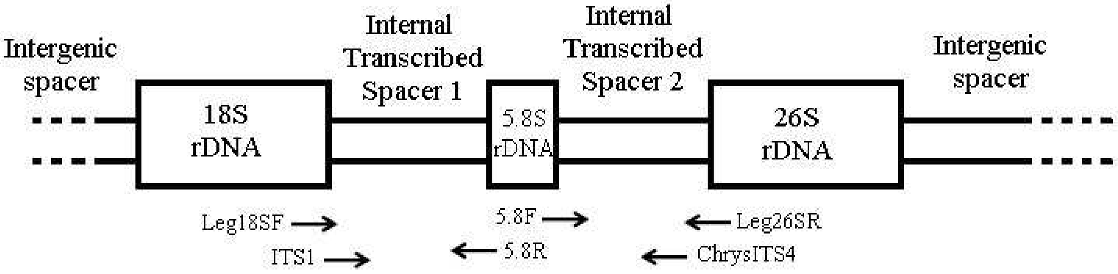


Figure 3.2.1: Diagrammatic representation of the ITS regions with primer start points and directionality. Boxes indicate functional rDNA genes.

Table 3.2.1: List of all samples used in DNA species-level phylogeny, including collection locality data.

Species	subspp	Sample(s)	Locality	South	East
caespitosa		RVC307	South Africa. Graaff-Reinet: Koudeveldberge, summit	32° 7' 30"	24° 7' 30"
		RVC_SR448	South Africa. Somerset East: Koudeberg, summit, Groot Vallei Farm.	32° 19' 50"	25° 00' 23"
ciliaris		RM1230	South Africa. Cape Town: Paarlberg.	33° 45' 8"	18° 57' 5"
		RM1382	South Africa. Clan William: Piketberg plateau	32° 48' 41"	18° 42' 40"
heterochaeta		RM1429_1	South Africa. Steytlerville: T2 road Steytlerville - Grootrivierpoort; 5km N Rietfontein turn	33° 22' 30"	24° 22' 30"
		RM1451	South Africa. Springbok: 5km N Steinkopf, beside N7 highway	39° 14' 4"	17° 45' 20"
jurineifolia	jurineifolia	RM1518	South Africa. Steynsburg: Eastern Cape: Conway, Alberta Farm.	31° 40'	25° 15'
		SR682	South Africa. Gamoep: 18km W of Aggeneys (between Springbok & Pofadder)	29° 22' 46"	18° 38' 53"
	scabra	CAM1604	Namibia. Witputz: Karas	27° 22' 30"	16° 07' 30"
		CAM2652	Namibia. Aus: In road verge on road between Aus and Rosh Pinah, in red sand	26° 45' 41"	16° 17' 21"
krebsiana	krebsiana	RM1114	South Africa. Fort Beaufort: Road to Bedford, R350.	32° 41'	26° 05'
		RM1136	South Africa. Colesberg: W of Venterstad, R58, 2km E of Gelykfontein farmstand.	30° 47'	25° 47'
	arctotoides	RM868	South Africa. Kenhardt: Rooipan, southeast of Lime Acres.	29° 47'	21° 56'
		RM876	South Africa. Aliwal North: Bloemfontein	30° 19'	26° 48'
	serrulata	RM965	South Africa. Lady Frere: 13km SW Elliot on R56 road.	31° 19'	27° 57'
		RM863	South Africa. Olifantshoek: southeast of Beeshoek	27° 45'	22° 37'
leiopoda		RM1309	South Africa. Kamiesberg: Roadside.	30° 24' 38"	18° 03' 09"
		M240901	South Africa. Calvinia: Nieuwoudtville, near turnoff to Rondekop.	31° 23' 23"	19° 11' 00"
lichtensteinii		CAM1916	Namibia. Luderitz: Gleckonberg West.	26° 22' 30"	15° 52' 30"
		RM1249	South Africa. Wuppertal: beside R355 road near Tankwa Karoo National Park.	32° 10' 30"	19° 42' 47"
linearis	linearis	RM1010	South Africa. Stanger: Mzimpunzi river mouth, Pondoland.	29° 13' 28"	31° 29' 51"
		SH113	South Africa. Stutterheim: 10km out of Stutterheim	32° 34'	27° 25'
	ovalis	RM854	South Africa. Grahamstown: north of Bathurst	33° 30' 18"	26° 49' 53"
		ND_Havens	South Africa. Butterworth: The haven, Transkei	32° 14' 50"	28° 54' 17"
maritima		M290606_6	South Africa. Simonstown: Table Mountain National Park, Diaz beach	34° 21' 12"	18° 25' 54"
		RM1038	South Africa. Bredasdorp: Cape Agulhas, about 2km E of actual cape, on shoreline.	34° 48' 48'	20° 02' 48"
othonnites		RM1306	South Africa. Springbok: Kleinzee, Molyneuz trail	29° 41' 27"	17° 05' 40"
pectinata		M120903_5	South Africa. Clanwilliam: Western Cape Province, Piketberg, Sauer, Uitvlug turnoff.	32° 50' 17"	18° 33' 14"
		RM1044_3	South Africa. Caledon: Agulhas peninsula, Bredasdorpberge.	34° 29' 47"	19° 53' 39"
rigens	rigens	RM763	South Africa. Grahamstown: Kasouga Beach.	33° 39'	26° 22'

		SR463	South Africa. Stanger: Tugela River mouth	29° 13'	31° 30'
	leucolaena	RM773	South Africa. Knysna: Plettenberg Bay	34° 02'	23° 22'
		RM952_1	South Africa. Humansdorp: Cape St Francis, in sand on rocky shoreline	34° 12'	24° 50'
	uniflora	RM920	South Africa. Grahamstown: SE of Cannon Rocks.	33° 44'	26° 33'
		JC201205	South Africa. Port St Johns: Lupatana, Pondoland, dunes between rocks and bush.	31° 25' 20"	29° 51' 15"
rigida		RM840	South Africa. Caledon: south of Caledon.	34° 16'	19° 26'
		M280902	South Africa. Oudtshoorn: Oudtshoorn, turn off to Zebra	33° 45' 45"	22° 20' 07"
schenckii		CAM2727	Namibia. Luderitz: Griffith bay area, in kloofs between rocky gneiss ridges	26° 40' 12"	15° 08' 00"
serrata		RM898	South Africa. Worcester: Robertson on R60 road.	33° 48'	19° 53'
		M250904_15	South Africa. Simonstown: Helderberg strand, R44 between Nautilus & Octopus streets	34° 08' 31"	18° 51' 06"
tenuifolia		CAM1601	Namibia. Witputz: Arras	27° 22' 30"	16° 07' 30"
		M7230	South Africa, Springbok: Goegap Nat Res, Bleshoek	29° 41' 31"	17° 58' 46"
sp. nov.		M040906_33	South Africa. Hondeklipbaai: Hondeklipbaai, coast at police station	30° 19' 22"	17° 16' 21"
Collector abbreviations: RM = Robert McKenzie, M = Laco Mucina, CAM = Colleen Mannheimer, SR = Syd Ramdhani, JC = Jessica Cockburn, RVC = Ralph Clark, ND = Nico Devos.					

Table 3.2.3: Primer names, uses, authors, sequences, PCR annealing temperature and number of cycles.

Name	Use	Reference	Sequence	Anneal Temp	No. Cycles
ITS				52°C	30-40
Leg18SF	Amplification		GTC CAC TGA ACC TTA TCA TTT AGA GG		
Leg26SR	Amplification		GCC GTT ACT AAG GGA ATC CTT GTT AG		
ITS1	Sequencing	White *et al.* 1990	TCC GTA GGT GAA CCT GCG G		
ChrysITS4	Sequencing		TCC TCC GCT TAT GGA TAT GC		
Chrys5.8F	Sequencing		GAC TCT CGG CAA CGG ATA TC		
Chromo5.8R	Sequencing	Barker *et al.*, 2003	GAT TCT GCA ATT CAC ACC		
ETS					
ETS 18S	Amplif/Seq	Linder *et al.*, 2000	ACT TAC ACA TGC ATG GCT TAA TCT	51°C	35
ETS 1F	Amplification	Linder *et al.*, 2000	CTT TTT GTG CAT AAT TGA TAT ATA GGG G		
ETS IntF	Sequencing		ACC AGC TGA TGG ACA AG		
ETS IntR	Amplif/Seq		ACC ACC CGA CTA GTA GCC		
***psb*A-*trn*H**					
psbA	Amplif/Seq	Sang *et al.*, 1997	GTT ATG CAT GAA CGT AAT GCT C	53°C	30
trnH	Amplif/Seq	Sang *et al.*, 1997	CGC GCA TGG TGG ATT CAC AAA TC		
***rpS*16**					
Rps16F	Amplif/Seq	Oxelman *et al.*,1997	GTG GTA GAA AGC AAC GTG CGA CTT	52°C	30
Rps16R2	Amplif/Seq	Oxelman *et al.*,1997	TCG GGA TCG AAC ATC AAT TGC AAC		
***trn*LF**					
tab c	Amplif/Seq	Taberlet *et al.*, 1991	CGA AAT CGG TAG ACG CTA CG	53-55°C	30-35
tab d	Amplif/Seq	Taberlet *et al.*, 1991	GGG GAT AGA GGG ACT TGA AC		
tab e	Amplif/Seq	Taberlet *et al.*, 1991	GGT TCA AGT CCC TCT ATC CC		
tab f	Amplif/Seq	Taberlet *et al.*, 1991	ATT TGA ACT GGT GAC ACG AG		

Initial ETS amplification of ±10 samples using the “ETS18S” and “ETS1F” primers of Linder *et al.* (2000) (Table 3.2.3) showed intermittent success. Addition of Bovine Serum Albumen (BSA, 10μg/ml) and dilution of DNA template (1:100 dH_2O) was sometimes necessary to amplify the entire 1.3 kbp of the ETS region. Even so, amplification success was limited and sequencing using the “ETS1F” primer was never successful. Additionally, there were multiple amplification products in several samples (as seen by the presence of up to three clear different sized bands on agarose gels).

Using sequences obtained with the “ETS18S” primer, two stable invariable regions were found (located approximately 460 bp and 760 bp from the 18S end of ETS) and used for the design of internal primers (see Table 3.2.3 for details, Figure 3.2.2). The use of the “ETS IntF” primer in conjunction with the “ETS18S” for PCR amplification significantly increased the success rate. 763 bp of the 18S end of the ETS region were amplified for the remaining samples. A second internal primer

“ETS IntR”, located approx 460 bp from the 18S end, was utilized as an internal reverse sequencing primer. Extremely troublesome samples could be amplified successfully with the addition of a 1:1000 dilution of the “ETS IntR” primer to stimulate elongation of the ETS region.

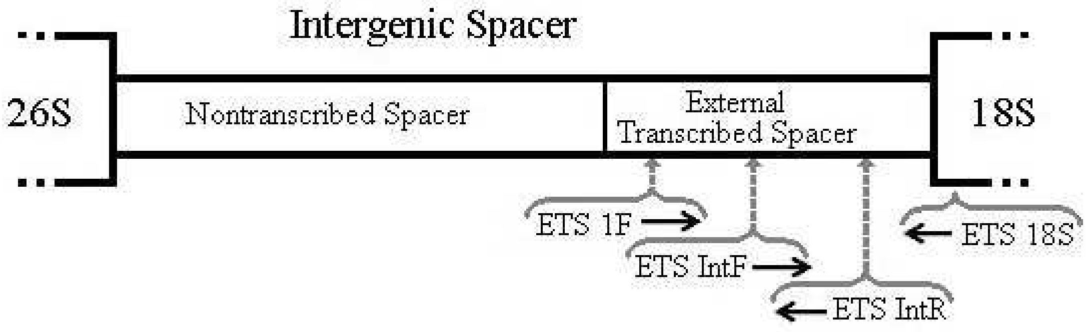


Figure 3.2.2: Diagrammatic representation of the IGS regions with primer start points and directionality. Boxes indicate functional rDNA genes.

The *trn*L intron and *trn*L-*trn*F spacer were co-amplified in most cases, with the primer pair of “tab c” and “tab f”. If amplification of this region in one segment was not successful, “tab c” and “tab d” were used to amplify the *trn*L intron and “tab e” and “tab f” were used to amplify the *trn*L-*trn*F spacer separately.

Sequence checking and alignment

Sequence data was checked and edited using SEQUENCHER (Version 3.1.1; Gene Code Corporation). Assembled sequences were exported from Sequencher, and imported into MACLADE (Version 4.06; Sinauer Associates, Inc.) and aligned manually by eye.

As the nuclear genome is biparentally inherited, two or more divergent copies of the ITS and ETS regions may be present in one organism. When the pool of divergent paralogous copies is sequenced, ambiguous bases (where two peaks of equal height occur at the same point in the electropherograms) are found. The presence of these ambiguous base calls (nucleotide additivity) has been considered evidence of the presence of multiple copies (Noyes, 2006; Dobeš *et al*., 2004). For this reason, the IUPAC (international) ambiguity coding was utilized for the nuclear data where clear multiple paralogous copies were sequenced. The ILD test as implemented in PAUP* (as the Partition Homogeneity Test) was used to investigate possible incongruence between the various data sets, using simple addition and TBR branch swapping, for 100 replicates, saving the 500 most parsimonious trees per replicate.

Treatment of gaps

Different methods of treating gaps in analyses can influence the resulting phylogenetic hypothesis (Simmons & Ochoterena, 2000, and papers listed therein). Treatment of gaps can vary widely, from secondarily mapping gaps onto the tree inferred from base characters alone, to treating all gaps as separate characters or character states (Simmons & Ochoterena, 2000). Gaps are often not included in phylogenetic analyses, because presumed identical gaps may in fact have multiple origins in unrelated taxa (Johnson & Soltis, 1995; Simmons & Ochoterena, 2000). For *Gazania*, gaps are omitted from the analyses, but mapped onto the branches of the final phylogenetic tree. Exclusion of gaps allowed for a conservative approach to analysis of the data, and inclusion of the gaps did not influence the final phylogenies or significantly alter the support for clades and thus were not given additional consideration.

Testing for incongruence

Advocates of conditional combination have argued that testing for incongruence between data partitions is an important step in data exploration (Cunningham, 1997). If two data sets are congruent (i.e. they track the same underlying history) then it should not matter which characters are assigned to which data set, the resulting trees should remain the same (Kellogg *et al*., 1994). The higher the incongruence between data partitions, the larger the homoplasy that arises when the partitions are combined (Ramirez, 2006). Some authors note that data partitions should be considered to be combinable if and only if they are not strongly incongruent with one another (Hipp *et al*, 2004). Siddall (1997) cautions, however, that incongruence and combinability are different things.

Dowton & Austin (2002) comment that the most generally used assessment of congruence is the Incongruence Length Difference (ILD; Mickevich & Farris, 1981; Farris *et al.*, 1994), also known as the partition homogeneity test (Swofford, 2001). Although the ILD test was intended to detect the presence of strongly supported character conflict (“hard” incongruence) among individual data sets within a combined analysis, the test has gained wide usage in parsimony analyses as a general test of combinability (Barker & Lutzoni, 2002). The reason for this is that evidence for phylogenetic incongruence can be interpreted as being indicative that data partitions have different evolutionary histories (Ramirez, 2006).

There are several versions of the ILD (summarised in detail by Dowton & Austin, 2002). The ILD test with multiple randomizations as described by Farris *et al.* (1994) is the most commonly used, and is the one implemented in the PAUP* software package used for phylogenetic analysis of the *Gazania* data sets. Barker & Lutzoni (2002) describe the ILD (as based on the ILD index of Mickevich & Johnson, 1976), which measures the proportion of inferred homoplasy attributable to the combination of individual data sets or partitions, which may each require conflicting minimal-length topologies. The ILD test first calculates the sum of the lengths of the two original trees, then all the characters are randomly partitioned into two new data sets (of the same size at the original two), and the two most parsimonious trees are computed and their lengths summed (Kellogg *et al.*, 1994). This is repeated to generate a distribution of the sums of tree lengths, and if the total length of the observed data falls within the distribution of the random data sets, then the division of the two data sets is inferred to be arbitrary, and there is no significant difference (incongruence) between them (Kellogg *et al.*, 1994). Otherwise, if the total length of the observed data sets falls outside of 95% of the randomly partitioned data, the data sets are considered to be significantly incongruent.

Despite some criticism (Albach & Chase, 2004; Barker & Lutzoni, 2002; Ramirez, 2006), the ILD has become a standard procedure in phylogenetic analyses involving more than one data set (Ramirez, 2006). Simulation studies have demonstrated that significant ILD test P values (i.e. $p < 0.05$, which is the original cut-off point suggested by Farris) even down to as low as $p < 0.001$ should not preclude data set combination (Yoder *et al*, 2001), and should not be taken as a conclusive demonstration that analyzing independent data partitions in combination will produce misleading phylogenies (Hipp *et al* 2004).

The interpretation of the significance of the p value from the ILD test as an indicator of combinability is subject to some debate (i.e. what value of p should be a cut-off mark). Clevinger & Panero (2000) considered a value of $p = 0.09$ as being positive support for combining their ITS and ETS data sets, but their cpDNA and nrDNA data sets were not considered combinable with $p = 0.026$. Chan *et al.* (2001) considered a value of $p = 0.07$ as being low enough to call into question whether data sets should be combined. Lee *et al.* (2002), however, considered a value of $p = 0.07$ to show that data sets were not significantly heterogeneous, and thus combined them with no further comments.

Ramirez (2006) notes that the results of the ILD test should be interpreted with caution, as common evolutionary conditions like heterogeneous rates of change between partitions may cause the test to report higher significance of incongruence than expected. Despite ITS and ETS being part of the same repeat array, the two data sets are not always congruent, and this apparent incongruence may be due to the faster rate of evolution in the ETS region. Okuyama *et al.* (2005) attribute significant incongruence between ITS and ETS to frequent hybridization, rather than rate heterogeneity.

In light of the controversy surrounding the ILD, while it is utilized for testing for the presence of incongruence between the various *Gazania* data sets, some advisable caution will be applied to the interpretation of the results.

Phylogenetic analyses

Several approaches can be used an aid to phylogeny reconstruction and these generally fall into three classes: parsimony, distance methods and maximum likelihood methods (Olmstead & Palmer 1994). A fourth method, Bayesian analysis has become very popular in recent years. The methods used in this chapter are Parsimony and Bayesian analysis. *Berkheya*, *Hirpicium* and *Gorteria* samples were used as the outgroup rooting point for phylograms. Maximum likelihood was not chosen for use as it is computationally demanding, and would require a long time to run the analyses (especially on data sets of this size).

Parsimony analysis

As noted by Maddison (1991), in a set of most-parsimonious trees for a data matrix, there may be several distinct classes (islands) of trees. An island consists of interconnected parsimonious trees (all less than a certain length), with each tree within an island differing from each other by only a single rearrangement of branches (Maddison, 1991). Trees in different islands may have different implications for character evolution and each run of a random input heuristic search will typically find only one island (Maddison, 1991).

PAUP* (Swofford, 2001) was used for all parsimony analyses. A random input analysis was performed, to ensure all islands of equally most parsimonious trees were found. A brief HEURISTIC search was conducted to find the length of the shortest tree (MAXTREES was set to 100000). A second HEURISTIC search was conducted, of 1000 replicates, at each replicate saving 1 tree (TSAVE=1) no longer than the shortest tree length, with start trees RANDOM, and the MULTREES and STEEPEST ASCENT options in effect, and TBR branch-swapping in effect. Once these trees had been generated, a final HEURISTIC search was conducted on the trees found by this method, using all trees in memory. All trees were allowed to swap to completion. A strict consensus tree was produced from the set of equally most parsimonious trees obtained. Bootstrap support values were calculated for 1000 replicates with (MAXTREES = 1000). PAUP* allows for the use of ambiguous base-calls in sequence analysis and this facility was used for nrDNA data sets. Gaps were coded as missing data.

Bayesian analysis

As Bayesian analysis is based on explicit models of DNA evolution, the MrModelTest (Nylander, 2004) software package was used to identify the model of DNA substitution that best fit the data. The Bayesian analysis was run using MrBayes v3.1.2 (Huelsenbeck & Ronquist, 2001) as follows: four Markov chains, three heated and one cold, were run simultaneously for 5,000,000 generations and trees were saved every 100 generations. The starting tree was random, the branch lengths were saved and the first 4000 trees were discarded as burnin. The sumt function was used to generate a consensus tree. A majority-rule consensus calculated in PAUP* was then used to determine the posterior probabilities.

Results and Discussion

Choice of data sets

The suitability of a region for use in a phylogenetic study is dependant on two factors: the rate of change, which determines the taxonomic level at which a particular genome (or partial DNA sequence thereof) is most informative (Palmer, 1987); and sufficient length of sequence to provide enough phylogenetically informative nucleotide positions (Olmstead & Palmer, 1994). Both the ITS and ETS regions proved to be sufficiently variable and informative in the initial screening to advocate further use of both regions for a more detailed study.

Combining data sets

Character sampling for phylogenetic analysis involves two important elements: whether characters are independent, and whether there are enough of them (Olmstead & Palmer, 1994). Sufficient character sampling is necessary not only to achieve resolution, but also to have enough characters for synapomorphies to outweigh the inevitable randomly occurring homoplasies (Olmstead & Palmer, 1994). Increasing the number of characters can reveal a consistent phylogenetic signal that maybe hidden by the noise in each individual data set (Santiago-Valentin & Olmstead, 2003).

Researchers note that many recent studies have indicated that combined molecular data sets using regions with different levels of variation has provided resolution at different areas of cladograms, and phylogenetic resolution and levels of support are improved by directly combining independent molecular data sets (Chase & Cox, 1998; Soltis *et al.*, 1998; Whitten *et al*., 2000). As noted previously, the combination of nuclear and cpDNA sequences also increases the likelihood of inferring a species tree instead of just a gene tree, which would allow any possible assessment of the role of hybridization in the evolution of a species or genus (Soliva *et al*., 2001). Genealogy, it is thought, will most accurately be recovered if data are collected from character sets that have been under different selective pressures (Dowton & Austin, 2002). However, the analysis of large, heterogeneous data sets is not straightforward.

Although the acquisition of large and diverse molecular data sets is undoubtedly beneficial to phylogenetic reconstruction, exactly how to analyze the data remains an ongoing debate (Creer *et al.*, 2003). A number of methods have been proposed for addressing how to optimize the analysis of multiple data sets from diverse gene partitions in the pursuit of robust organismal phylogenies (Creer *et al*., 2003). There are two major opposing approaches to the utilization of multiple data sets in phylogenetic analysis: (i) Total evidence; and (ii) Congruence. 'Total evidence' requires that all the data be pooled into one large data set and analysed as one; and has been defined as the analysis of an unpartitioned body of evidence, ideally all the data available for a group of terminal taxa, that is characterised as seeking a single, best-fitting hypothesis, which in cladistics involves maximizing character congruence (Williams, 1994). The competing approach is 'taxonomic congruence' (also referred to as 'consensus'), which holds that trees derived from each separate data set should be compared to determine congruence, and seeks a consensus of hypotheses obtained from different data sets (Williams, 1994).

The advantages and disadvantages of each approach can depend on the heterogeneity of the data across multiple data sets. If data heterogeneity is rare, then the total evidence approach can lead to the best results, and if data heterogeneity is common, then combining all the data sets can lead to an erroneous answer that can obscure phylogenetic signal (Huelsenbeck, *et al*., 1996). Proponents of total evidence hold that all of the independent characters available to the systematists should be combined and then analysed using parsimony. An extension of that argument says that all of the available taxa should be combined (both living and fossil) in a phylogenetic analysis (Huelsenbeck, *et al*., 1996). Siddall (1997) opines that keeping data sets separate is anathema to explaining all of the data.

Instead of choosing between the two approaches, Huelsenbeck *et al.* (1996) advocate the idea of conditional combination. This is seen as sitting midway between the two extremes, as it prevents combination of heterogeneous data sets when partitions are clear, as well as allowing for interpretation of evolutionary processes when data sets are determined to be inappropriate for combination (Huelsenbeck *et al*., 1996). Levasseur & Lapointe (2001) advocate another approach: using both combined and separate analyses jointly.

Testing for incongruence

The ILD test indicated that the ITS and ETS data sets were not significantly incongruent (p=0.19), and that all three cpDNA regions were highly congruent with each other (p=0.79). Based on these results, the ITS and ETS data sets were combined into the “nrDNA” data set, and the *psbA-trnH*, *rpS16* and *trnL-L-F* regions were combined into a “cpDNA” data set. The composite nrDNA and cpDNA data sets were, however, highly incongruent with each other (p=0.01) indicating that they should not be combined.

Final data set composition, variability and informativeness

Appendix 3 and 4 contain all sequence data for the nrDNA and cpDNA data sets. Table 3.3.1 lists the number of taxa, number of characters, variability, and informativeness of each nrDNA and cpDNA region, as well as the information for each compilation data set.

The presence of ambiguous base calls (indicated by two or more equally high signal peaks in otherwise clear electropherograms) is a sign that more than one paralogue of nrDNA is present in the plant genome of that particular sample. Out of 46 samples, 32 samples had at least one ambiguous base.

Table 3.3.1: Characteristics of each data set and DNA region, including number of samples, total number of characters, number and percentage of variable and parsimony informative characters, as well as data signal statistic.

			Variable Characters		Parsimony Inform. Ch.	
	No. samp.	Tot. chars	Number	%	Number	%
cpDNA	46	2367	204	8.6	84	3.5
trnL-L-trnF	46	901	60	6.7	16	1.8
psbA-trnH	46	600	73	12.2	46	7.7
rpS16	46	866	71	8.2	22	2.5
nrDNA	46	1441	439	30.5	232	16.1
ITS	46	678	176	26.0	92	13.6
ETS	46	763	263	34.5	140	18.3

Analyses results: nrDNA data set

Parsimony analysis

Parsimony analysis found 100000+ trees (CI =0.709, RI =0.889) for the nrDNA data set. The strict consensus of these trees (Figure 3.3.1) shows several strongly supported clades. These include:

1) *G. jurineifolia* (although there is no clear separation of the two subspecies), with 100% Bootstrap support (BS);

2) *G. tenuifolia*, with 100% BS;

3) *G. heterochaeta*, with 100% BS;

4) G. *lichtensteinii*, with 100% BS;

5) *G. ciliaris*, with 100% BS; and

6) *G. caespitosa*, rendered paraphyletic by the *G. ciliaris* samples (with 100 % BS for the branch as a whole).

The remaining samples group together in a large well supported (100% BS) clade, named the "K-R clade" (due to the preponderance of *G. rigens* and *G. krebsiana* samples in the clade). There are two clades with significant support within this K-R clade:

7) a clade of all except two *G. rigens* specimens (with 94% BS); and
8) the grouping together of the *G. othonnites* sample and the sample of a putative new species (with 94% BS).

There is little other clear taxonomic pattern within this large group and no significant support exists for any other internal branches which includes a number of Roessler's "species".

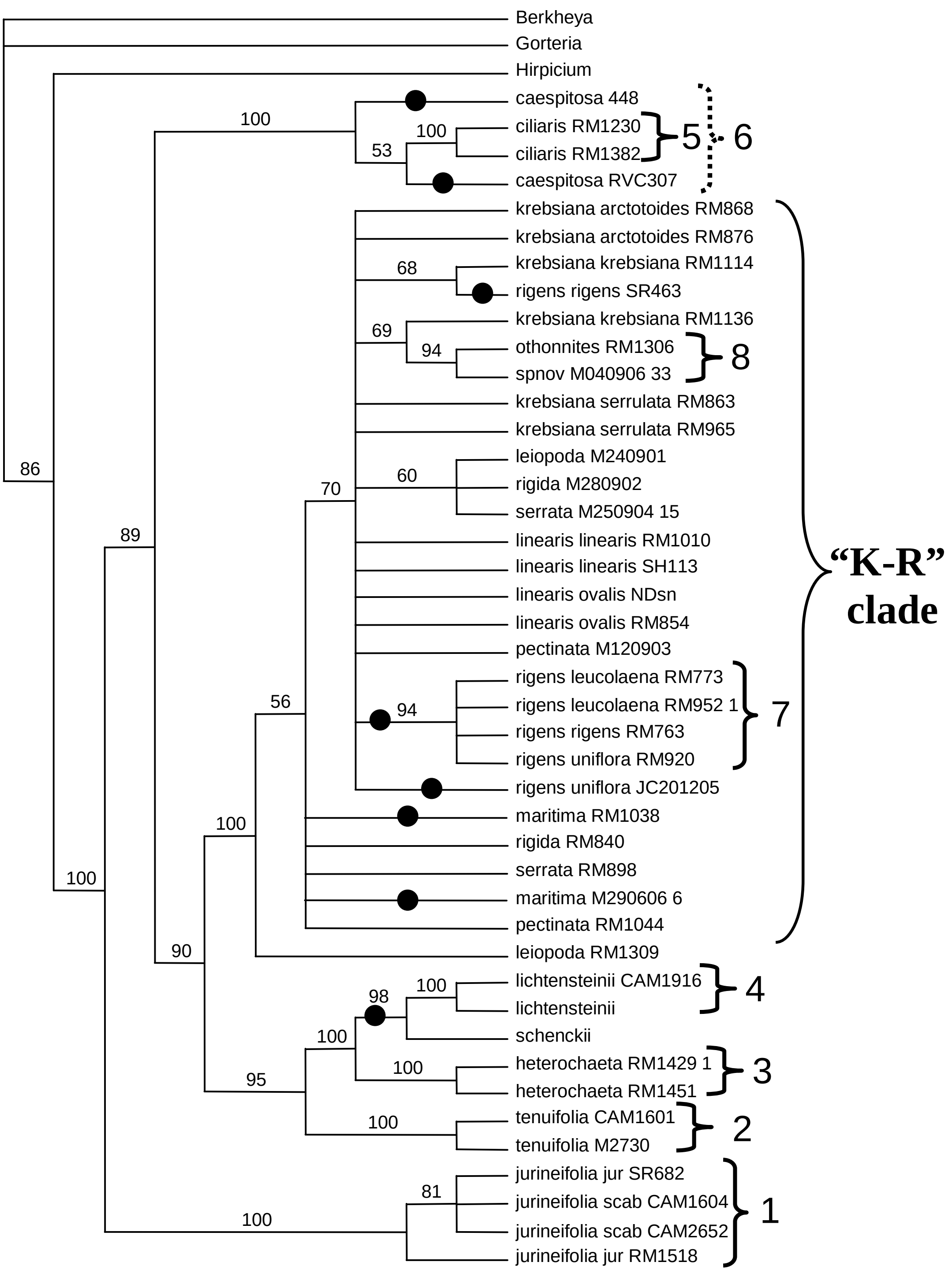


Figure 3.3.1: nrDNA strict consensus tree of 100000+ trees, L=508, CI=0.711, RI=0.896. Bootstrap support indicated above branches. Brackets highlight species clades discussed in the text. Black circles indicate the developed stem habit.

Bayesian analysis

For the nrDNA data set, MrModelTest identified the General Time Reversible model (GTR+G) (Tavaré, 1986) as the best fit (specific settings: Prset statefreqpr=dirichlet(1,1,1,1); Lset nst=6 rates=gamma). The Bayesian tree (Figure 3.3.2) shows exactly the same groupings as seen in the Parsimony results.

Correspondence between molecular phylogeny and taxonomy

Habits (rosette or developed stem) were mapped onto the phylogeny, with the presence of black circles indicating those samples with the developed habit. No particular pattern of growth habit in relation to phylogeny is apparent. This does not rule out the possibility that state reversals may have occurred (leafy stems may define Clade 6, with a subsequent reversal of state for Clade 5).

The nrDNA data set resolves seven taxa with high support (*G. lichtensteinii*, *G. heterochaeta*, *G. schenckii*, *G. tenuifolia*, *G. jurineifolia*, *G. ciliaris* and *G. caespitosa*). Four of these taxa (*G. jurineifolia*, *G. heterochaeta*, *G. tenuifolia* and *G. lichtensteinii*) also showed strong morphological distinction in the morphometric analyses (Chapter 2). This provides clear evidence (from the nuclear genome) of good species delimitations for at least some of the species of *Gazania*.

The remaining species samples form a large, poorly resolved clade composed of nine “species” that show little genetic grouping (the K-R clade). One nominal exception exists: an internal clade that groups most (but not all) of the *G. rigens* samples with strong support (94-100% BS). *G. rigens* was one of the other two morphologically defined clades from Chapter 2 (*G. rigens* and *G. linearis* subsp *ovalis*), but neither clade shows much genetic cohesion in the nrDNA analyses.

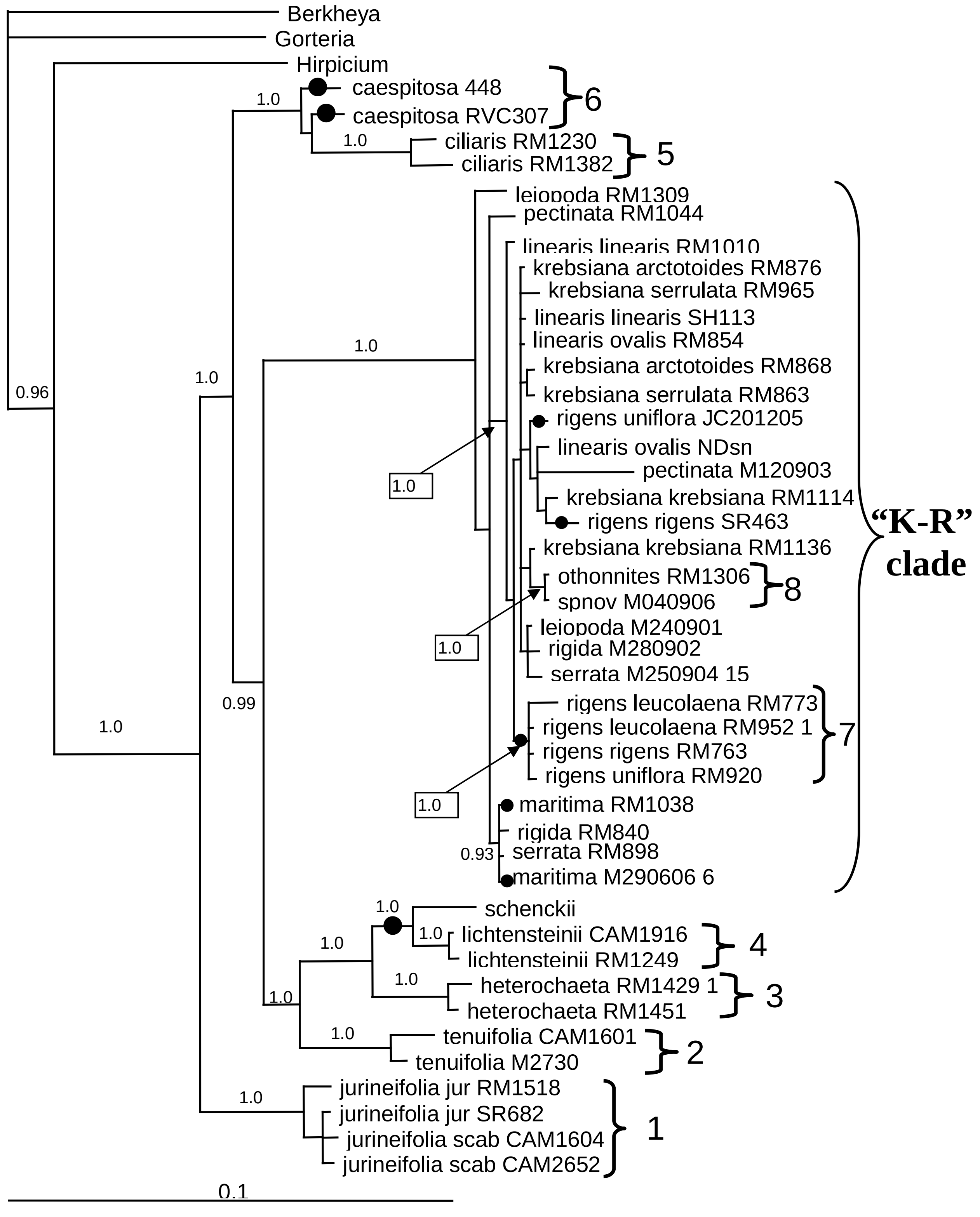


Figure 3.3.2: nrDNA Bayesian consensus tree. Posterior probabilities indicated on branches. Brackets highlight species clades discussed in the text. Black circles indicate the developed stem habit.

Analyses results: cpDNA data set

Parsimony analysis

Parsimony analysis found 100000+ trees (CI =0.785, RI =0.894) for the cpDNA data set. The Strict consensus of these trees (Figure 3.3.3) resolves only some of the same species groupings seen in the nrDNA trees. These include:

1) *G. jurineifolia*, with 100% BS;
2) *G. tenuifolia*, with 96% BS;
3) *G. ciliaris*, with 100% BS; and
4) *G. caespitosa,* with 77% BS.

The remaining samples show no clear species structure but are relatively strongly supported (80% BS) as a clade. The *G. rigens* clade seen in the nrDNA data is not retrieved in the cpDNA data.

Bayesian analysis

For the cpDNA data set, MrModelTest identified the General Time Reversible model (GTR+I+G) (Tavaré, 1986) as the best fit (specific settings: Prset statefreqpr=dirichlet(1,1,1,1); Lset nst=6 rates=invgamma). The Bayesian consensus tree (Figure 3.3.4) shows exactly the same groupings as the parsimony analysis. Some resolution is obtained inside the largest unresolved branch, although this shows little species coherency.

Correspondence between molecular phylogeny and taxonomy

Habits (rosette or developed stem) were mapped onto the phylogeny, with the presence of black circles indicating those samples with the developed habit. No particular pattern of growth habit in relation to phylogeny is apparent.

The cpDNA data set resolves only four taxa with high support (*G. jurineifolia, G. tenuifolia, G. ciliaris,* and *G. caespitosa*). These taxa were also well resolved in the nrDNA data set and two (*G. jurineifolia* and *G. tenuifolia*) were well resolved in the morphometric analysis in Chapter 2. This lends additional support to their status as distinct species.

As with the nrDNA data set, beyond the resolved clades, there remains a large unresolved clade consisting of multiple species samples.

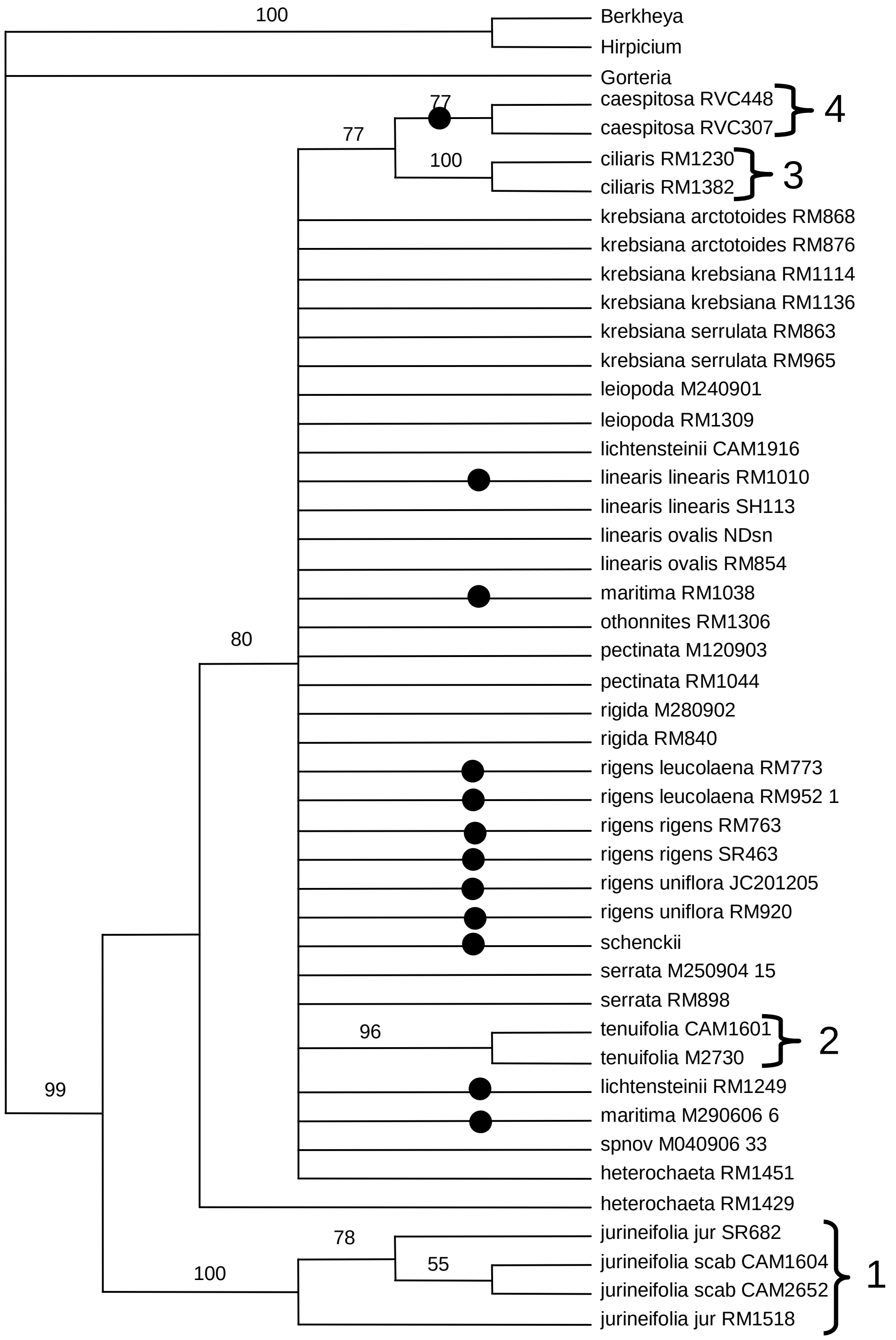


Figure 3.3.3: cpDNA strict consensus tree of 100000+ trees, L=112, CI =0.795, RI =0.894. Bootstrap support indicated above branches. Brackets highlight species clades discussed in the text. Black circles indicate the developed stem habit.

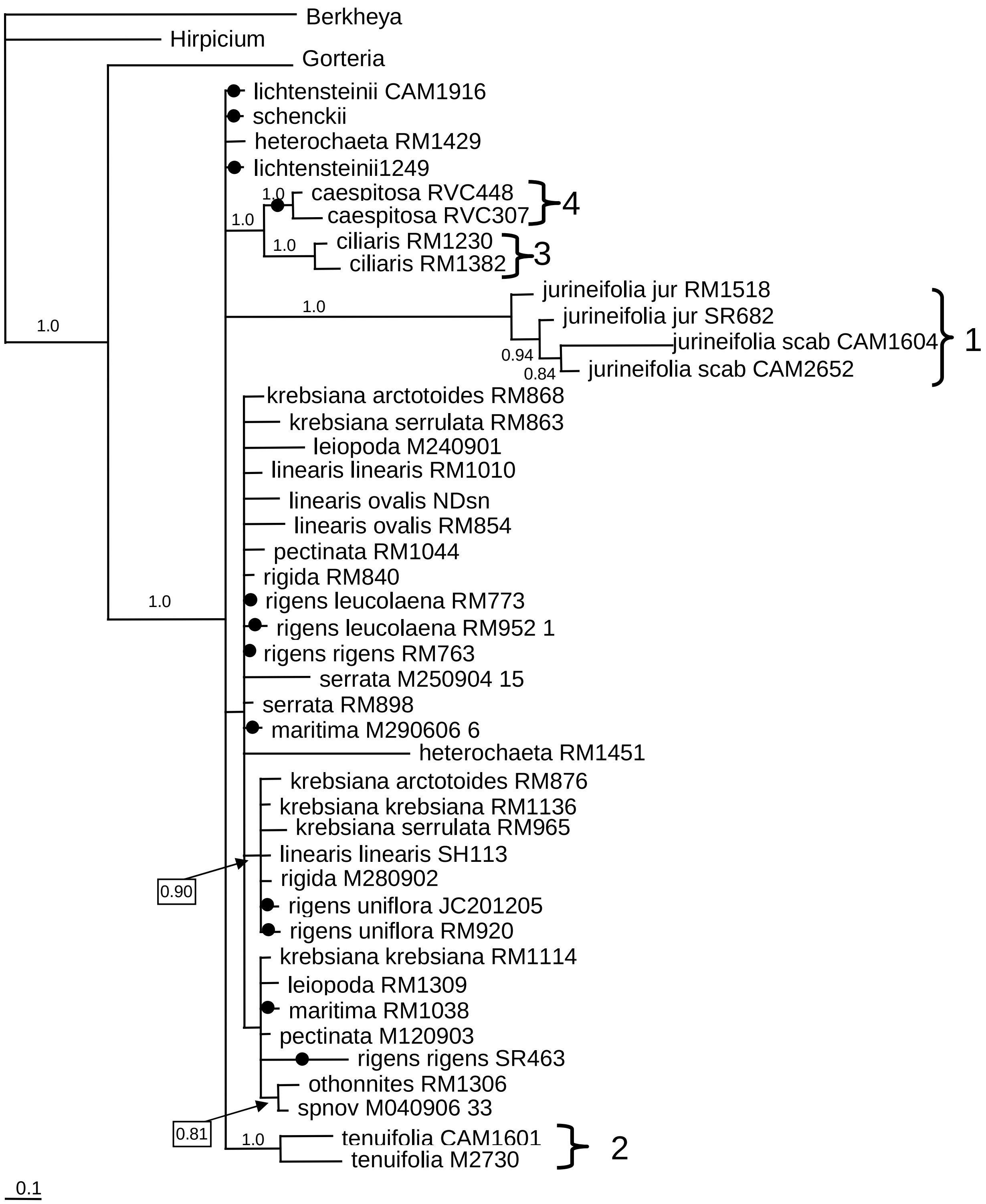


Figure 3.3.4: cpDNA Bayesian consensus tree. Posterior probabilities indicated above branches. Brackets highlight species clades discussed in the text. Black circles indicate the developed stem habit.

Composite combined evidence phylogeny

Despite the ILD test results, which indicate that the cpDNA and nrDNA data sets should not be combined, the two data sets repeatedly resolve the same genetically discrete basal species clades, suggesting that any incongruence present is more than likely due to the unresolved K-R clade, although it may also be due to rate heterogeneity. Sequential removal of taxa from the K-R clade resulted in improvements in the ILD test statistics. The initial test result was p=0.01 when all K-R clade taxa were present. Removal of all duplicate taxa in the K-R clade (i.e. so that there were only a single representative of each taxa present) resulted in p=0.01 again. Removing half of the species in the K-R clade (such that there were only eight taxa left) resulted in p=0.1. Halving this number again (such that there were only four taxa left) resulted in p=0.27. Total removal of the K-R clade taxa resulted in p=0.36. This indicates that the incongruence between the two data sets was due to the confounding effects of the K-R clade polytomy.

Disregarding the ILD test results, a composite data set (“combined”) was compiled from the cpDNA and nrDNA data, and subjected to parsimony analysis and Bayesian analysis (using the GTR+I+G model, with all other settings as for the cpDNA analysis).

The parsimony consensus tree (Figure 3.3.5) and the Bayesian consensus tree (Figure 3.3.6) once again retrieve the same basal well-resolved species clades. The Bayesian tree shows very strong support for all the basal clades (all with pp=1.0), while the support in the parsimony analysis remains much the same as the nrDNA analysis. *G. caespitosa* is no longer paraphyletic with respect to *G. ciliaris,* and there is still little species resolution in the well-supported K-R clade. The congruence between the combined DNA phylogeny and the nrDNA phylogeny supports the idea that the incongruence between the cpDNA and nrDNA data sets as indicated by the ILD test could be due to the confounding effects of the polytomy of the K-R clade.

Gaps in relation to species phylogeny

Gaps were mapped onto replicates of the combined DNA phylogeny. Gaps in both cpDNA (Figure 3.3.7) and nrDNA (Figure 3.3.8) were phylogenetically informative, although cpDNA showed some state reversals for these gaps. These apparent state reversals may be evidence of either hybridization events (with the dissimilar samples retaining cpDNA from maternal parents which lack the indels present in the majority of samples) or lineage sorting (with some few dissimilar samples retaining a less common ancestral cpDNA haplotype that lack the indels present in the majority of other samples).

Polytomies

There are polytomies present in results from both the nrDNA and cpDNA data sets. These may be a consequence of consensus methods (where conflicting relationships in different phylogenetic trees are summarised as a polytomy), or as the short branch lengths seen in the K-R clade in the Bayesian tree also indicate, a very low level of difference between the samples (i.e. lack of data). Although phylogenetic hypotheses can provide insights into mechanisms of evolution, their utility is limited by an inability to differentiate simultaneous speciation events (hard polytomies) from rapid cladogenesis (soft polytomies) (Walsh *et al.*, 1999). Phylogenetic analyses of molecular data often recover polytomies (multifurcating rather than bifurcating relationships) and most of these polytomies are assumed to be "soft" (i.e. they can be resolved by the addition of more data from more sources) (Walsh *et al.*, 1999). If, however, an ancestral lineage does generate three or more lineages at one time, the resulting multiple simultaneous speciation events are represented by a "hard" polytomy (i.e. no matter how many datasets are added, polytomies and uncertainties will remain) (Walsh *et al.*, 1999). These hard polytomies will remain even after analyses of very large data sets as they are genuine representations of multiple simultaneous branching events (Walsh *et al.*, 1999).

In the case of polytomies within *Gazania*, the low number of phylogenetically informative characters in the cpDNA data set does not resolve a soft polytomy that might be resolved with more informative data sources. However, the lack of resolution in the faster evolving nrDNA data set (with proportionally five times as many characters, 15% informative for nrDNA vs 3% informative for cpDNA) suggests a hard polytomy within the large, unresolved, nine-“species” K-R clade, due to a recent and rapid radiation event. Whether this was in fact a “speciation” event is open to interpretation, as this relies on the assumption that the morphologically based “species” that Roessler delimited are actually species in their own right.

Rapid cladogenesis and other such speciation events present serious difficulties for phylogeny reconstruction from molecular sequences as reconstruction of such recent radiations is hampered by insufficiently rapid sequence evolution and problems with incomplete lineage sorting and reticulate evolution (Fishbein & Soltis, 2004). Lee *et al.* (2005) noted that a lack of accumulated molecular sequence variation and the convergence of morphological traits limits one’s ability to make sense of evolutionary past of many plants, especially those suspected to be the products of radiations. This inadequacy is further confounded by the possibly misleading inferences that have been based on single-marker phylogenies (i.e. “gene trees” vs. “species tree” differences), as well as the poorly documented role of hybridization and introgression in radiations (Lee *et al.*, 2005).

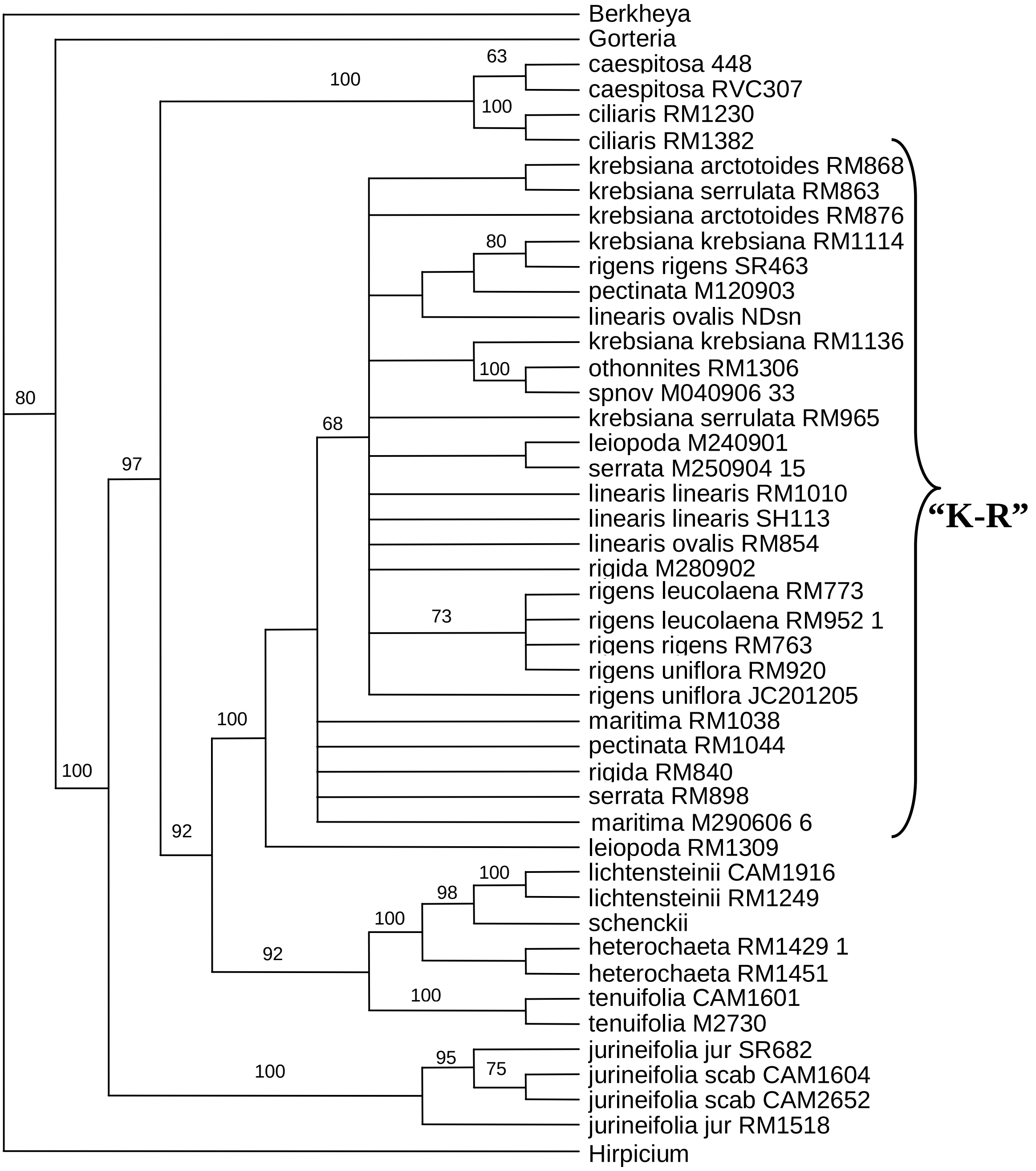


Figure 3.3.5: Combined DNA strict consensus tree of 100000+ trees, L=596, CI =0.678, RI =0.883. Bootstrap support indicated above branches.

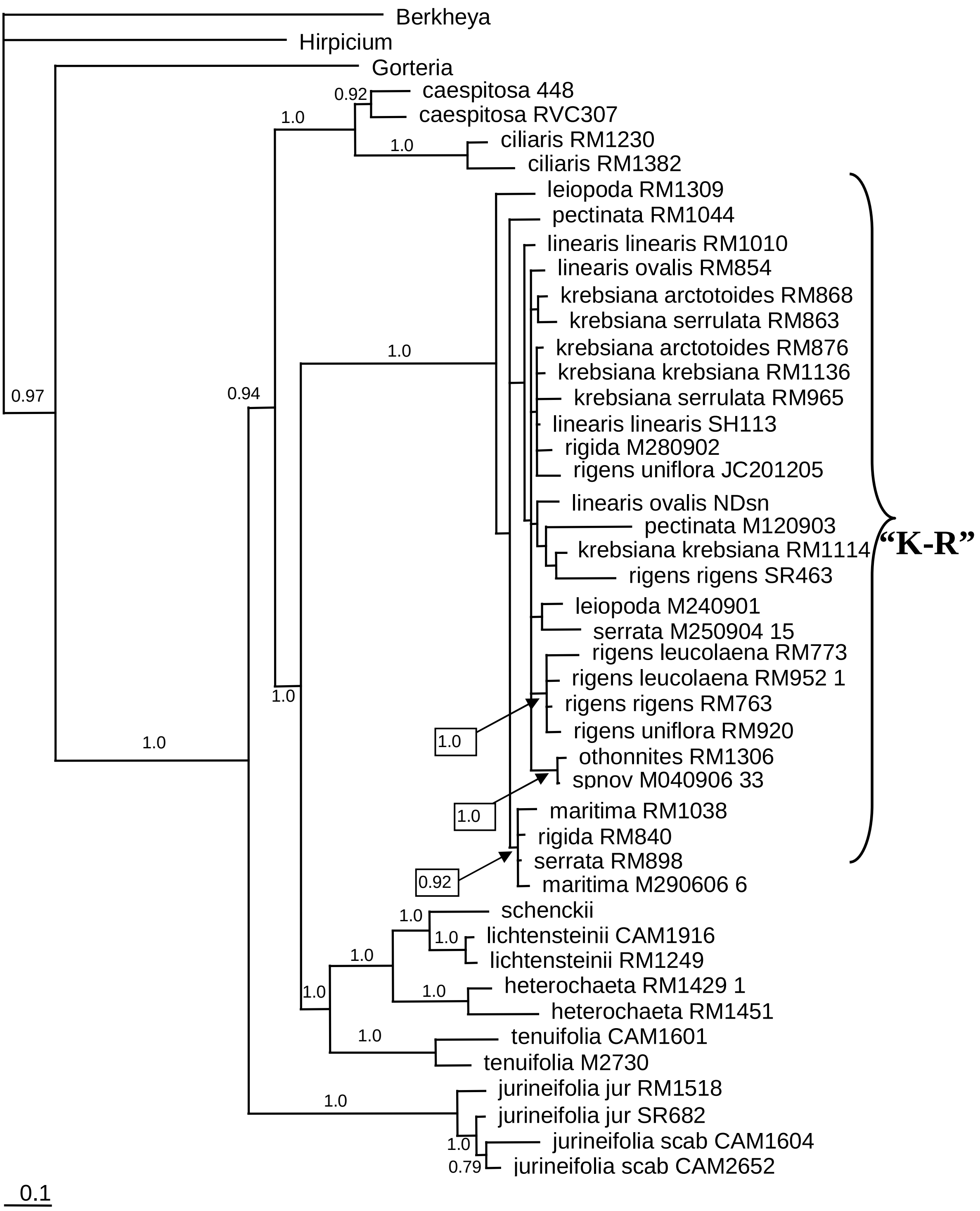
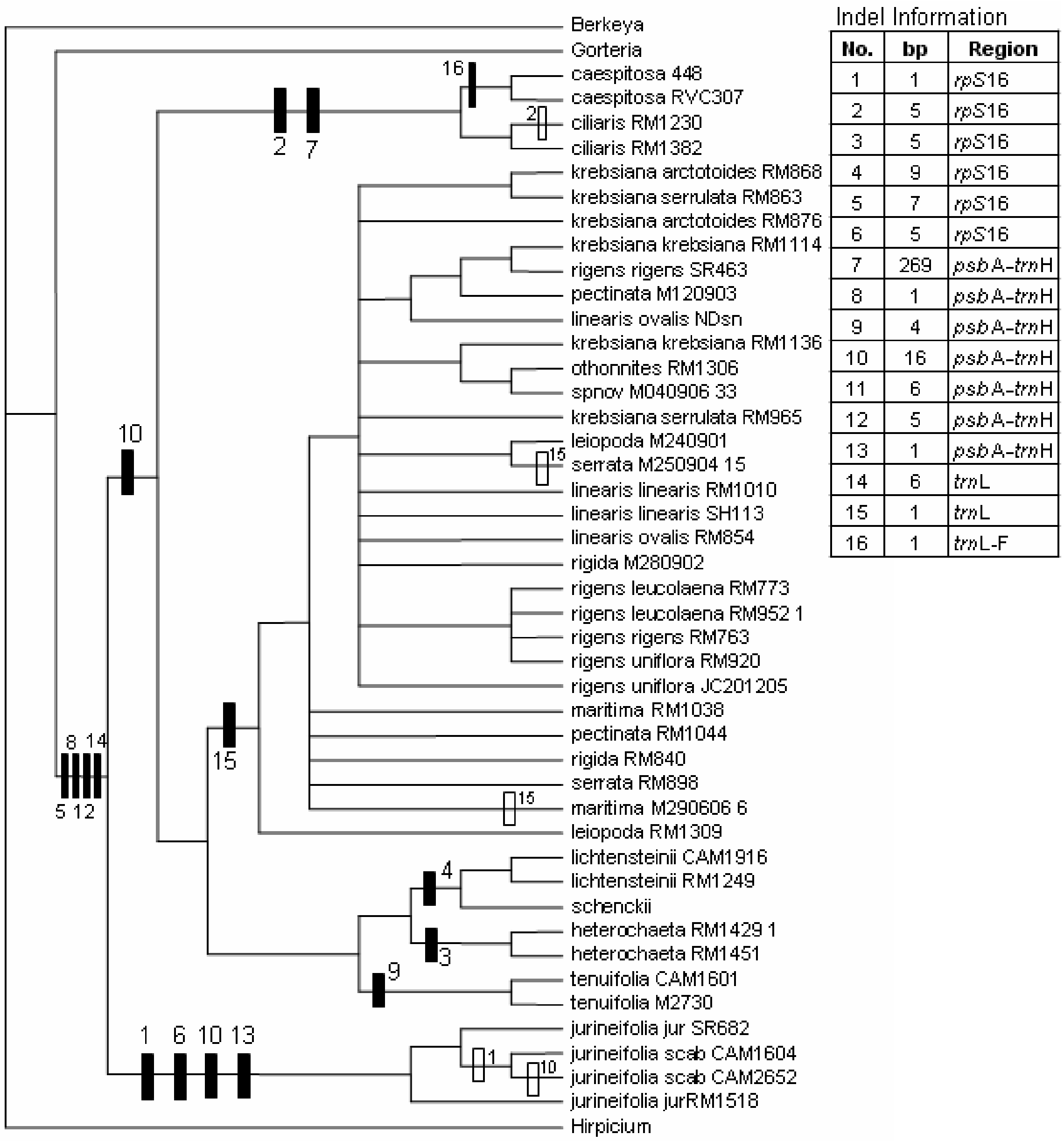


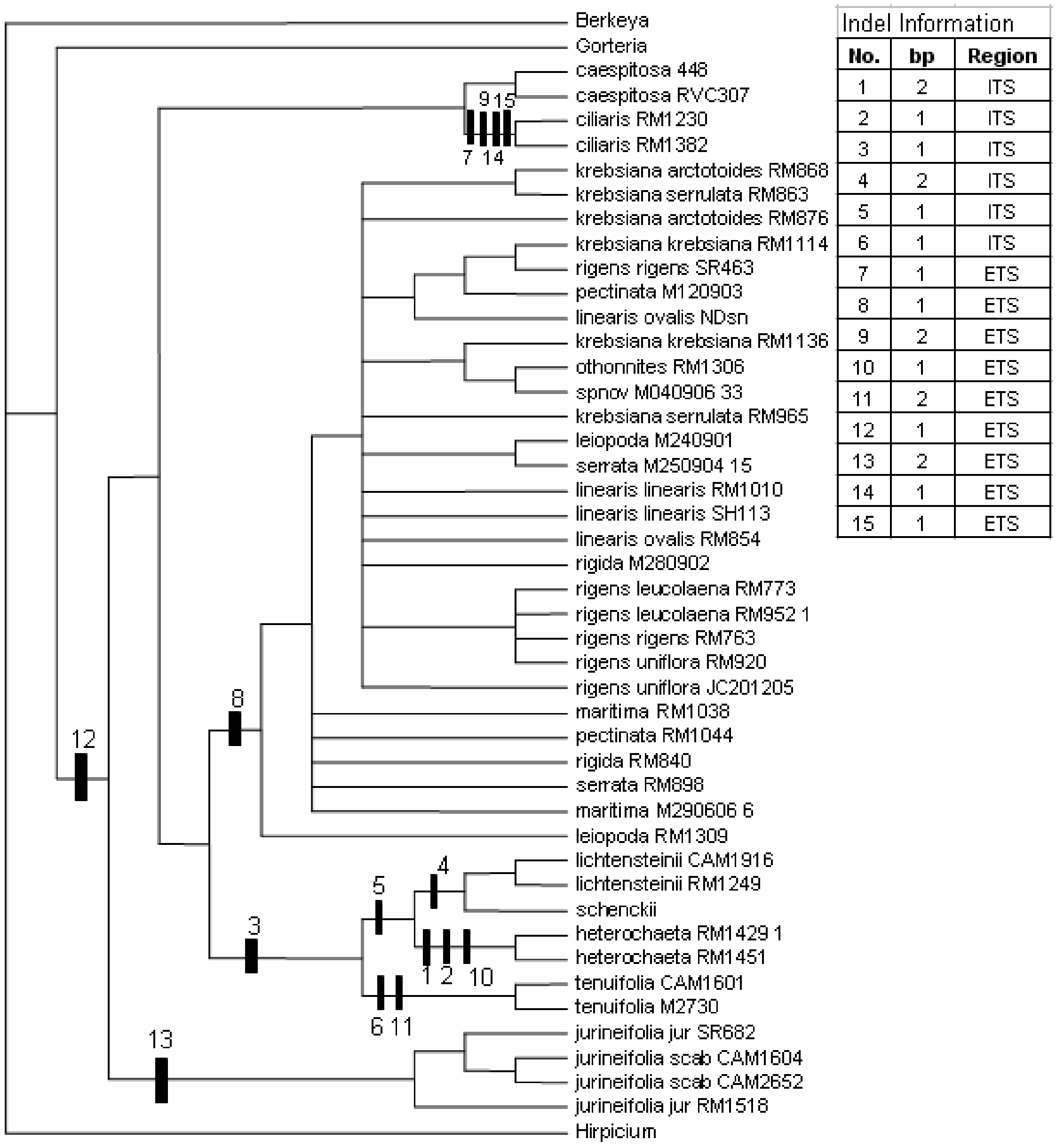
Figure 3.3.6: CombinedDNA Bayesian consensus tree. Posterior probabilities indicated on branches.



Indel Information

No.	bp	Region
1	1	*rpS*16
2	5	*rpS*16
3	5	*rpS*16
4	9	*rpS*16
5	7	*rpS*16
6	5	*rpS*16
7	269	*psb*A-*trn*H
8	1	*psb*A-*trn*H
9	4	*psb*A-*trn*H
10	16	*psb*A-*trn*H
11	6	*psb*A-*trn*H
12	5	*psb*A-*trn*H
13	1	*psb*A-*trn*H
14	6	*trn*L
15	1	*trn*L
16	1	*trn*L-F

Figure 3.3.7: Combined DNA strict consensus tree. Black bars indicate synapomorphic gaps in cpDNA data, white bars indicate state reversals.



Indel Information

No.	bp	Region
1	2	ITS
2	1	ITS
3	1	ITS
4	2	ITS
5	1	ITS
6	1	ITS
7	1	ETS
8	1	ETS
9	2	ETS
10	1	ETS
11	2	ETS
12	1	ETS
13	2	ETS
14	1	ETS
15	1	ETS

Figure 3.3.8: Combined DNA strict consensus tree. Black bars indicate synapomorphic gaps in nrDNA data.

Gene trees vs species trees

Doyle (1992) notes that while molecular phylogenies are now an accepted part of systematics, it often seems forgotten that the terminal taxa of a DNA phylogenetic reconstruction are genes, not necessarily species. No matter how well resolved and strongly supported a DNA phylogeny is, it can only be a hypothesis of relationships among the plants bearing these genes (Doyle, 1992). Wendel & Doyle

(1998) likewise note that with the proliferation of molecular tools has come a growing awareness that reliance on a single data set may often result in insufficient phylogenetic resolution, or misleading inferences. In accordance with this, they note, it has become increasingly widespread practice to apply multiple data sets to a common group of taxa.

One should exercise caution in estimation of species trees from gene trees, as while species trees may be “estimated” from gene trees, but the two are not synonymous (Doyle, 1992). Reliance on a single gene can result in a lack of resolution, misleading conclusions or both (Reeves *et al.*, 2001). Ideally, multiple regions from multiple genomes should be utilised. The three different genomes present in plants have different inheritance patterns. In angiosperms organellar markers are inherited maternally (usually) and transmitted by seed, while nuclear markers are inherited biparentally, through both pollen and seed (Albach & Chase, 2004). This differing pattern of inheritance allows for different aspects of the phylogenetic history of an organism to be investigated: the chloroplast genome tracks maternal inheritance patterns while the nuclear genome tracks population level processes of gene flow and hybridization.

The use of two different sources of sequence data lends stronger support to the species that are resolved. Likewise the presence of the same unresolved species in both phylogenies reaffirms the taxonomic uncertainty that surrounds these “species”.

Polyploidy

The possibility that polyploidy could have a confounding effect on phylogeny reconstruction (especially that of multicopy nrDNA) must also be considered. There is relatively little published information available on the chromosome numbers in *Gazania*. Mehra & Remananandan (1969) provide a count of x=8 for *Gazania krebsiana*, while Nordenstam (1967) provides x=10 for the same species. An initial attempt by the author to obtain a chromosome count for *Gazania rigens* resulted in a count of x=9. The Arctoteae are usually x=9 (Carr *et al*., 1999), so this seems the most likely count for *Gazania* as well. While at least two species in the K-R complex do not show polyploidy, but this does not rule out polyploidy in other species of *Gazania*. Further research needs to be conducted in this regard.

Caveats

Given the possibility that ITS and ETS may suffer from reticulation (being a non-hierarchically inherited gene system, as opposed to maternally inherited cpDNA), the phylogeny presented here may perhaps be interpreted with some caution. The presence of several instances of ambiguous base calls likewise suggests that reticulation and paralogy should be considered as having some effect on the phylogeny.

Conclusions

The nrDNA sequence data examined here reveals that there are seven clearly genetically distinct phylogenetic species in *Gazania*, some of which also show correlation with morphologically distinct species clades from Chapter 2. These are: *G. lichtensteinii*, *G. heterochaeta*, *G. schenckii*, *G. tenuifolia*, *G. jurineifolia*, *G. ciliaris* and *G. caespitosa*. There is some partial genetic cohesion for some *G. rigens* samples and none at all for *G. linearis* subsp *ovalis* (both of these showed strong morphometric distinction in Chapter 2). However, the cpDNA sequence data examined here only supports four of these distinct taxa (*G. jurineifolia*, *G. tenuifolia*, *G. ciliaris*, and *G. caespitosa*). This lack of support in the cpDNA does not, however, contradict the distinction of taxa in the nrDNA data set.

Despite the use of a substantial combined nuclear and chloroplast DNA data set, further resolution of species taxa could not be achieved. For the remaining nine unresolved “species” in the K-R clade, there is no clear correlation between morpho-species designation and phylogeny (or partial correlation as seen in *G. rigens*). The lack of genetic resolution for eight of the nine species (seven of which also showed an absence of morphometric separation in Chapter 2) casts further doubt on the validity of Roessler’s species delimitations for these taxonomic entities.

It should be noted that there are occasions where genetic data may not reflect clear morphological separations. In such cases, other methods (e.g. RFLP, microsatellites) can prove more informative (e.g. *Scalesia affinis*; Nielsen, 2004). This may certainly prove useful in *Gazania*, and is recommended as a future project.

As Roessler noted, for some species the geographical origin is important in species determination. The possibility that the groupings in the K-R clade may be dictated by geographical origin, rather than species designation, should be investigated. The use of phylogeographical methods is an appropriate tool for this, and may also elucidate the evolutionary history and origin and (potentially rapid and recent) diversification of the species within the genus *Gazania*.

Chapter 4.
Phylogeography of *Gazania*

> "Between the remaining taxa, such close relationships and overlaps of characteristics exist that a clear separation becomes impossible. So only the observation that certain feature combinations arise especially frequently and are concentrated geographically in certain regions provides clues for a classification." (Roessler, 1959, pp 100, translated from the original German).

Aim: To undertake a phylogeographic study of the genetic entities within *Gazania*.

Introduction

Apart from organisms with very short generation times, there is rarely an opportunity to observe the process of evolution directly, to track changes in diverging lineages as they become distinct (Harrison, 2001). To gain insights into change over time, evolutionary biologists attempt to infer historical events and processes from current patterns of genetic variation (Harrison, 2001). Phylogenies provide an estimate of the sequence of events leading to present-day patterns of species-richness and so provide indispensable information towards understanding the processes operating towards the evolution of diversity (Barraclough *et al.*, 1998). Relatively new techniques (such as phylogeography) enable geography and biology to develop more synergistically, whereby patterns revealed by one discipline can be used as a hypothesis for testing by the other (Wallis & Trewick, 1998).

Phylogeography has a number of differently worded definitions, but all of them rely on two sources of data: a phylogeny and the geographical origins or distributions of the terminal taxa in that phylogeny. Phylogeography is defined by Bermingham & Moritz (1998) as an investigation of the fundamental links between population processes and regional patterns of diversity and biogeography. Avise (2000) defined phylogeography as being concerned with principles and processes governing the geographical distribution of genealogical lineages, but adds an additional note that this is especially true at the intraspecific level. This investigation into *Gazania* is not using phylogeography in the strictest sense of population level studies, but rather in the broader sense of correlation between phylogeny and geography.

Arbogast & Kenagy (2001) indicate that the goal of phylogeography renders it a subdiscipline of biogeography, in which the primary units of analysis are monophyletic groups that are inferred from phylogenetic analyses. Although this typically entails the use of one or more molecular markers when intraspecific population phylogeny is being examined, in principle, any set of phylogenetically informative characters could be used (Arbogast & Kenagy, 2001).

Phylogeography, as an analytical method, explicitly integrates micro-evolution and macro-evolution, relates ecology to evolution, current distributions to historical events, the physical environment to genetic structure, and patterns of variation within species to patterns of variation across species (Avise, 2000). This analysis relies on interpreting patterns of congruence (or lack of congruence) between the geographical distribution of haplotypes and their genealogical relationships (Schaal *et al.*, 1998).

Besides phylogeography's strength in testing for explicit evolutionary relationships between geographical areas occupied by phylogenetically related taxa, a phylogeographic approach traces the history of genealogic lineages (Dobeš *et al.,* 2004). Like Avise (2000), Dobeš *et al.* (2004) also emphasize a species level focus, noting that the advantage mentioned in the previous sentence may be of special importance at the junction of the intra- and interspecific level, where partially divergent lines may occur sympatrically. Phylogeography provides a framework to explain and integrate these patterns of biodiversity at infra- and supra-specific levels (Dawson, 2005), as well as investigating a wide range of other issues related to biogeography, including the relative roles of gene flow, bottlenecks, population expansion, and vicariant events in shaping geographical patterns of genetic variation (Arbogast & Kenagy, 2001).

In the last 20 years, phylogeographic research has added considerable insight into the effects of history on species distributions and diversification patterns (Ayoub & Riechert, 2004). Phylogeography has also been used to trace the origins and invasive histories of invasive species (Provan *et al.*, 2005; Shoemaker *et al.*, 2006). In many cases, phylogeographic analyses have revealed cryptic and deeply divergent evolutionary lineages that are not reflected in the current taxonomy, and nominal species have been found to be poly- or paraphyletic (see Arbogast & Kenagy, 2001, for list of examples).

<u>Sources of genetic data</u>

Geographical interpretation of current patterns of genetic variation can reveal the signature of historical events, but the ongoing influence of natural selection, gene flow, and genetic drift can erase those signatures, reflecting the current balance of evolutionary forces rather than the consequences of historical events (Harrison, 2001). While organellar DNA is theoretically ideal for studying phylogeographic patterns (Heuertz *et al.*, 2004), at very low levels of the taxonomic hierarchy, where insufficient time has elapsed for variation to accumulate in the slowly evolving chloroplast genome, a more rapidly evolving source of data must be utilized (with relevant caveats and cautions noted; Harrison, 2001).

Harrison (2001) notes some of the "biological hurdles" associated with using diploid nuclear markers, including the larger effective population size (four times that of organellar DNA). One can also expect random lineage extinction to be slower and ancestral polymorphisms to persist longer, meaning potentially less concordance among nuclear gene genealogies and less correspondence with the "real" population history (Harrison, 2001). Harrison (2001) also notes that nuclear gene genealogies will inevitably inform one's understanding of recent population history, as they trace independent pathways of descent for multiple gene regions (and any discordance between species or population designation and nuclear gene history will in itself tell the researcher something about the population history). Different regions of the genome will therefore provide different windows on recent evolutionary history (Harrison, 2001). Heuertz *et al.* (2004) claim that chloroplast DNA is a useful tool for the identification of recent post-glacial colonization routes, as colonization patterns which derive from seed dispersal are not blurred by pollen flow.

Application of phylogeographic methods to *Gazania*

The previous two chapters have shown that Roessler’s species in *Gazania* can be divided into seven clades that show clear species groupings (some both morphologically and genetically) and nine that show little cohesion using either criterion. The phylogeography of both sets of species will be investigated, both as a means to investigate more recent and ongoing evolutionary, but also as a means to investigate the past evolutionary history of the group.

Phylogeographic analysis is an ideal tool to investigate the nine problematic *Gazania* species that fall into the K-R clade found in species-level analysis (Chapter 3). In *Gazania*, where little resolution exists in the slowly evolving cpDNA data, the faster evolving nrDNA data may provide clearer phylogenetic signal. A greater sampling of the nine species that fell into the large unresolved K-R clade collected from across South Africa is necessary to investigate any phylogeographical signal that may be present, and to infer possible evolutionary or ecological processes from the recent past. In addition, two samples from a potentially new species of *Gazania* (*G. sp. nov.)* are included in the analysis. The putative new species shares some characters (e.g. glaucous leaves, and a slight succulence to the leaves, stem and involucre) with a species recognised by Roessler: *G. othonnites*.

In Chapter 3 it became evident that cpDNA was not variable enough to provide much phylogenetic signal. For this reason, nrDNA sequence data (from both ITS and ETS) were utilized to assemble a much larger data set to better investigate the phylogeographic signal within the various taxonomic entities in *Gazania*.

Methods

Sampling

DNA was taken from 24 samples of the seven genetically discrete clades, and 145 samples of species that fall within the K-R clade, including those initially used for the species-level phylogeny (see Table 4.2.1 for details). These samples were selected not only to cover as wide a distribution range as possible, but also to investigate the validity of the morphologically delimited species of Roessler. Two datasets were defined: one of all the samples (using *Berkheya* and *Gorteria* samples as the rooting outgroup), and a second subset of the samples from the K-R clade (using *G. ciliaris* and *G. caespitosa* samples as the rooting outgroup). Additional sequences not already presented for the Chapter 3 phylogeny in Appendix 3 are presented in Appendix 6.

These samples were amplified and sequenced for both ITS and ETS, using the methods as outlined in Chapter 3. Due to the low resolution of the unresolved K-R clade taxa seen in the results obtained by Parsimony analysis, other methods have to be utilized. Therefore, Bayesian and Neighbor-Joining analysis are used, as well as additional Neighbor-Net analysis for the K-R clade. Neighbor-Joining was utilized in this study due to its sensitivity to low levels of nucleotide variation. The Neighbor-Net analysis produces a reticulating network, rather than a bifurcating tree. Unfortunately, many of the software packages developed for phylogeographic studies cannot handle data with ambiguity coding. Settings for Bayesian analysis are identical to those given in Chapter 3. Details of the Neighbor-Joining and Neighbor-Net methods are given below.

Neighbor-Joining

Neighbor-Joining (NJ) is a distance method, which converts the aligned sequences into a distance matrix of pairwise differences (distances) between the sequences. The Neighbor-Joining method is both fast and accurate (Bryant & Moulton, 2004). MrModelTest (Nylander, 2004) was used to identify the model of DNA substitution that best fit the data. PAUP* was used to conduct Neighbor-Joining analyses. Missing data was ignored for pairwise comparisons, and negative branch lengths were set to zero. Bootstrap support values were calculated from 1000 replicates, and shown on the NJ tree.

Neighbor-Net analysis

The ability to represent reticulating relationships (especially at the species-level) becomes a problem that requires methods other than bifurcating trees (Vriesendorp & Bakker, 2005). There are a range of methods and software for network estimation that can handle reticulations and multifurcations, but these methods have not been used frequently in published studies of angiosperm species phylogenies

(Vriesendorp & Bakker, 2005). These methods are often designed to be used with organellar data (e.g. the TCS software package), and thus cannot handle ambiguity coding (as utilised in the nrDNA data for this study). The use of networks, rather than simple branching trees, is necessary when the underlying evolutionary history is not treelike and confused by phenomena such as recombination, hybridization, gene conversion and gene transfer (Bryant & Moulton, 2004). Networks can uncover data ambiguity in a way that consensus trees cannot, providing new insights in the analysis of data structure (Vriesendorp & Bakker, 2005).

The Neighbor-Net algorithm is an extension of the Neighbor-Joining method, using similar selection and reduction formulae, but Neighbor-Net can additionally represent conflicting signals in the data, which NJ bifurcating trees cannot (Bryant & Moulton, 2004). These networks do not restrict the data to a rigid hierarchical single-line tree structure, but allow for the identification and visualisation of character conflicts within the data (Hollingsworth *et al.*, 1998), as contradictory signals are represented by box-like parts of the graph, whereas portions of the graph with little conflict appear more tree-like (Kennedy *et al.*, 2005). Neighbor-Nets are often more resolved than split-decomposition networks, especially when the number of taxa is large, as they do not show a tendency to become star-like as more taxa are added (Kennedy *et al.*, 2005). For this reason, a Neighbor-Net analysis was conducted on the unresolved K-R clade using the software SPLITSTREE v4 (Huson & Bryant, 2005), using the Neighbor-Net method (Bryant & Moulton, 2004). Outgroups were excluded from this analysis.

Distribution maps

The geographical origin of each clade (or subclade for the K-R clade) in the NJ and Bayesian trees were plotted onto maps of Southern Africa in an attempt to elucidate any phylogeographic patterns.

Morphometric comparison

A cluster analysis comprising samples of species occurring only in the K-R clade was undertaken. This was utilized to compare genetic clades with morphological clusters to determine if there is any correlation between morphometric characters and gene flow patterns. All CA settings are as per Chapter 2. The comparison between pairwise genetic distance and pairwise morphometric distance for all pairs of samples in each data set can illustrate the level of agreement between genetic signal and morphological signal. The genetic distances were taken from the uncorrected distances as output by PAUP*, the morphometric distances were taken from the distance matrix as output by the SIMINT function in NTSYS-pc. These were then plotted pair by pair on a scatterplot and the correlation between the two was analysed in STATISTICA 6.1 (StatSoft, Inc).

Table 4.2.1: List of all samples used in DNA species-level phylogeny, including collection locality data

Sample no	Spp	Subspp	Locality	South	East
Genetically discrete samples					
CAM1916	lichtensteinii		Namibia. Lüderitz: Glockenberg West.	26° 22' 30"	15° 52' 30"
RM1323	lichtensteinii		South Africa. Kamiesberg: roadside, 40km northeast of Kamieskroon	30° 07' 44"	18° 13' 40"
M050906_2	lichtensteinii		South Africa. Vanrhynsdorp: Knersvlakte, Bitterfontein, road to Kilrand.	31° 12' 55"	18° 32' 26"
RM1249	lichtensteinii		South Africa. Wuppertal: beside R355 road near Tankwa Karoo National Park,	32° 10' 30"	19° 42' 47"
CAM2727	schenckii		Namibia. Luderitz: Griffith bay area, in kloofs between rocky gneiss ridges	26° 40' 12"	15° 08' 00"
M160901_5g	heterochaeta		South Africa. Gamoep: Springbok, Goegap Nat Res, 4x4 tracks N of reserve headquarters.	29° 39' 33"	18° 00' 29"
RM1348	heterochaeta		South Africa. Springbok: Roadside, 80km east of Port Nolloth	29° 14' 57"	17° 40' 33"
RM1451	heterochaeta		South Africa. Springbok: 5km N Steinkopf, beside N7 highway	29° 14' 04"	17° 45' 20"
RM1429_1	heterochaeta		South Africa. Steytlerville: T2 road from Steytlerville to Grootrivierpoort; 5km N of turnoff to Rietfontein;	33° 22' 30"	24° 22' 30"
RM1255	heterochaeta		South Africa. Worcester: beside R355, North of Karoopoort.	33° 09' 41"	19° 45' 03"
CAM1601	tenuifolia		Namibia. Witputz: Arras	27° 22' 30"	16° 07' 30"
M7219_10	tenuifolia		South Africa. Gamoep: Springbok, Goegap Nat. Res., SE of Carolusberg, 4x4 route N of reserve headquarters	29° 39' 23"	18° 00' 32"
M7230_2	tenuifolia		South Africa, Springbok: Goegap Nature Reserve, Bleshoek	29° 41' 31"	17° 58' 46"
RM1352	tenuifolia		South Africa. Springbok: 40km east of Port Nolloth	29° 17' 56"	17° 12' 21"
RM1230	ciliaris		South Africa. Cape Town: Paarlberg.	33° 45' 08"	18° 57' 05"
RM1382	ciliaris		South Africa. Clan William: Piketberg plateau	32° 48' 41"	18° 42' 40"
SR705	ciliaris		South Africa. Peddie: Fish River, near Port Alfred. Seven seas.	33° 28' 58"	27° 04' 48"
RVC307	caespitosa		South Africa. Graaff-Reinet: Koudeveldberge, summit	32° 7' 30"	24° 07' 30"
RVC448	caespitosa		South Africa. Somerset East: Koudeberg, summit, Groot Vallei Farm.	32° 19' 50"	25° 00' 23"
SR682	jurineifolia	jurineifolia	South Africa. Gamoep: 18km W of Aggeneys (between Springbok & Pofadder)	29° 22' 46"	18° 38' 53"
RM1518	jurineifolia	jurineifolia	South Africa. Steynsburg: Eastern Cape: Conway, Alberta Farm.	31° 40'	25° 15'
CAM2652	jurineifolia	scabra	Namibia. Aus: In road verge on road between Aus and Rosh Pinah, in red sand	26° 45' 41"	16° 17' 21"
CAM1604	jurineifolia	scabra	Namibia. Witputz: Karas	27° 22' 30"	16° 7' 30"
CAM1953	jurineifolia	scabra	Namibia. Aus: Klein Aus Vista.	26° 37'	16° 22'
K-R clade samples					
Boknes1	rigens	uniflora	South Africa. Grahamstown: Boknes river mouth	33° 43'	26° 35'
Boknes2	linearis	linearis	South Africa.Grahamstown: Boknes river mouth	33° 43'	26° 35'

JC201205	rigens	uniflora	South Africa. Port St Johns: Lupatana, Pondoland, dunes between rocks and bush.	31° 30'	29° 30'
M040906_33	sp nov?		South Africa. Hondeklipbaai: Namaqualand, Hondeklipbaai, coast at the police station.	30° 19' 22"	17° 16' 21"
M041001_2G	linearis	ovalis	South Africa. Grahamstown: Thornycroft at road between Alexandria and Port Elizabeth	33° 36' 42"	26° 01' 43"
M070704_1	rigens	leucolaena	South Africa. Simonstown: Miller's Point. 3m. granite (Cape Suite) coastal rocks; influence of salt spray	34° 13' 58"	18° 28' 32"
M071001_1g	krebsiana	krebsiana	South Africa. Port Elizabeth: Coega salt works, edge of succulent thicket, salty loamy soil.	33° 46' 35"	25° 40' 05"
M071001_3GL	krebsiana	krebsiana	South Africa. Queenstown: Stormberg Plateau, Penhoek Pass, rest place at road 3km North of the pass.	31° 25' 33"	26° 41' 29"
M071001_3GP	krebsiana	arctotoides	South Africa. Queenstown: Stormberg Plateau, Penhoek Pass, rest place at road 3km North of the pass.	31° 25' 33"	26° 41' 29"
M100903_4	rigida		South Africa. Cape Town: Darling, Tienie Versveld Flower Reserve.	33° 20' 07"	18° 16' 16"
M100904_4	rigida		South Africa. Beaufort West: Uniondale, bridge over Keurboomsrivier, gravel road bank.	33° 45' 39"	22° 57' 44"
M110805_10	rigida		South Africa. Bredasdorp: De Hoop Nature Reserve, Potberg, Melkosheuwel in the Potteberg River Valley.	34° 22' 50"	20° 29' 16"
M120805_80	rigida		South Africa. Sutherland: De Hoop Nature Reserve, Potberg, NE of the Potberg entrance.	34° 22' 10"	20° 31' 32"
M120903_5	pectinata		South Africa. Clanwilliam: Piketberg, Sauer, near turnoff to Uitvlug. Edge of salt pan.	32° 50' 17"	18° 33' 14"
M160704_5	leiopoda		South Africa. Hondeklipbaai: Namaqualand, Kamieskroon, on N7 40.1 km (near turnoff to Soebatsfontein).	30° 14' 15"	17° 53' 43"
M180904_5	pectinata		South Africa. Bredasdorp: De Hoop Nat Res., Kopie Alleen, disturbed edge of coastal sandy fynbos.	34° 28 ' 41"	20° 30' 39"
M210902_1	krebsiana	krebsiana	South Africa. Fort Beaufort: N of Fort Brown, road to Fort Beaufort, road verge.	32° 55' 43"	26° 37' 28"
M230803_8	krebsiana	krebsiana	South Africa. Port Shepstone: Umtamvuna Nature Reserve, Beacon hill. Sourveld grassland.	30° 48'	30° 11'
M230901_7G	serrata		South Africa. Vanrhynsdorp: Knersvlakte, Vanrhynsdorp, Quaggaskop Farm. Quartzite patch.	31° 24' 46"	18° 38' 33"
M250901_34	leiopoda		South Africa. Vanrhynsdorp: road from Vredendal to Strandfontein, near turnoff to Papendorp.	31° 42' 06"	18° 13' 32"
M250901_37	pectinata		South Africa. Vanrhynsdorp: Strandfontein, on road to Dooringbaai, 60m, disturbed road verge.	31° 45' 18"	18° 14' 02"
M250904_15	serrata		South Africa. Simonstown: Helderberg, strand. R44 btwn Nautilus and Octopus streets,	34° 08' 31"	18° 51' 06"
M260901_2G	pectinata		South Africa. Clanwilliam: Cederberg, Pakhuis pass, 720m.	32° 08' 11"	18° 58' 15"
M260901_5G	maritima		South Africa. Simonstown: Cape Peninsula, Cape of Good Hope.	34° 20' 46"	18° 27' 47"
M261001_2	krebsiana	krebsiana	South Africa. Queenstown: Stormberg, Penhoek Pass, road rest site.	31° 15' 34"	26° 44' 51"
M270901_5G	maritima		South Africa. Simonstown: Cape of Good Hope Nat Res. Neptune's Diary. Sandy beach.	34° 20' 46"	18° 27' 47"
M280902_9	rigida		South Africa. Oudtshoorn: Oudtshoorn, turn off to Zebra, succulent karoo, edge of dirt road.	33° 45' 45"	22° 20' 07"
M290606_6	maritima		South Africa. Simonstown: Cape peninsula, Simonstown, Table mountain national park, Diaz Beach.	34° 21' 12"	18° 28' 54"
M7293_1	rigens	rigens	South Africa. Humansdorp: Jeffereys Bay, beach south of Kabejouws River mouth, coastal dune.	34° 00' 53"	24° 55' 42"
M7298_2	rigens	rigens	South Africa. Humansdorp: St Francis Bay, near bridge over Kromme river, middle tidal salt marsh.	34° 08' 15"	24° 48' 28"
M7527_2	rigens	rigens	South Africa. Riversdale: Gouritzmond, coast, near parking lot, leeward slope of coastal sandy dune.	34° 21' 01"	21° 53' 00"
MSG200901_22G	leiopoda		South Africa. Hondeklipbaai: Kamieskroon, Arakop Farm.	30° 05' 31"	17° 54' 33"
MSG240901_19	leiopoda		South Africa. Calvinia: Nieuwoudtville, near turnoff to Rondekop.	31° 23' 23"	19° 11' 00"

MSG7237_4	sp nov?		South Africa. Port Nolloth: South of McDougalls Bay.	29° 17' 39"	16° 52' 45"
NB_Hermanus	serrata		South Africa. Caledon: Hermanus, roadside grassland.	34° 25'	19° 08'
ND_Havens	linearis	ovalis	South Africa. Butterworth: The Haven, Transkei.	32° 14'	28° 54'
NPB 1465	krebsiana	krebsiana	South Africa. Steytlerville: Graaff Rienet. Farm Welgemoed. Lower slopes of track to Nardousberg plateaux.	32° 47'	24° 32'
RM 1010	linearis	linearis	South Africa. Calvinia: Mzimpunzi river mouth, Pondoland, grassland.	31° 19'	29° 56'
RM 1013	linearis	linearis	South Africa. Port St Johns: North of Mbotyi river mouth.	31° 26'	29° 43'
RM 1021	rigens	leucolaena	South Africa. Bredasdorp: Plettenberg Bay, Keurboomstrand. Seabeach rocks.	34° 00' 16"	20° 27' 19"
RM 1038	maritima		South Africa. Bredasdorp: Cape Agulhas, about 2km E of actual cape, in sand on shoreline.	34° 48' 48"	20° 02' 48"
RM 1044_1	pectinata		South Africa. Caledon: Agulhas peninsula, Bredasdorpberge. In young fynbos in ex pine plantation.	34° 29' 47"	19° 53' 39"
RM 1044_3	pectinata		South Africa. Caledon: Agulhas peninsula, Bredasdorpberge. In young fynbos in ex pine plantation.	34° 29' 47"	19° 53' 39"
RM 1061	garden hybrid?		South Africa. Capetown: Clanwilliam. Possible garden escape growing wild and profusely.	32° 11' 45"	18° 54' 32"
RM 1063	leiopoda		South Africa. Vanrynsdorp: SW of Lutzville on R362 road between Papendorp and Lutzville.	31° 33'	18° 21'
RM 1082	rigida		South Africa. Tshane: Karenterivierdam.	34° 00' 19"	21° 09' 30"
RM 1090	linearis	linearis	South Africa. Port St Johns: 25km W of Coffee Bay on road to village, roadside grassland.	31° 58'	29° 08'
RM 1092	linearis	linearis	South Africa. Port St Johns: Coffee Bay, Bumvu river mouth, grassland, E-facing slope.	31° 58'	29° 09'
RM 1094	linearis	linearis	South Africa. Port St Johns: W of Port St Johns, beside R61 road; at lookout point for Execution Rock.	31° 36'	29° 30'
RM 1103	linearis	linearis	South Africa. Port Edward: Mkambati Nature Reserve, N of the Msikaba River Mouth, grassland.	31° 01' 24"	30° 13' 48"
RM 1114	krebsiana	krebsiana	South Africa. Fort Beaufort: Road to Bedford, R350.	32° 41'	26° 05'
RM 1136	krebsiana	krebsiana	South Africa. Colesberg: W of Venterstad, 2km E of Gelykfontein stnd farm beside R58 road.	30° 47'	25° 47'
RM 1137	krebsiana	serrulata	South Africa. Bloemfontein: Bayswater area, junction of N1 + R400 roads.	29° 10'	26° 13'
RM 1182	linearis	linearis	South Africa. Humansdorp: on N2, Seekoei river.	34° 02'	24° 46'
RM 1210	rigida		South Africa. Bredasdorp: 14.5km North of Bredasdorp on R319 road.	34° 25' 50"	20° 07' 22"
RM 1216	serrata		South Africa. Caledon: 1km SW of Caledon on R320 road.	34° 16' 24"	19° 26' 09"
RM 1241	serrata		South Africa. Worcester: Du Toits Kloof Pass.	33° 41' 50"	19° 04' 06"
RM 1245	serrata		South Africa. Worcester: Skurweberg.	33° 14' 11"	19° 17' 42"
RM 1254	rigida		South Africa. Wuppertal: base of Katbakkies Pass, Swartruggens.	32° 52' 58"	19° 44' 27"
RM 1260	serrata		South Africa. Worcester: Calvinia.	33° 30' 21"	19° 44' 23"
RM 1270	rigida		South Africa. Wuppertal: North of base of Pakhuis Pass.	32° 3' 37"	19° 10' 10"
RM 1280	serrata		South Africa. Calvinia: 5km East of Nieuwoudtville.	31° 23'	19° 06'
RM 1291	leiopoda		South Africa. Hondeklipbaai: roadside.	30° 18' 37"	17° 53' 37"

RM 1306	othonnites		South Africa. Springbok: Kleinzee, Molyneux trail.	29° 42'	17° 04'
RM 1309	leiopoda		South Africa. Kamiesberg: roadside.	30° 24' 38"	18° 03' 09"
RM 1320	leiopoda		South Africa. Hondeklipbaai: Kamiesberg, 1070m	30° 11' 16"	17° 59' 21"
RM 1390	pectinata		South Africa. Caledon: Franschoek Pass, summit of pass.	33° 54' 27"	19° 09' 19"
RM 713	krebsiana	krebsiana	South Africa. Port Elizabeth: Coega.	33° 46'	25° 40'
RM 763	rigens	rigens	South Africa. Grahamstown: Kasouga Beach.	33° 39'	26° 22'
RM 770	krebsiana	arctotoides	South Africa. Willowmore: Prince Alfred's Pass.	33° 45'	23° 08'
RM 772	rigens	rigens	South Africa. Knysna: Plettenberg Bay.	34° 02'	23° 22'
RM 773	rigens	leucolaena	South Africa. Knysna: Plettenberg Bay.	34° 02'	23° 22'
RM 780	linearis	linearis	South Africa. Fort Beaufort: between East London and Cintsa turnoff on N2 highway.	32° 53'	28° 04'
RM 782	rigens	uniflora	South Africa. Port St Johns: Second Beach.	31° 37'	29° 32'
RM 783	rigens	uniflora	South Africa. Port St Johns: Third Beach.	31° 37'	29° 32'
RM 785	rigens	uniflora	South Africa. Umtata: Transkei, Misty Mount.	31° 34'	28° 55'
RM 787	linearis	linearis	South Africa. Umtata: between Umtata and Umlambo Mputi on N2 highway.	31° 59'	28° 40'
RM 789	linearis	linearis	South Africa. Umtata: between Umtata and Umlambo Mputi on N2 highway.	31° 35'	28° 47'
RM 794	linearis	linearis	South Africa. Stutterheim: south of King William's Town on N2 highway.	32° 52'	27° 23'
RM 804	krebsiana	krebsiana	South Africa. Grahamstown: Riebeek East, 'Willowfontein' farm.	33° 12'	26° 09'
RM 812	serrata		South Africa. Worcester: Dassiehoek Nature Reserve.	33° 50'	19° 30'
RM 813	rigida		South Africa. Worcester: Dassiehoek Nature Reserve, track to Arangie's Kop.	33° 50'	19° 30'
RM 821	serrata		South Africa. Worcester: Robertson aerodrome.	33° 48'	19° 53'
RM 831	krebsiana	arctotoides	South Africa. Oudtshoorn: south of Oudtshoorn on N12 highway.	33° 35'	22° 11'
RM 840	rigida		South Africa. Caledon: south of Caledon.	34° 16'	19° 26'
RM 854	linearis	ovalis	South Africa. Grahamstown: north of Bathurst.	33° 29'	26° 49'
RM 856	krebsiana	krebsiana	South Africa. Willowmore: Bloukrans River.	33° 58'	23° 39'
RM 863	krebsiana	serrulata	South Africa. Olifantshoek: southeast of Beeshoek.	27° 45'	22° 37'
RM 868	krebsiana	arctotoides	South Africa. Kenhardt: Rooipan, southeast of Lime Acres.	29° 47'	21° 56'
RM 874	krebsiana	krebsiana	South Africa. Kimberley: SE of Kimberley on N8 highway.	28° 47'	24° 47'
RM 876	krebsiana	arctotoides	South Africa. Aliwal North: Bloemfontein.	30° 19'	26° 48'
RM 877	krebsiana	serrulata	South Africa. Aliwal North: north of Rouxville.	30° 25'	26° 49'
RM 884	linearis	linearis	South Africa. Fort Beaufort: Tor Doone, Hogsback.	32° 34'	26° 56'
RM 885	linearis	linearis	South Africa. Fort Beaufort: Tor Doone, Hogsback.	32° 34'	26° 56'
RM 888	krebsiana		South Africa. Peddie: north of Great Fish River, north of Kudu Lyndon Game Farm.	33° 29'	27° 07'

RM 898	serrata		South Africa. Worcester: Robertson on R60 road.	33° 48'	19° 53'
RM 900	rigida		South Africa. Grahamstown: between Uniondale and Willowmore	33° 14'	26° 37'
RM 903	krebsiana	arctotoides	South Africa. Graaff-Rienet: southwest of Aberdeen on N9 highway.	32° 31'	24° 00'
RM 904	krebsiana	arctotoides	South Africa. Graaff-Rienet: between Graaff-Reinet and Adendorp on R75 road.	32° 15'	24° 33'
RM 906	krebsiana	krebsiana	South Africa. Fort Beaufort: south of Bedford.	32° 41'	26° 05'
RM 919	rigens	leucolaena	South Africa. Grahamstown: SE of Cannon Rocks.	33° 44'	26° 33'
RM 920	rigens	uniflora	South Africa. Grahamstown: SE of Cannon Rocks.	33° 44'	26° 33'
RM 929	krebsiana	krebsiana	South Africa. Witbank: Middelburg, Agter-Renosterberg, between Uitsig hut and Welterede farmhouse in Transkaroo hiking trail.	25° 43'	29° 25'
RM 949	krebsiana	krebsiana	South Africa. Humansdorp: Eskom substation c. 500m north of N2 on R330 road to Hankey.	34° 08' 38"	24° 10' 41"
RM 950	krebsiana	krebsiana	South Africa. Humansdorp: NE of Humansdorp. 175m. on exposed ridge in Bobartia veld.	34° 01' 27"	24° 47' 24"
RM 951	linearis	linearis	South Africa. Humansdorp: St Francis bay beside R330 road, just before turnoff to St Francis Bay village.	34° 11'	24° 50'
RM 952	rigens	uniflora	South Africa. Humansdorp: Cape St Francis, in sandy and shelly substrate on rocky shoreline.	34° 11'	24° 50'
RM 960	krebsiana	krebsiana	South Africa. Fort Beaufort: SW of Seymour, junction of R67 and road to Katberg Pass.	32° 35'	26° 44'
RM 962	krebsiana	krebsiana	South Africa. Queenstown: NE of Queenstown on R359 road.	31° 49'	26° 55'
RM 965	krebsiana	serrulata	South Africa. Lady Frere: 13km SW Elliot on R56 road.	31° 19'	27° 57'
RM 966	krebsiana		South Africa. Lady Grey: Barkley Pass.	30° 57'	27° 36'
RM 968	krebsiana	krebsiana	South Africa. Matatiele: Carlisle's Hoek, beside road to Tiffindell Ski resort.	30° 40'	28° 03'
RM 992	krebsiana	krebsiana	South Africa. Lady Frere: Baster Voetpad. Near Elliot.	31° 19'	27° 57'
RM 996	krebsiana		South Africa. Lady Grey: W of Barkly East, top of road cutting on Wside of Kraairivier R58 road.	30° 57'	27° 35'
RM1403	krebsiana	krebsiana	South Africa. Hanover: Wapadsberg pass, at top of the bass beside R81 road.	31° 56'	24° 53'
RM1406_1	linearis	linearis	South Africa. Hanover: Compassberg, Compassberg farm, on flats at the base of the mountain.	31° 45'	24° 32'
RM1406_2	linearis	linearis	South Africa. Hanover: Compassberg, Compassberg farm, on flats at the base of the mountain.	31° 45'	24° 32'
RM1466	leiopoda		South Africa. Hondeklipbaai: Namakarroo National Park, W of Kamieskroon.	30° 05' 47"	17° 35' 03"
RMcolHerm	serrata		South Africa. Caledon: Hermanus.	34° 24'	19° 13'
RVC162	krebsiana		South Africa. Graaff-Rienet: Sneeuberg, 1800m+, mountain peak.	32° 09'	24° 32'
SH 110	krebsiana	krebsiana	South Africa. Grahamstown: 100m from Great Fish River Bridge.	33° 29'	26° 55'
SH 111/1	krebsiana	krebsiana	South Africa. Peddie: 10km East Peddie.	33° 12'	27° 07'
SH 111/2	krebsiana	krebsiana	South Africa. Peddie: 10km East Peddie.	33° 12'	27° 07'
SH 112	krebsiana	krebsiana	South Africa. Stutterheim: Road out of Kaiskammahoek.	32° 49'	27° 11'
SH 113	linearis	linearis	South Africa. Stutterheim: 10km out of Stutterheim.	32° 34'	27° 25'
SH 115	krebsiana		South Africa. Somerset East: S of Cradock beside N10.	32° 11'	25° 37'
SH 116	linearis	linearis	Somerset East: Daggaboersnek, 50 km SE from Cradock on N10 highway.	32° 11'	25° 37'

SH 117	linearis	linearis	South Africa. Grahamstown: W of Riebeck East, at N10/R400 road junction.	33° 12'	26° 09'
SH 118	krebsiana	krebsiana	South Africa. Somerset East: Daggaboersnek, 50 km SE from Cradock on N10 highway.	32° 11'	25° 37'
SH 131	linearis	linearis	South Africa. Stutterheim: Road between Hogsback and Cathcart, 7km out of Hogsback.	32° 33'	27° 04'
SH 132	linearis	linearis	South Africa. Stutterheim: Road between Hogsback and Cathcart, 14km out of Hogsback.	32° 22'	27° 07'
SH 133	krebsiana		South Africa. Fort Beaufort: Road from Hogsback to Committees, before Great Fish Nat. Res., after Alice.	32° 43'	26° 52'
SH135	krebsiana		South Africa. Potchefstroom: Road from Johannesburg to Potchefstroom.	26° 11'	27° 54'
SR 463	rigens	rigens	South Africa. Stanger: Tugela River mouth.	29° 13'	31° 30'
SR 480	krebsiana		South Africa. Grahamstown: Fort Brown, resolution hatchery.	33° 09' 53"	26° 37' 18"
SR 520	krebsiana		South Africa. Underberg: Estcourt.	29° 02’ 35"	29° 52’ 19"
SR 523	linearis	linearis	South Africa. Humansdorp: Maitlands, on road between Seaview and Maitlands River.	34° 00'	25° 41'
SR 564	krebsiana		South Africa. Port Edward: Umtamvuna nature reserve.	31° 04'	30° 11'
SR 571	linearis	linearis	South Africa. Port Shepstone: Port Shepstone.	30° 44'	30° 27'
SR 574	rigens	rigens	South Africa. Port Shepstone: Umkomaas, Warner Beach, Baggies Beach, 10km N Durban.	30° 04'	30° 52'
SR 575	rigens	rigens	South Africa. Stanger: Durban, Blue Lagoon.	29° 48'	31° 02'
SR 581	rigens		South Africa. Grahamstown: Kowie river.	33° 36'	26° 53'
SR 625	rigens	uniflora	South Africa. Skoenmakerskop: Cape Reciefe (Between PE and seaview).	34° 00'	25° 39'
SV GAZ HF1	krebsiana	krebsiana	South Africa. Grahamstown: Hownslow farm, edge of Grahamstown.	33° 17'	26° 31'
SV GAZ HF2	krebsiana	arctotoides	South Africa. Grahamstown: Hownslow farm, edge of Grahamstown.	33° 17'	26° 31'

Collector abbreviations: RM = Robert McKenzie, M = Laco Mucina, MSG= Mucina & Santos Guerra, CAM = Colleen Mannheimer, SR = Syd Ramdhani, JC = Jessica Cockburn, RVC = Ralph Clark, ND = Nico Devos, NPB = Nigel Barker, SV = Susi Vetter.

Results and Discussion

MrModelTest identified the General Time Reversible (Tavaré, 1986) model of DNA sequence evolution as the best fit to the data set.

The length, variability and informativeness of the ITS and ETS regions are presented in Table 4.3.1 below. The ETS region is nearly twice as informative as the ITS region.

Table 4.3.1: Length, number of variable and parsimony informative characters, and g_1 statistics for ITS, ETS and combined nrDNA data set.

			Variable Characters		Parsimony Inform. Ch.		
	No. samp.	Tot. chars	Number	%	Number	%	g_1
nrDNA	171	1452	562	38.7	309	21.3	-0.93
ITS	171	696	212	30.5	108	15.5	-1.0
ETS	171	756	350	46.3	201	26.6	-0.9

Sample M7219_10 was found to have a deletion 244 bp in length.

Genetically discrete species

Neighbor-Joining analysis

The NJ tree of the seven genetically discrete (Figure 4.3.1) illustrates that increased sample number does not change the monophyly of the species clades, except for *G. caespitosa*, which is paraphyletic with respect to *G. ciliaris*, as it was in the original nrDNA phylogeny in Chapter 3 (only the addition of cpDNA data could render it monophyletic).

Figures 4.3.2 to 4.3.7 illustrate the distributions for samples of each of the genetically discrete species. *G. jurineifolia*, *G. tenuifolia* and *G. lichtensteinii* all have distributions that extend from south Namibia into western and central South Africa, while *G. schenckii* is limited to Namibia. *G. ciliaris* and *G. caespitosa* are found in the southern half of South Africa (Figure 4.3.7). The most basal of the G. ciliaris samples (SR705) is also the most easterly.

Bayesian analysis

Bayesian analysis (Figure 4.3.8) results in the same species clades as NJ, although the support for the internal nodes of the species clades is higher. There is also some difference in internal clade arrangement for *G. tenuifolia* and *G. jurineifolia*.

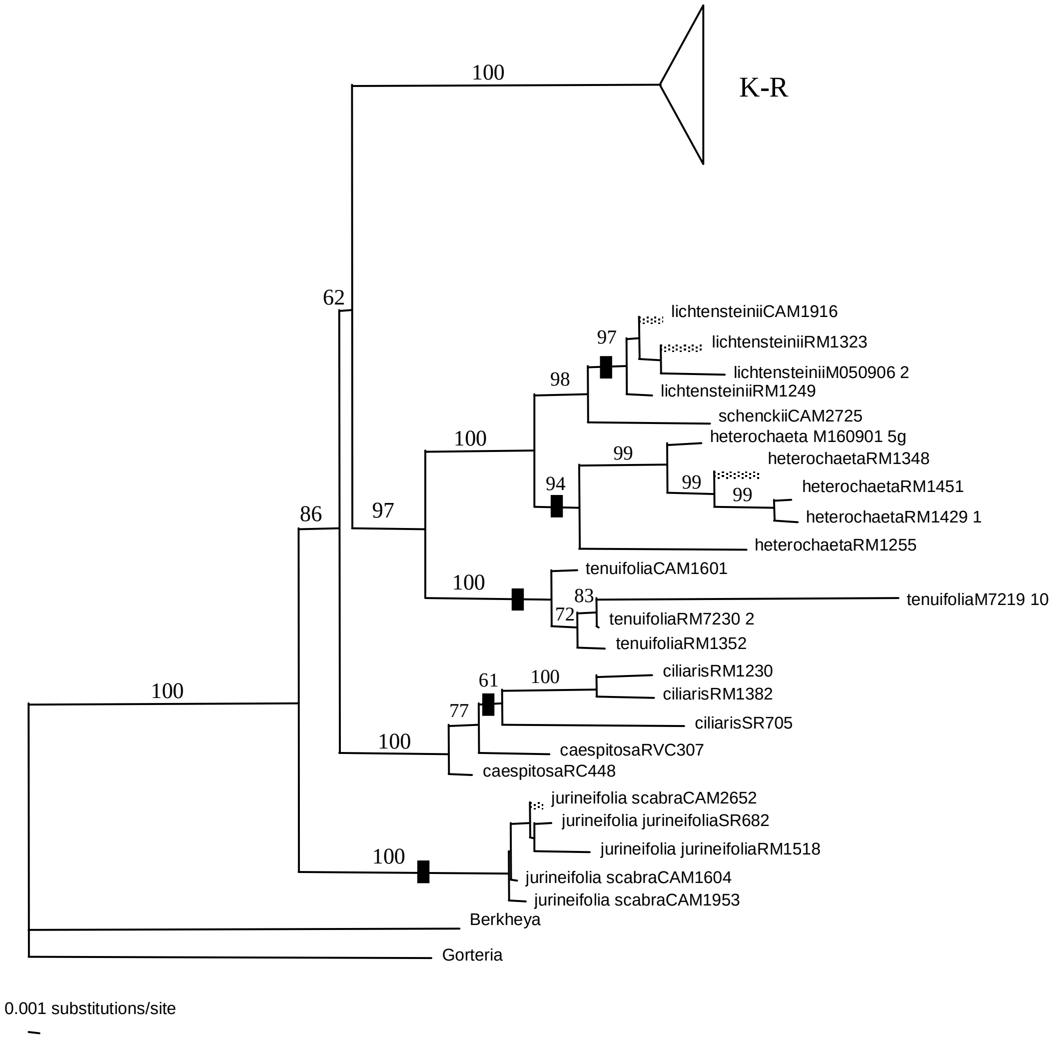


Figure 4.3.1: Neighbor-Joining tree of expanded nrDNA sample set of genetically discrete species. Bootstrap support above branches. Black bars indicate monophyletic species branches.

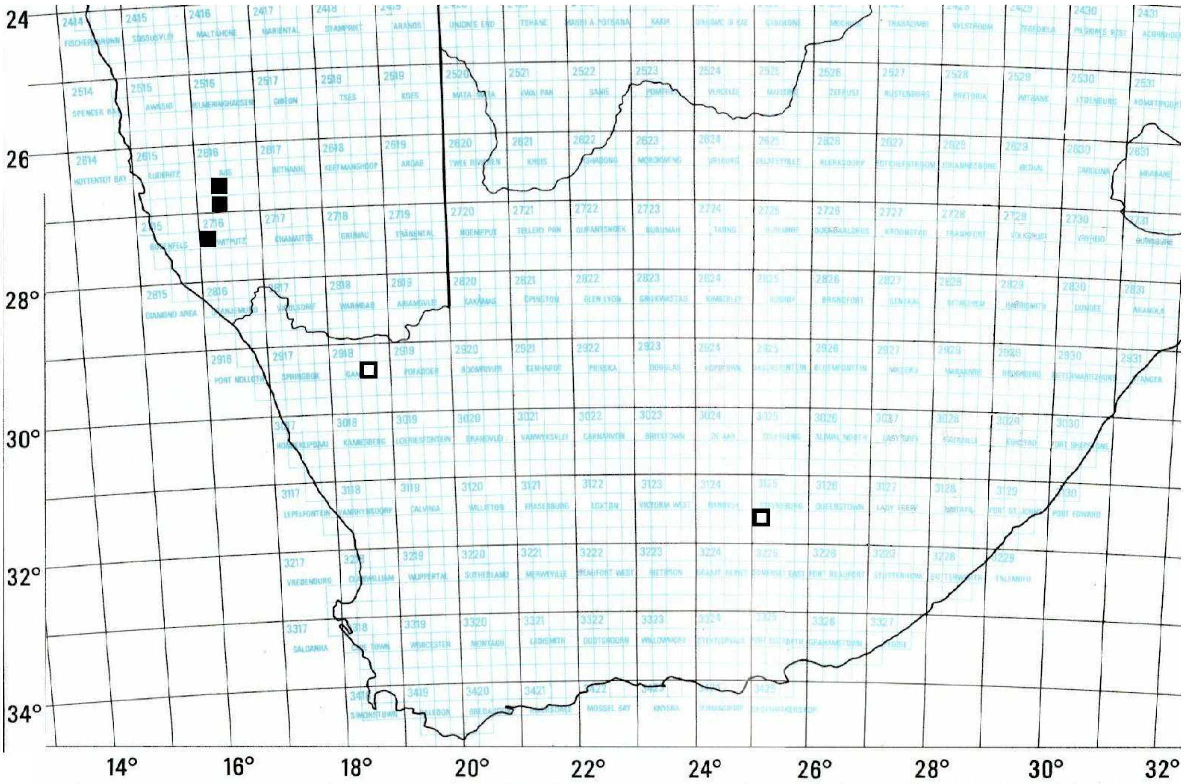


Figure 4.3.2: Distribution of samples for *G. jurineifolia*. Black squares indicate *G. jurineifolia* subsp *scabra* samples, hollow squares indicate *G. jurineifolia* subsp *jurineifolia* samples.

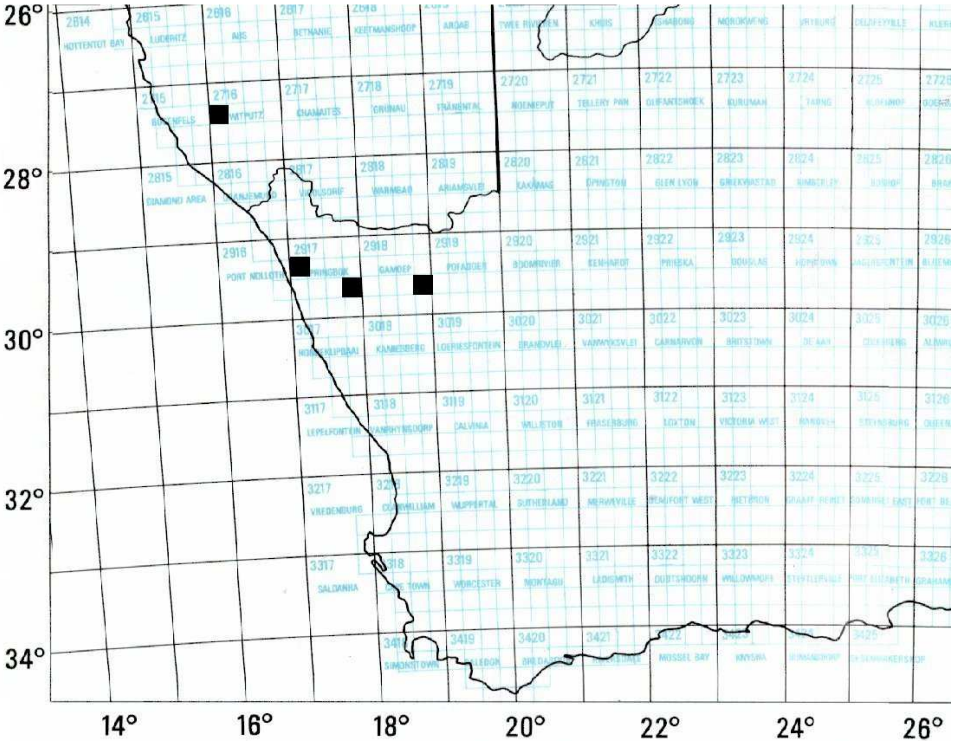


Figure 4.3.3: Distribution of samples for *G. tenuifolia*.

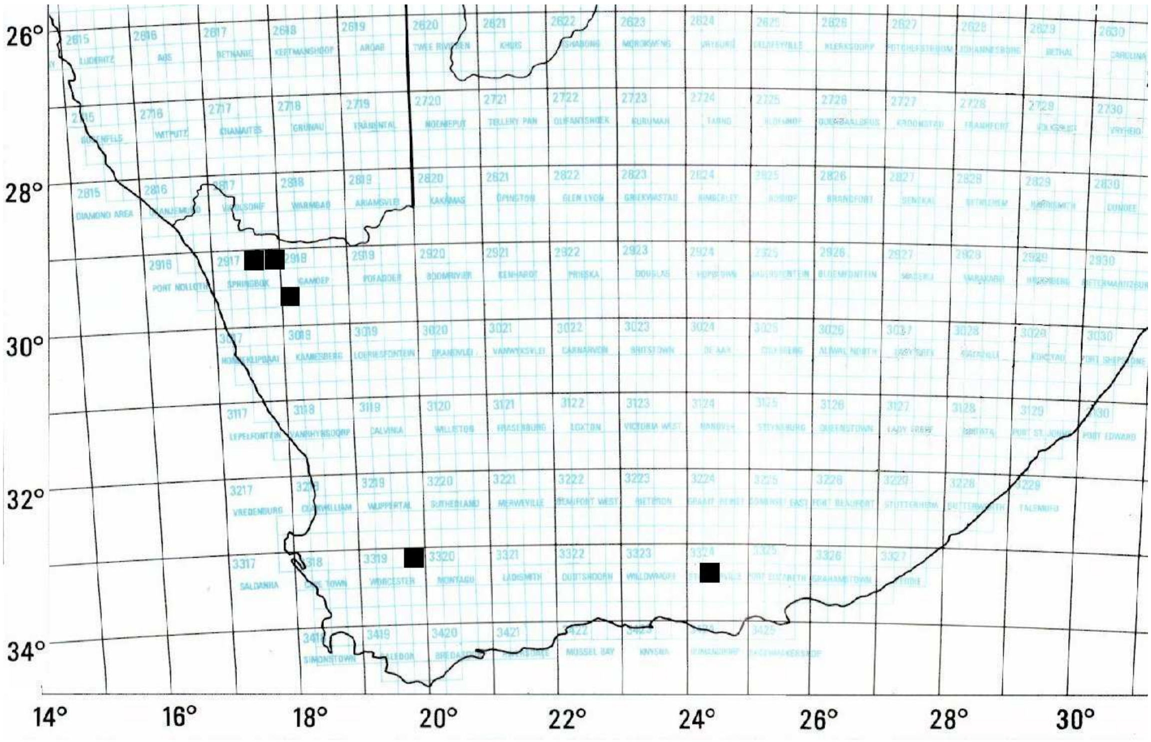


Figure 4.3.4: Distribution of samples for *G. heterochaeta*

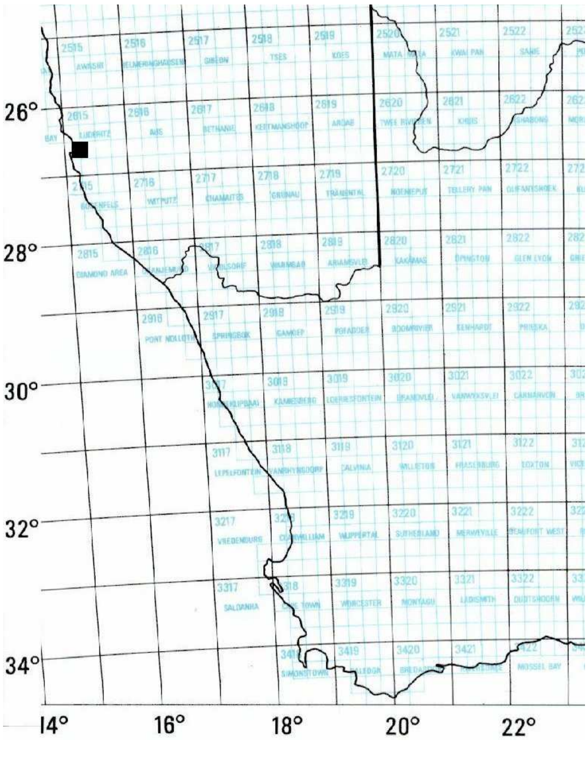


Figure 4.3.5: Distribution of samples for *G. schenckii*

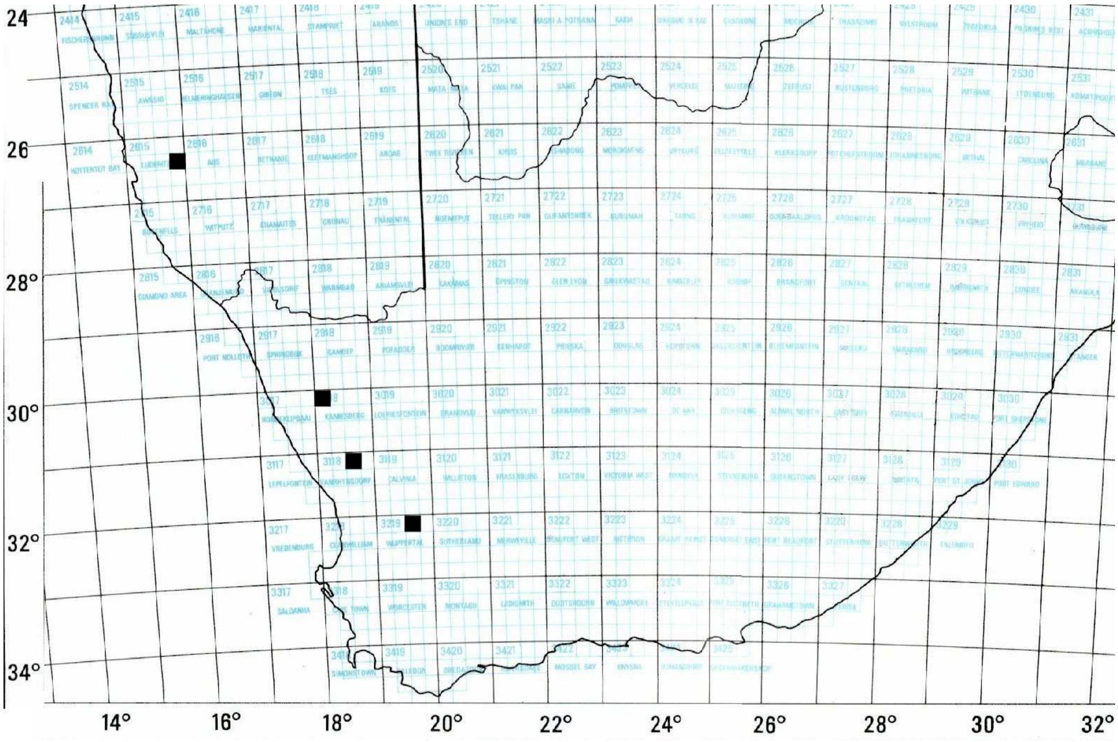


Figure 4.3.6: Distribution of samples for *G. lichtensteinii*

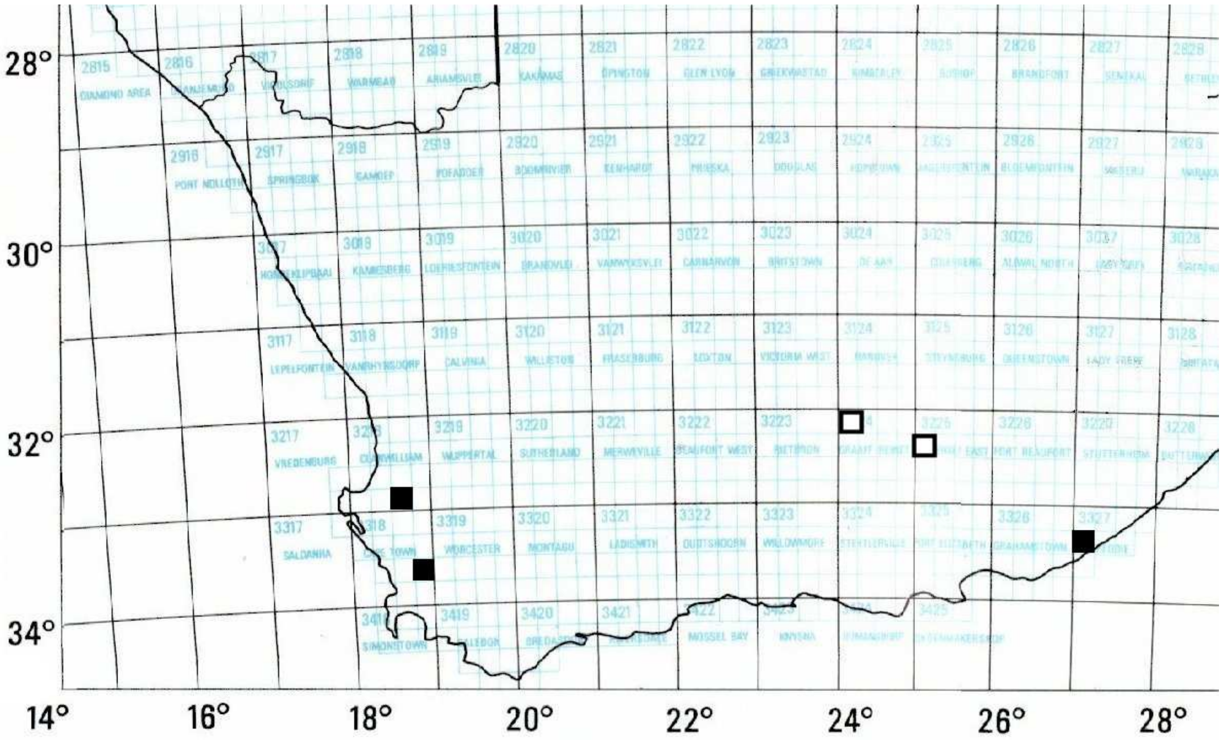


Figure 4.3.7: Distribution of samples for *G. ciliaris* (black squares) and *G. caespitosa* (hollow squares).

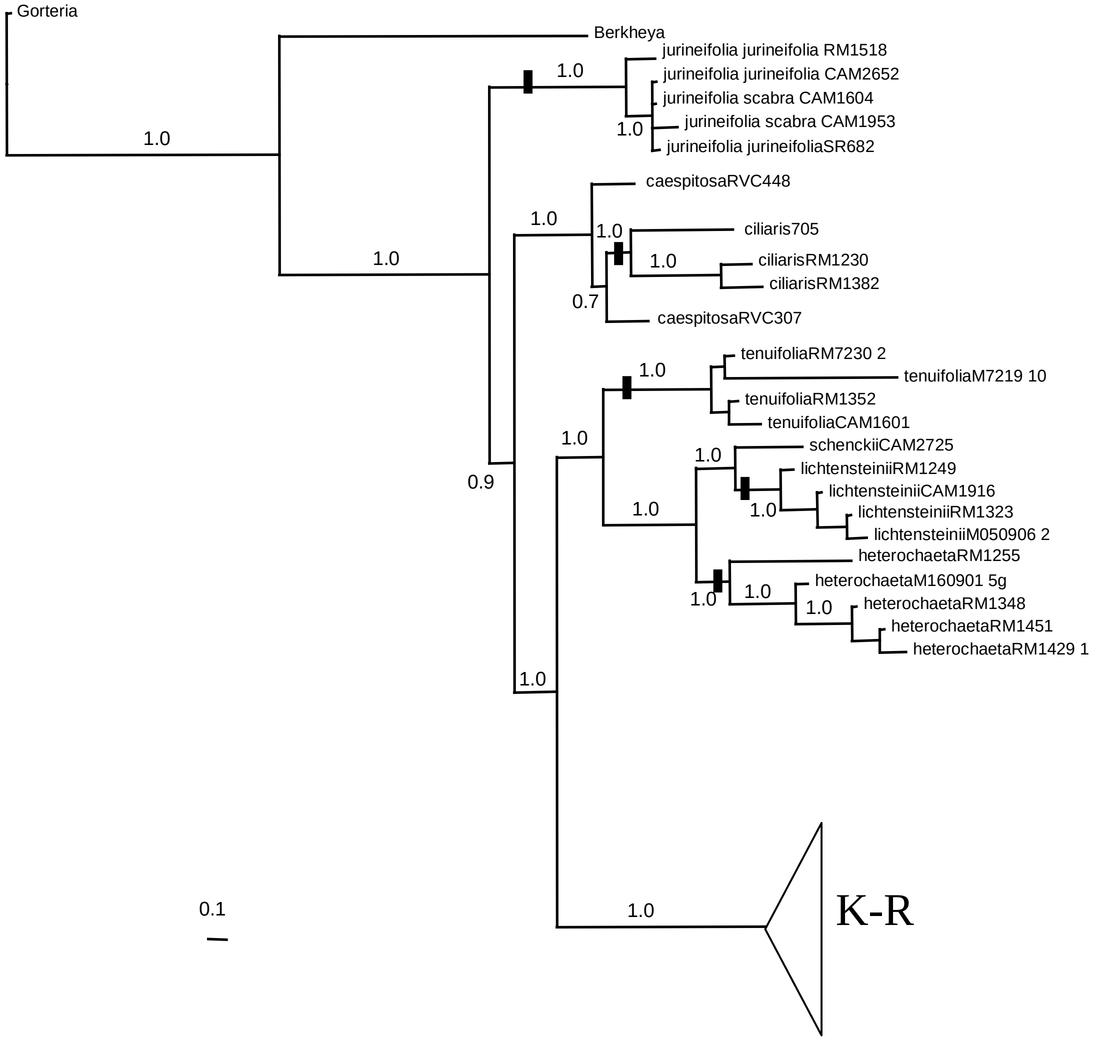


Figure 4.3.8: Bayesian consensus tree of expanded nrDNA sample set of genetically discrete species. Posterior probabilities indicated on branches. Black bars indicate monophyletic species branches.

K-R clade

Neighbor-Joining analysis

The Neighbor-Joining tree of the expanded K-R clade is presented in Figure 4.3.9, rooted using samples of *G. caespitosa* and *G. ciliaris.* 12 clades are obtained positioned along a poorly supported backbone, with a few samples placed between them. The localities of the samples of species are mapped, branch by branch, in Figures 4.3.10 to 4.3.21. No complete species cohesion is seen in this large clade as a whole, although two branches (Branch 1, which contains only *G. leiopoda* samples; and Branch 8, which contains only *G. rigens* samples) do show some species cohesion. However, these branches do not contain all the samples of these species, as some samples are found in distant branches of the tree.

The K-R clade has some structure around the basal clades (Branches 1-4), but no bootstrap support for these branching patterns, and there is a large polychotomous backbone along which the majority of the terminal branches (5-12) are placed.

The first basal bifurcation results in Branch 1 (Figure 4.3.10), which contains only *G. leiopoda* samples (90% BS), and has some bootstrap support for its internal structure (a relative rarity in the rest of the K-R clade). The geographical origins of the samples in this clade fall into a small area around Hondeklipbaai (30º S 17º E) in the north Western Cape.

Branch 2 (Figure 4.3.11) shows little species cohesion and no bootstrap support, comprising a mix of *G. pectinata, G. serrata*, *G. rigida* and *G. maritima* samples. Despite the broad taxonomic mix, the geographical origins of these samples fall within a limited area of the Southern Cape, suggesting that geographical locality is superseding morphotaxonomic affinity (possibly due to recent hybridization or introgression, though neither of these can be conclusively proven by this dataset). Of course, the alternative explanation is that the species themselves may be badly delimited. If the localities of the samples are overlaid on the floristic regions (defined by Weimarck; Linder, 2003) the samples are not limited to only one region, but fall into the South Western centre, Peninsula, Agulhas and Langeberg regions.

Branches 3 (54% BS) and 4 (Figures 4.3.12 and 4.3.13) both show some internal bootstrap support. However, neither branch shows species coherency, both being composed of a mix of species. The geographical origins of the samples in each branch fall into two areas in the western and southern cape. Samples in Branch 3 occur in the South Western centre and Peninsula regions of the CFR, while samples in Branch 4 occur only in the North Western centre of the CFR.

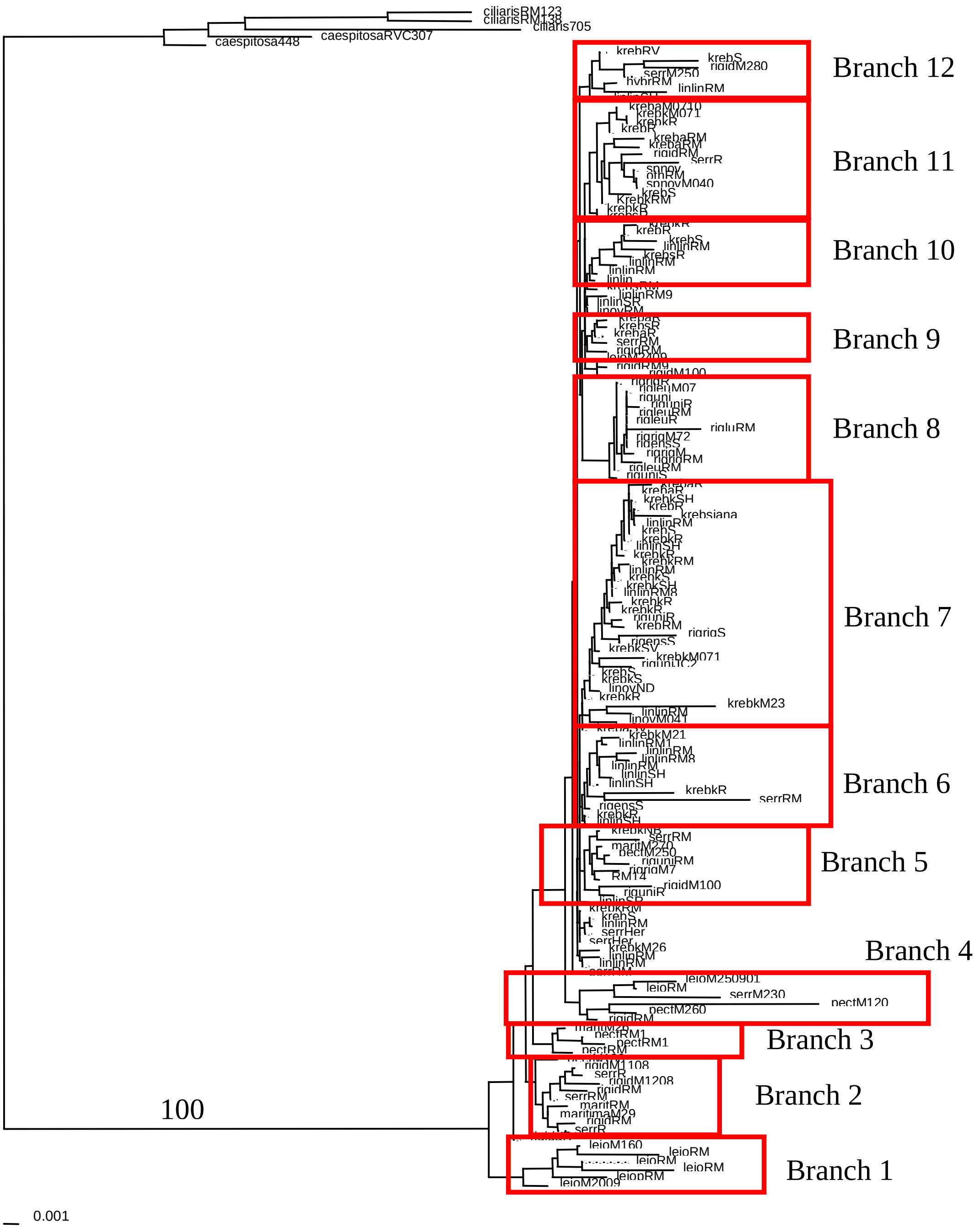


Figure 4.3.9: Neighbor-Joining tree of expanded large unresolved clade nrDNA data set. Boxes indicate main branches expanded in detail in figures that follow. Bootstrap support on main branch, all other bootstrap support for finer branches presented in detailed figures that follow.

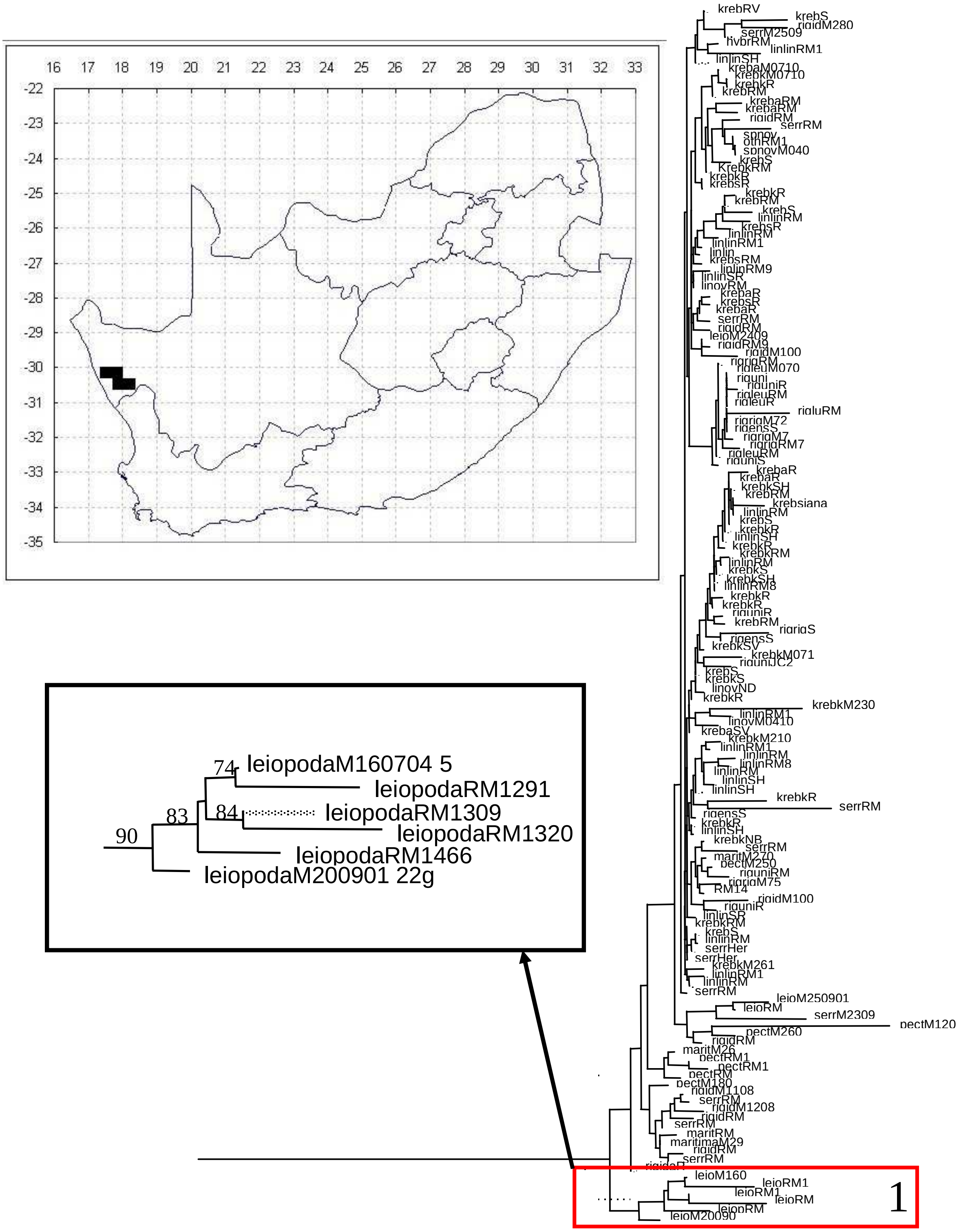


Figure 4.3.10: Branch 1 in detail with bootstrap support, the geographical origins of each sample and its position in the large unresolved clade

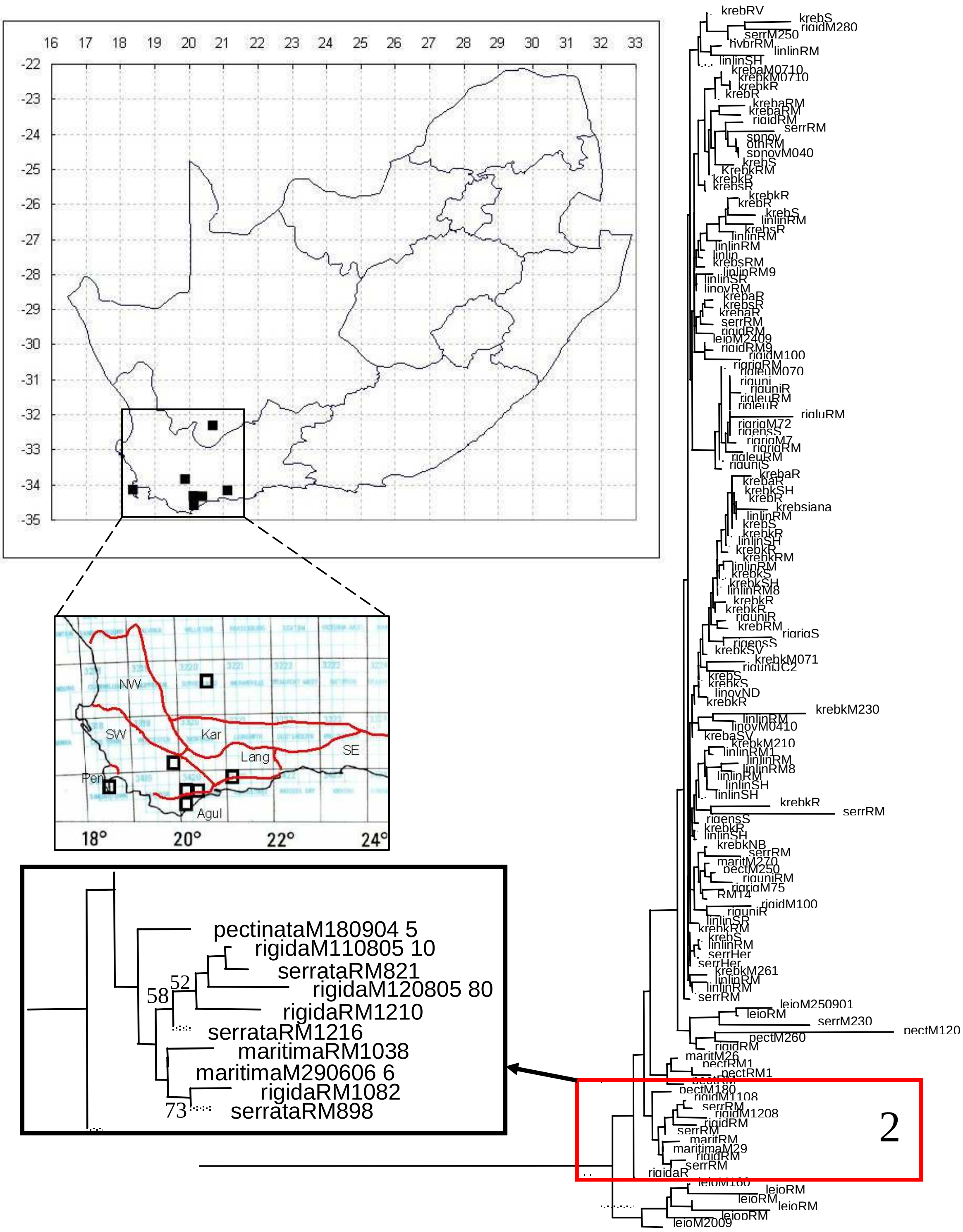


Figure 4.3.11: Branch 2 in detail with bootstrap support, the geographical origins of each sample and its position in the large unresolved clade. Red lines and letters on detailed map indicate Weimarck’s floristic regions of CFR (Linder, 2003).

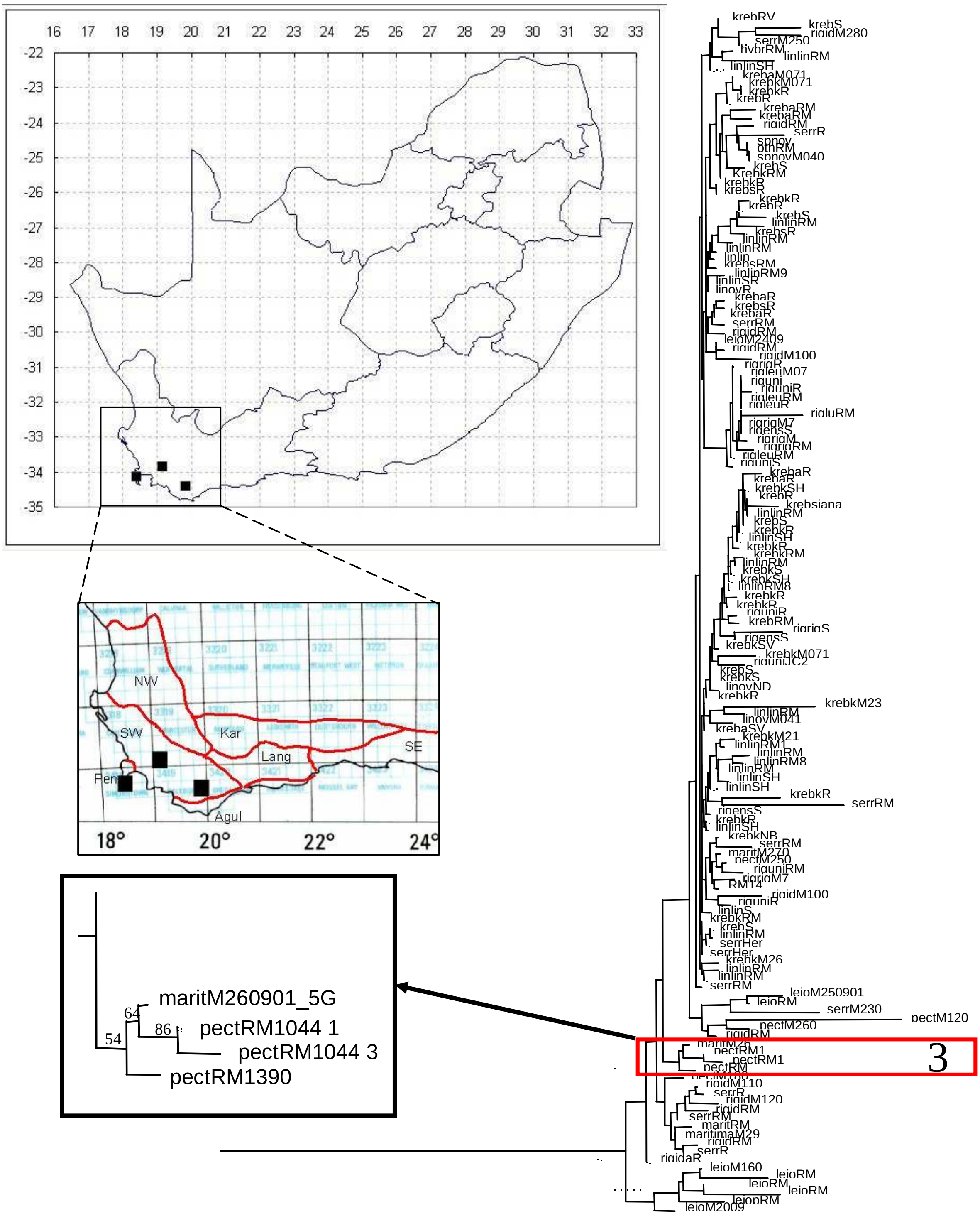


Figure 4.3.12: Branch 3 in detail with bootstrap support, the geographical origins of each sample and its position in the large unresolved clade. Red lines and letters on detailed map indicate Weimarck’s floristic regions of CFR (Linder, 2003).

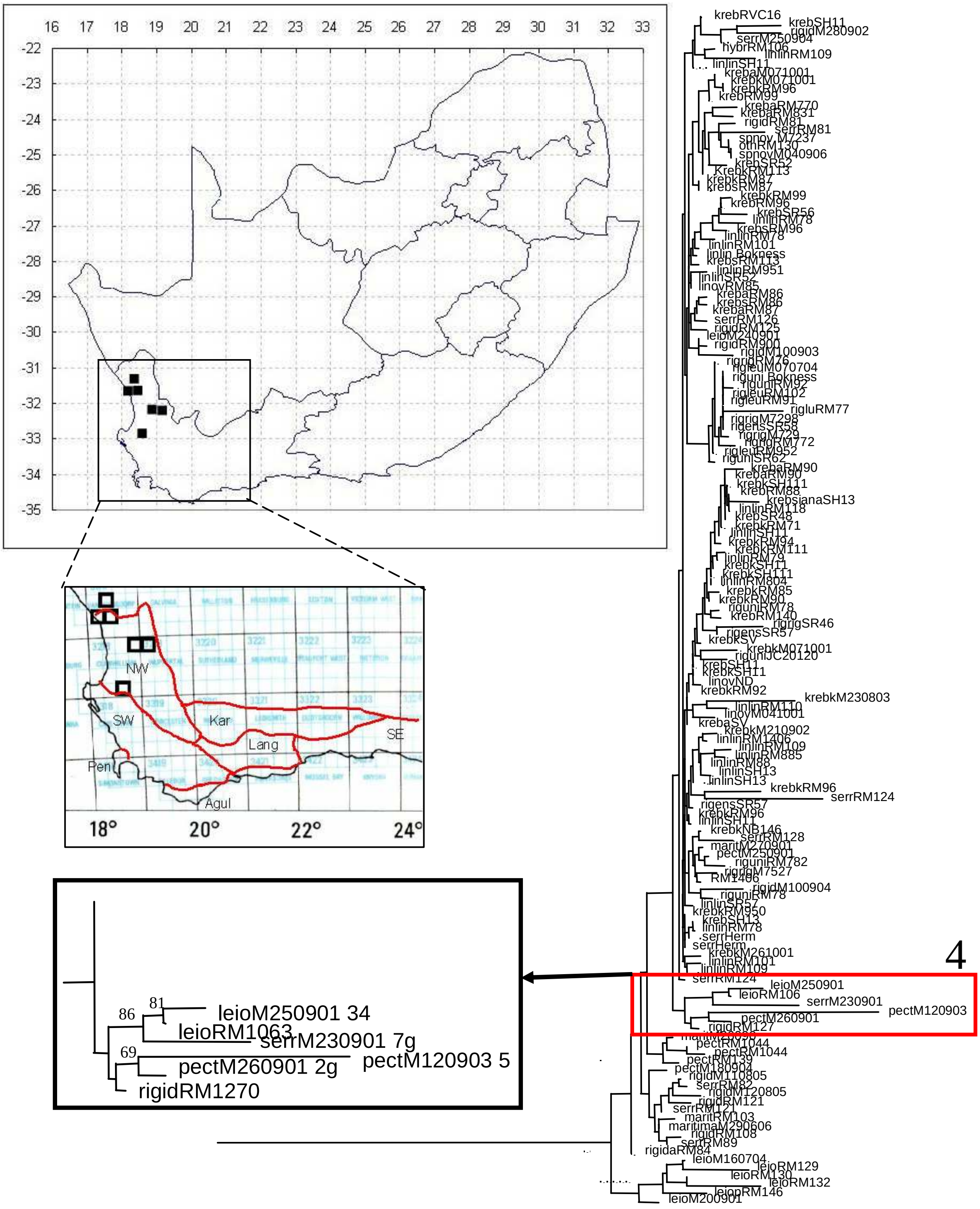


Figure 4.3.13: Branch 4 in detail with bootstrap support, the geographical origins of each sample and its position in the large unresolved clade. Red lines and letters on detailed map indicate Weimarck's floristic regions of CFR (Linder, 2003).

Branches 5 and 6 (Figures 4.3.14 and 4.3.15) show no bootstrap support, no species cohesion and no clear geographical signal, although samples in Branch 6 occur mostly in the Eastern Cape and Kwazulu-Natal.

Branch 7 (Figure 4.3.16) is a large branch composed of mostly (but not exclusively) *G. krebsiana* samples. It has no bootstrap support, but is composed of samples that fall only within the eastern half of South Africa.

Branch 8 (Figure 4.3.17) is composed of only *G. rigens* samples (with 66% BS). There are two samples (RM1021 and M070704_1) which occur in the Western Cape, and fall outside of Roessler's distribution limits for *G. rigens*. These may not be naturally occurring samples, and could have been transplanted for cultivation purposes, or may be hybrid garden escapes. Many cultivated *Gazania* specimens have a silvery-grey hirsute layer on the dorsal surface of their leaves and a decumbent habit, which is characteristic of *G. rigens* subsp *leucolaena*, which is what the two outlier samples in the Western Cape are. As such, these two outliers should probably be disregarded from further consideration, due to their high potential to be horticultural hybrids. The *G. rigens* samples in Branch 8 that do occur in the Eastern Cape only occur in the southern half of the eastern coast. In contrast, the other samples of *G. rigens* that do not fall into Branch 8, occur (with two exceptions in the southern coast) in the northern half of the eastern coast of South Africa. The disjunction between the southern samples and the north-eastern samples may be due to a lack of suitable dune habitats along the rocky areas of the Wild Coast coastline that bisects the two distributions. However, a lack of intensive collection in this area may also account for this pattern.

Branch 9 (Figure 4.3.18) shows no species cohesion, bootstrap support or clear geographical signal, but could represent the poorly sampled semi-arid interior.

Branch 10 (Figure 4.3.19) with some internal support, is composed of samples that only occur in the eastern half of South Africa.

Branch 11 (Figure 4.3.20) shows some internal bootstrap support, but little species cohesion or geographical signal, except for the *G. othonnites/sp. nov*. clade (65% BS), suggesting a common link. Both possess mild succulence, and glaucous leaves, but some of the *G. sp. nov*. samples may have hispid leaves, which does not fit Roessler's description of *G. othonnites*. The hispid *G. sp. nov*.

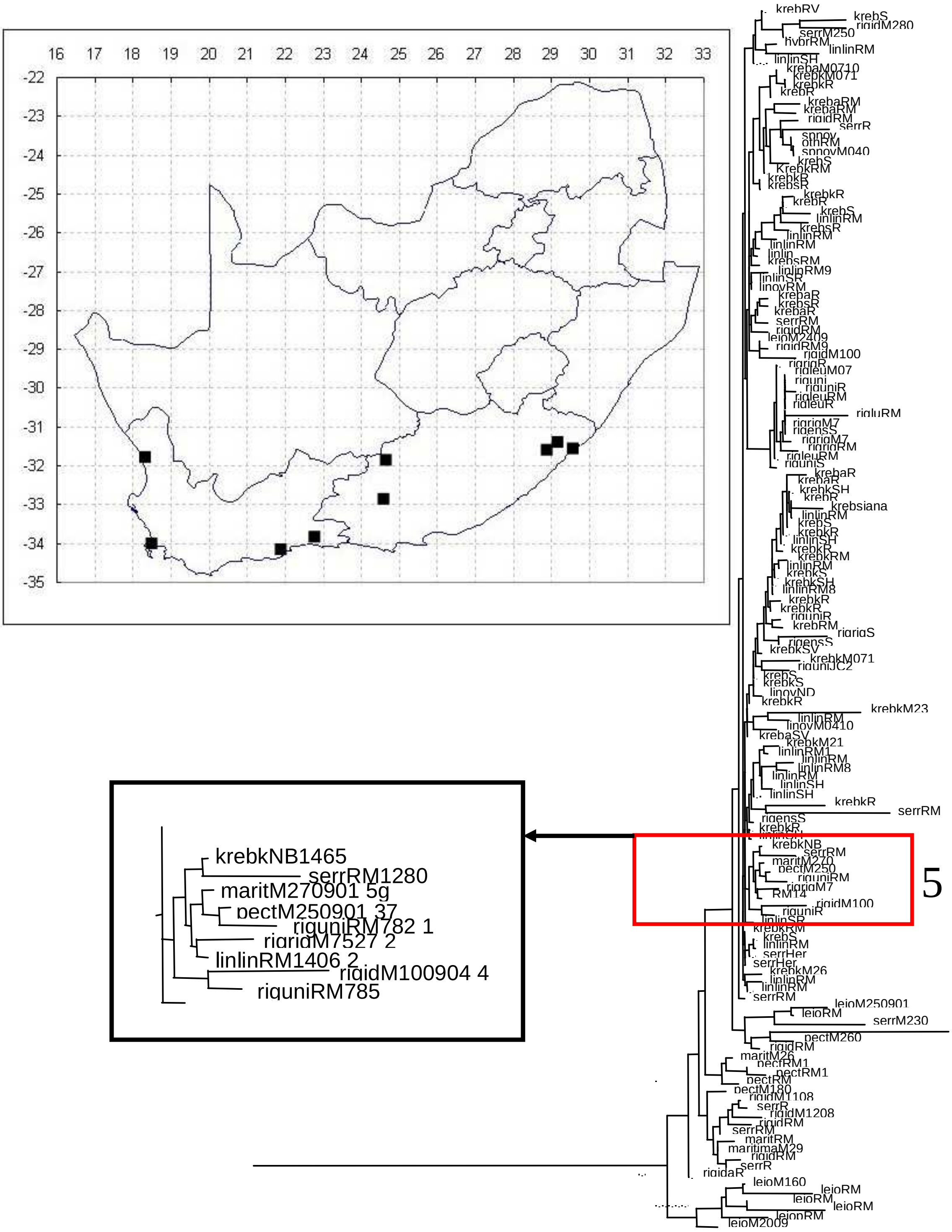


Figure 4.3.14: Branch 5 in detail, the geographical origins of each sample and its position in the large unresolved clade.

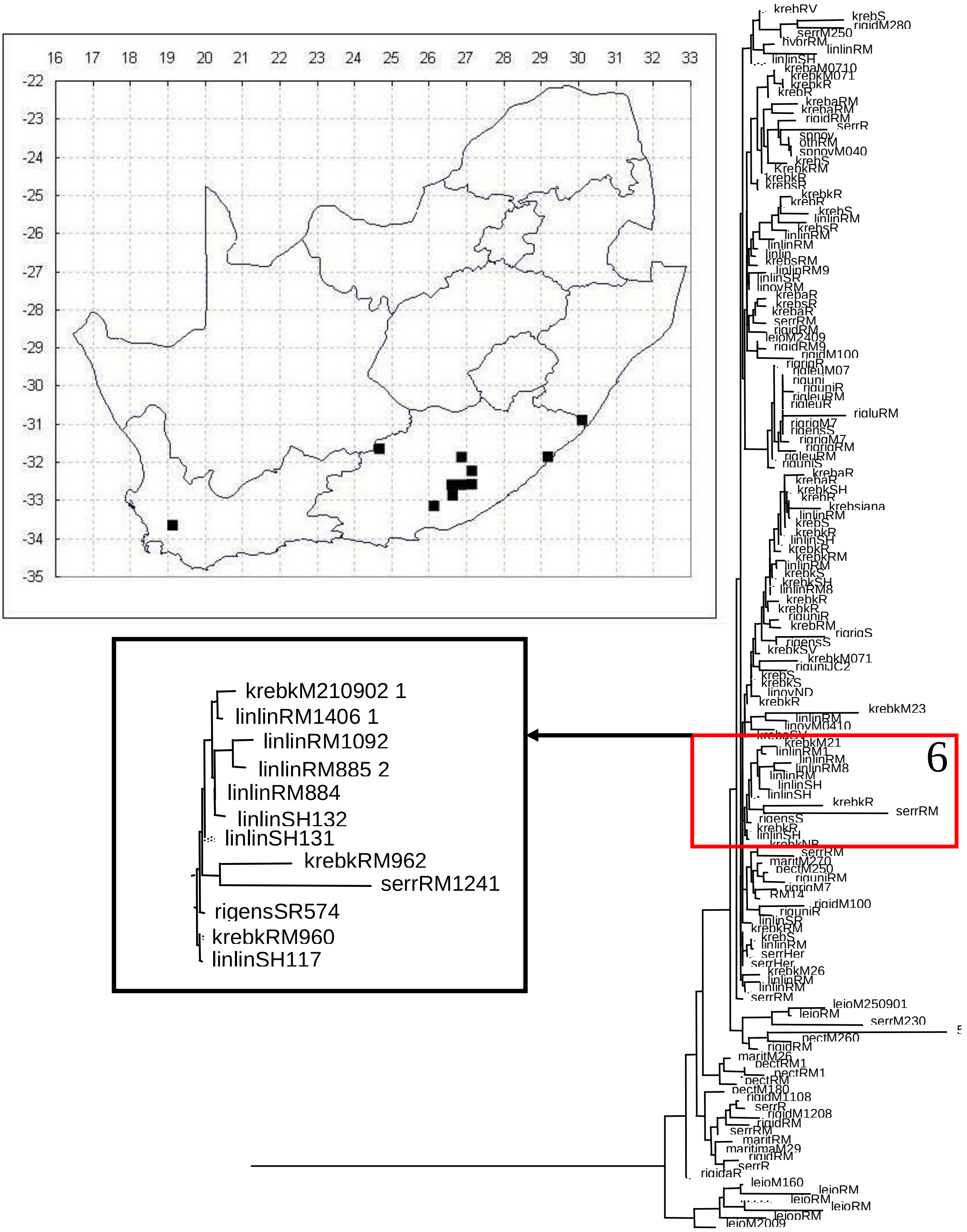


Figure 4.3.15: Branch 6 in detail, the geographical origins of each sample and its position in the large unresolved clade.

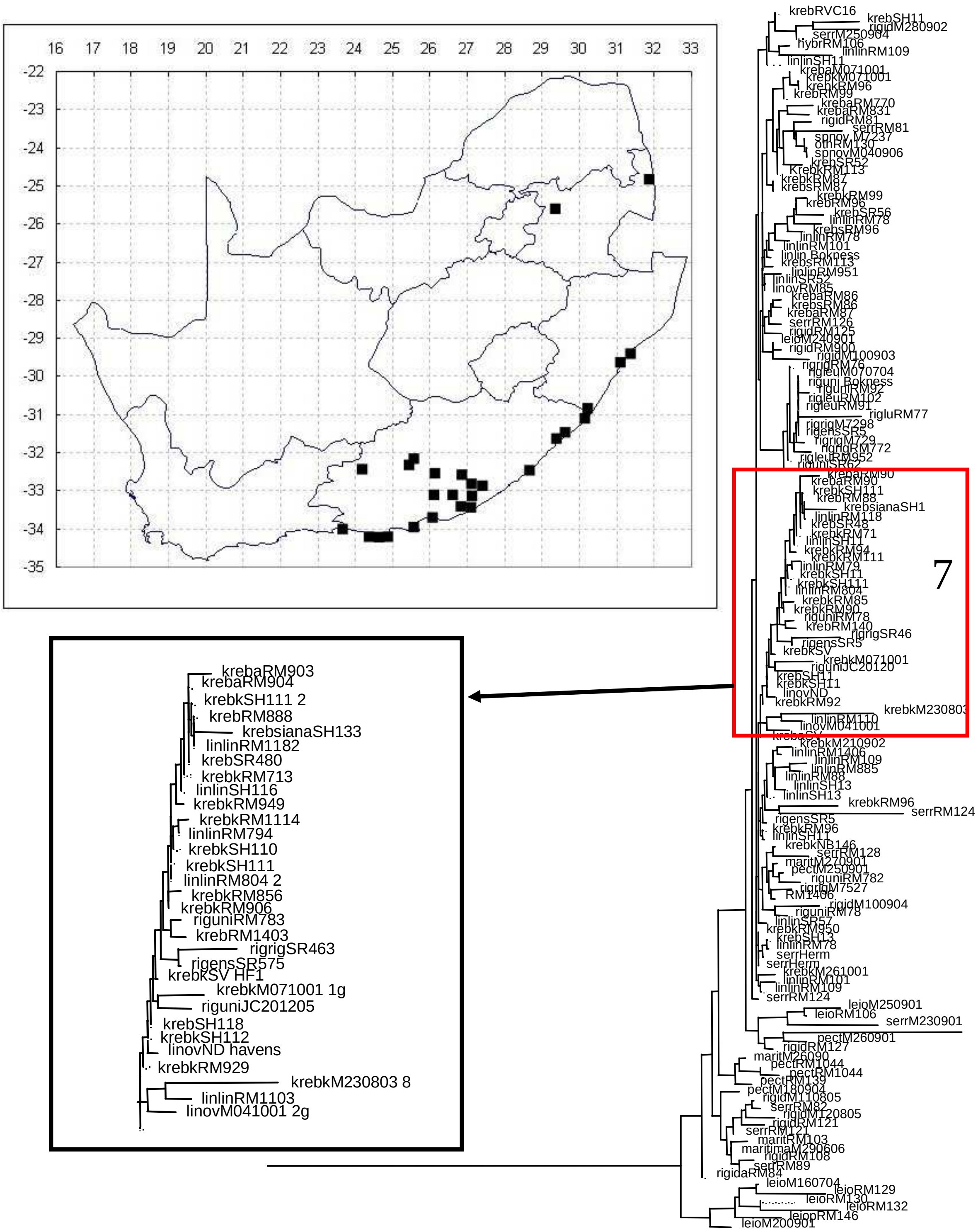


Figure 4.3.16: Branch 7 in detail, the geographical origins of each sample and its position in the large unresolved clade.

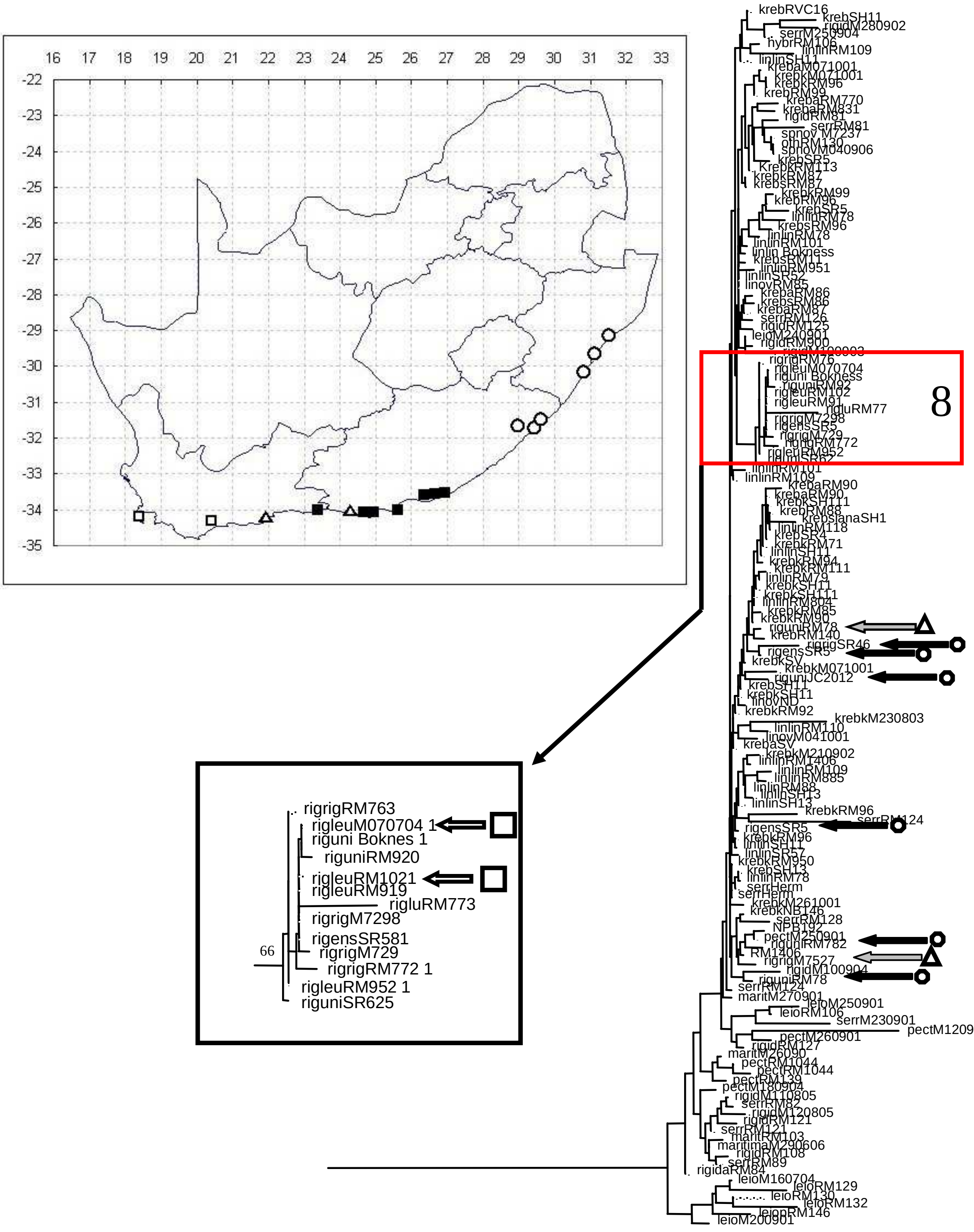


Figure 4.3.17: Branch 8 in detail with bootstrap support, and its position in the large unresolved clade, along with the geographical origins of each sample (black squares = samples that fall within Roessler's distributional range for *G. rigens*, hollow squares = samples that fall outside of that range, hollow circles = *G. rigens* samples that fall outside of branch 7 and occur on the northern part of the eastern coastline, hollow triangles = *G. rigens* samples that fall outside of branch 7 and occur on the southern coast).

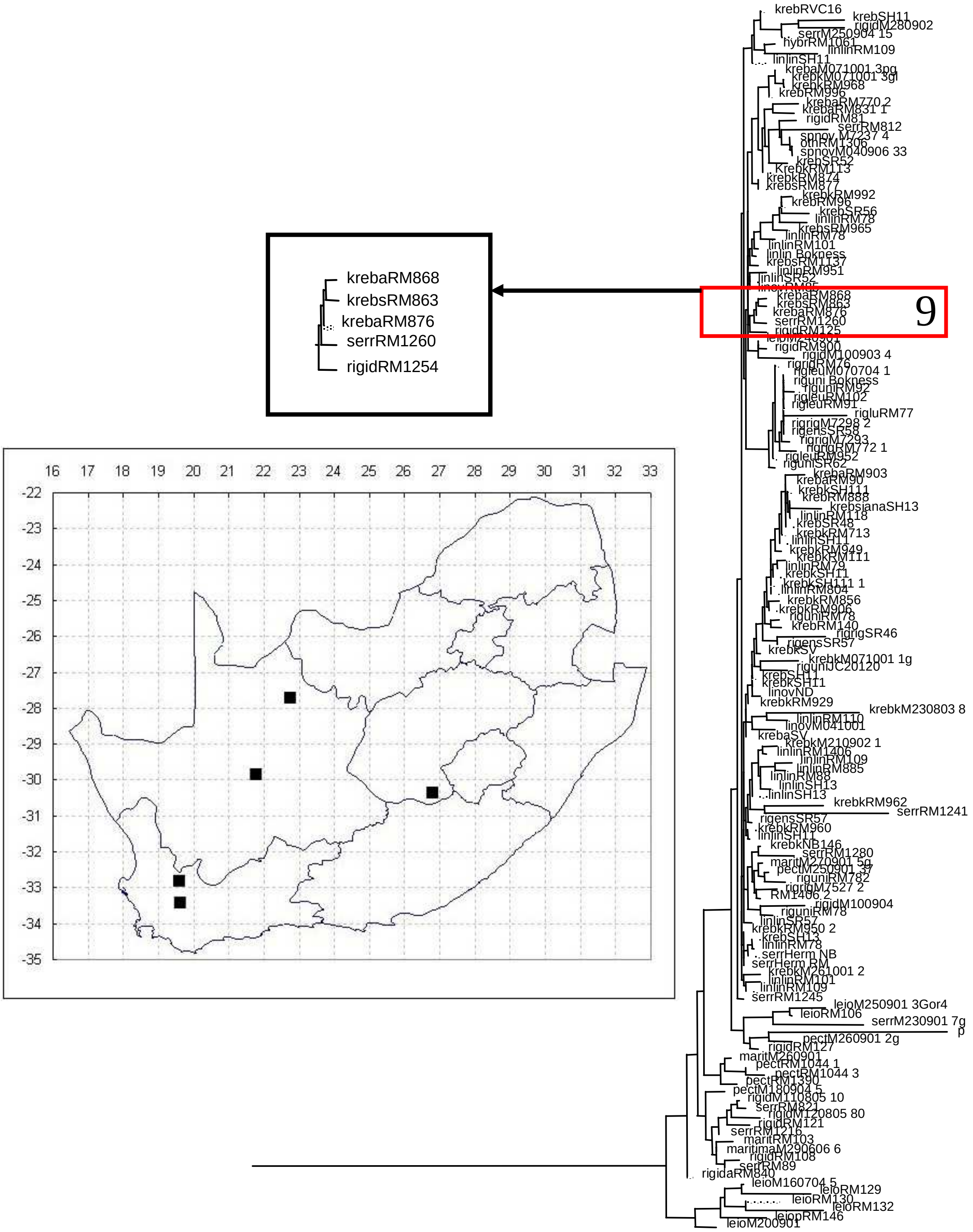


Figure 4.3.18: Branch 9 in detail, the geographical origins of each sample and its position in the large unresolved clade.

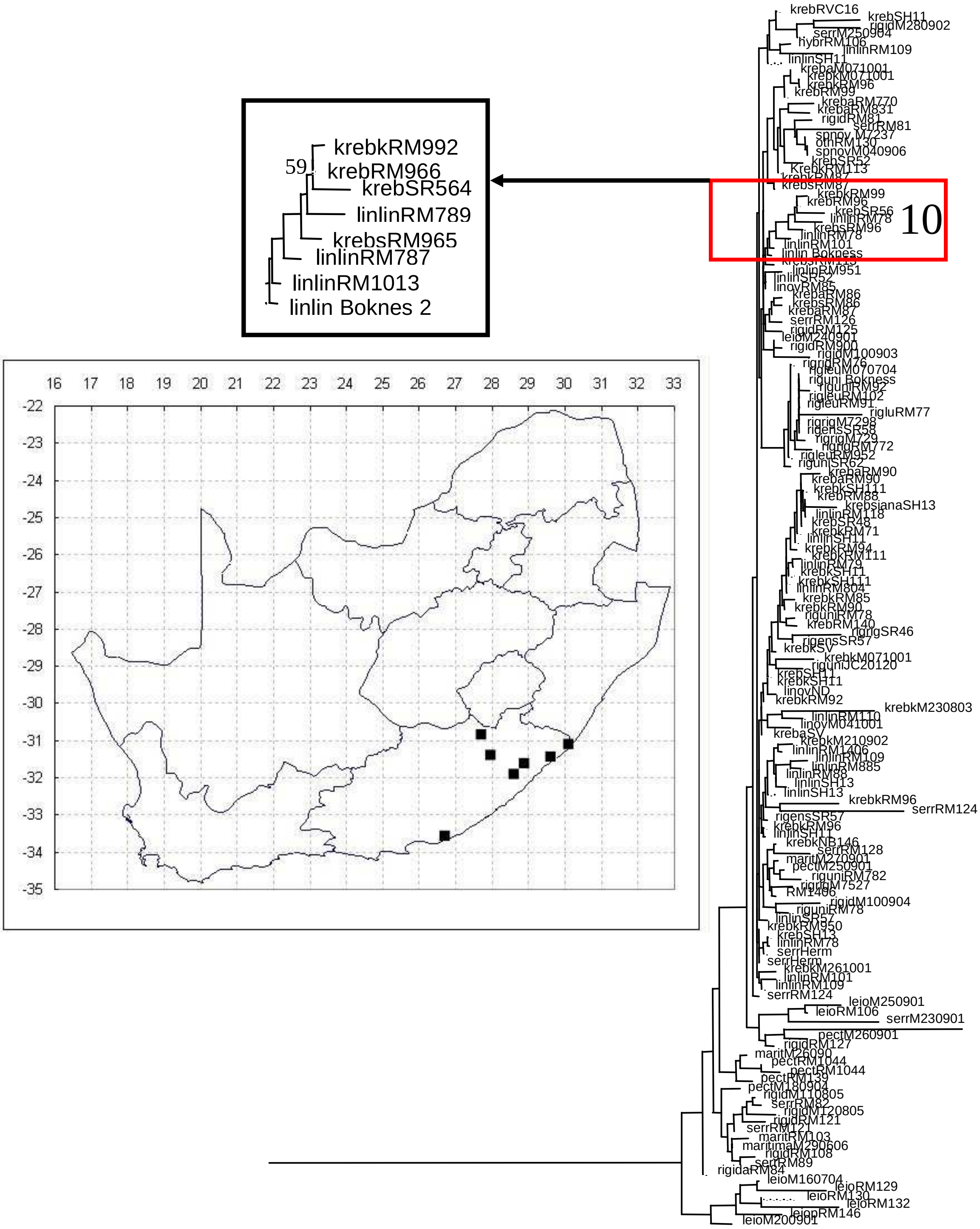


Figure 4.3.19: Branch 10 in detail with bootstrap support, the geographical origins of each sample and its position in the large unresolved clade.

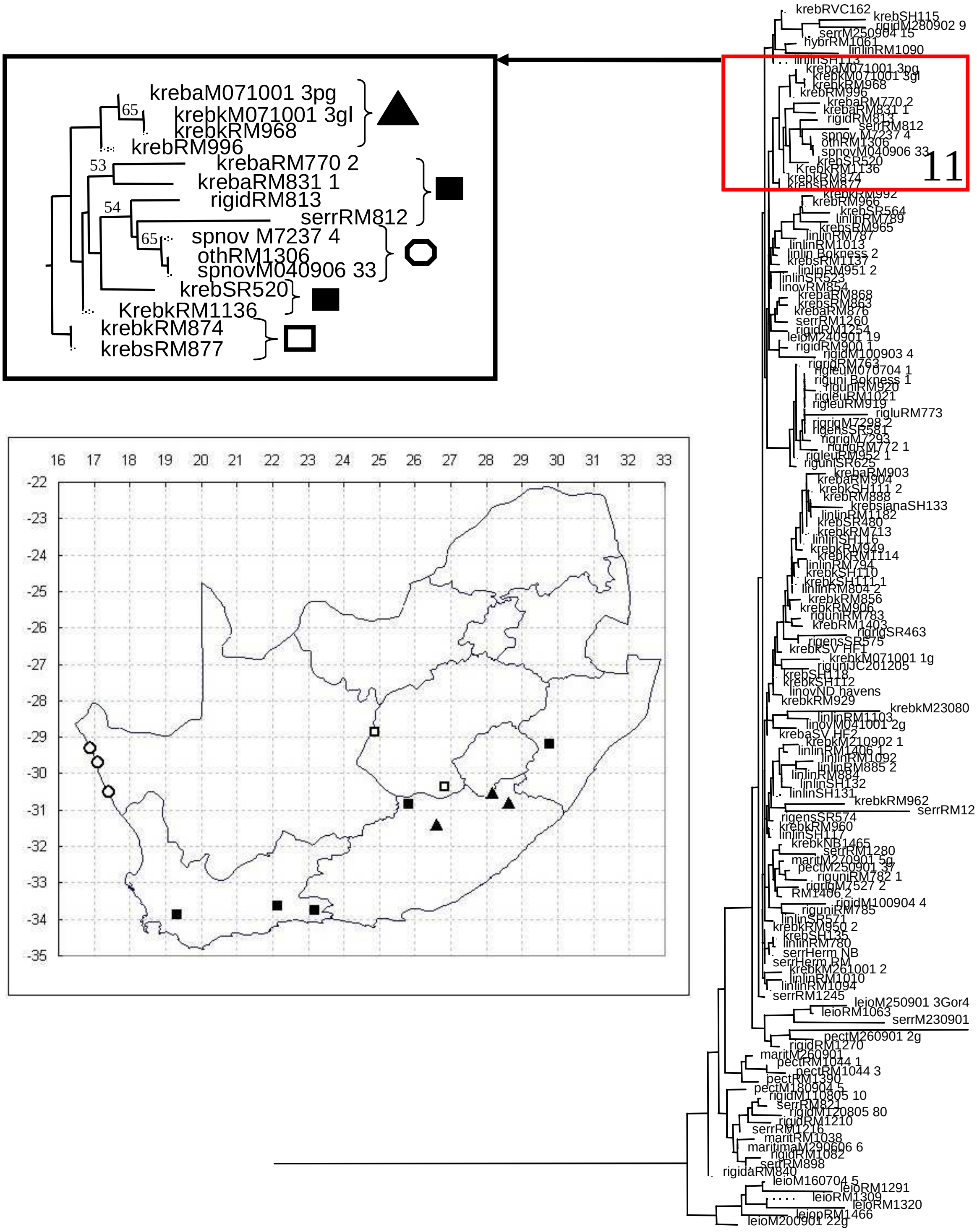


Figure 4.3.20: Branch 11 in detail with bootstrap support, the geographical origins of each sample and its position in the large unresolved clade.

samples may be examples of mixing between the glaucous *G. othonnites* morphotype and proximal hispid western cape *Gazanias*. This clade as a whole shows a strong geographical signal, and some moderate bootstrap support.

Branch 12 (Figure 4.3.21) shows no species cohesion, bootstrap support or clear geographical signal.

Although there are some trends of branches correlating to geographical areas, there is no overwhelming correlation between "species", the clades they occur in and their geographical origins. As an example of this lack of clarity, it should be noted that two members of the same subspecies taken from the same area do not necessarily end up in the same branch (e.g. RM1406_1 and RM1406_2, are both *G. linearis* subsp *linearis*, and both are collected from the same area, yet one occurs in Branch 5 and the other in Branch 6). This may be a result of hybridization or simply a function of extremely low data signal.

Bayesian analysis

The Bayesian consensus tree (Figure 4.3.22) shows less resolution than the NJ tree, but retains the same basic branch structure. The branches along the polytomy in the Bayesian analysis tend to agree with the branches found in the NJ analysis, although some branches found in the NJ analysis have collapsed in the Bayesian analysis. There is some swapping of single samples between branches when the two analysis results are compared. This is not unexpected due to the very low level of informativeness in the data and the general lack of structure and support. A large number of samples do not show any clade groupings, but instead occur along the backbone.

Those branches that co-occur in both trees are as follows:

- Branch 4 remains the same in both analysis trees, although the version in the Bayesian tree has much higher support for internal nodes.
- Likewise, the *G. rigens* branch (Branch 8) remains the same in both trees.
- The Bayesian version of Branch 5 is missing three samples found in the NJ version of the same branch (see Figure 4.3.23 for detailed comparison).

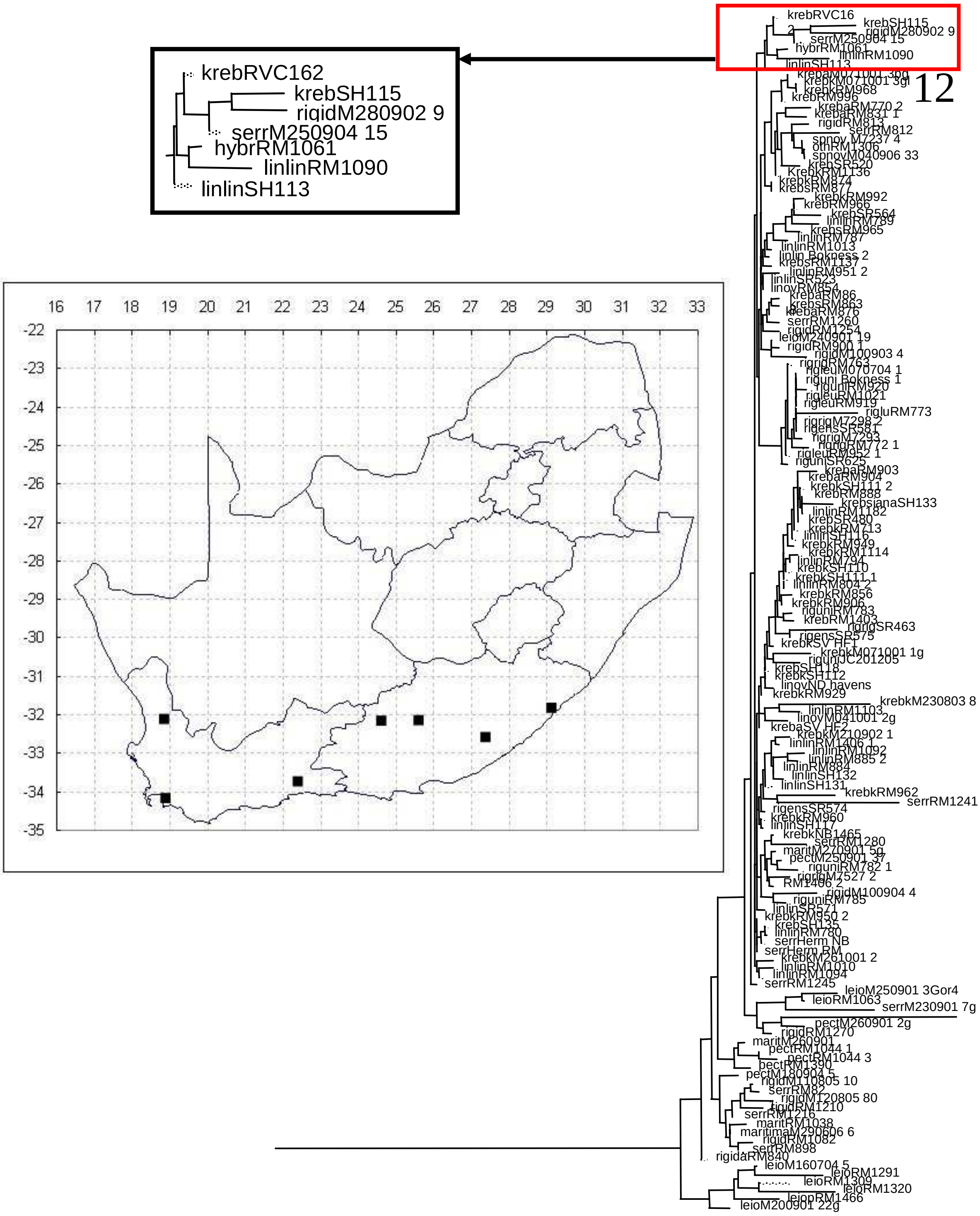


Figure 4.3.21: Branch 12 in detail with bootstrap support, the geographical origins of each sample and its position in the large unresolved clade.

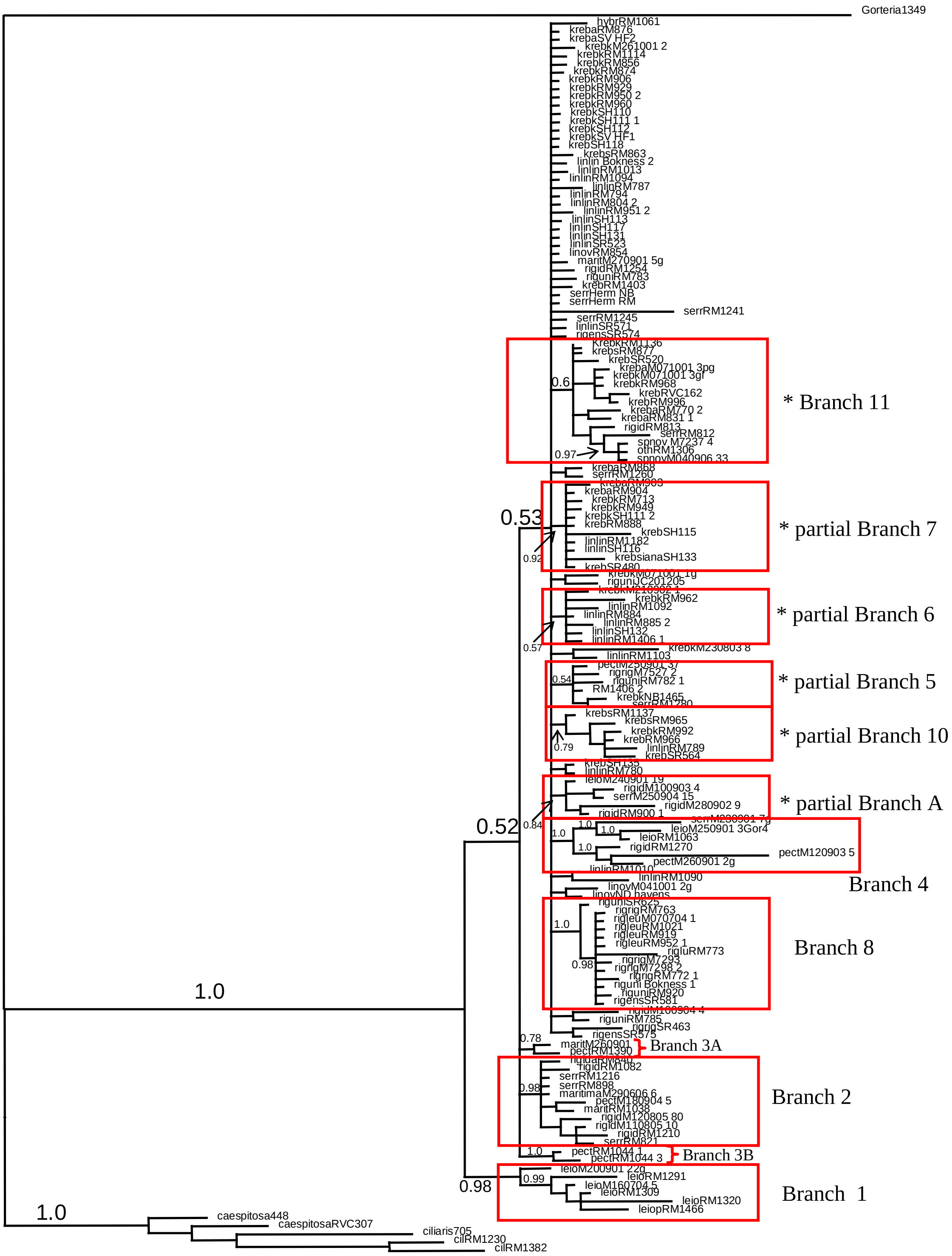


Figure 4.3.22: Bayesian consensus tree of the expanded large unresolved clade nrDNA data set. Boxes indicate main branches that correspond with branches retrieved in the NJ tree in Figure 4.3.1. Branch names with * indicate the branch contains missing or additional samples that are not present in the NJ tree branch of the same number, and are detailed in following figures. Posterior probabilities are indicated on branches.

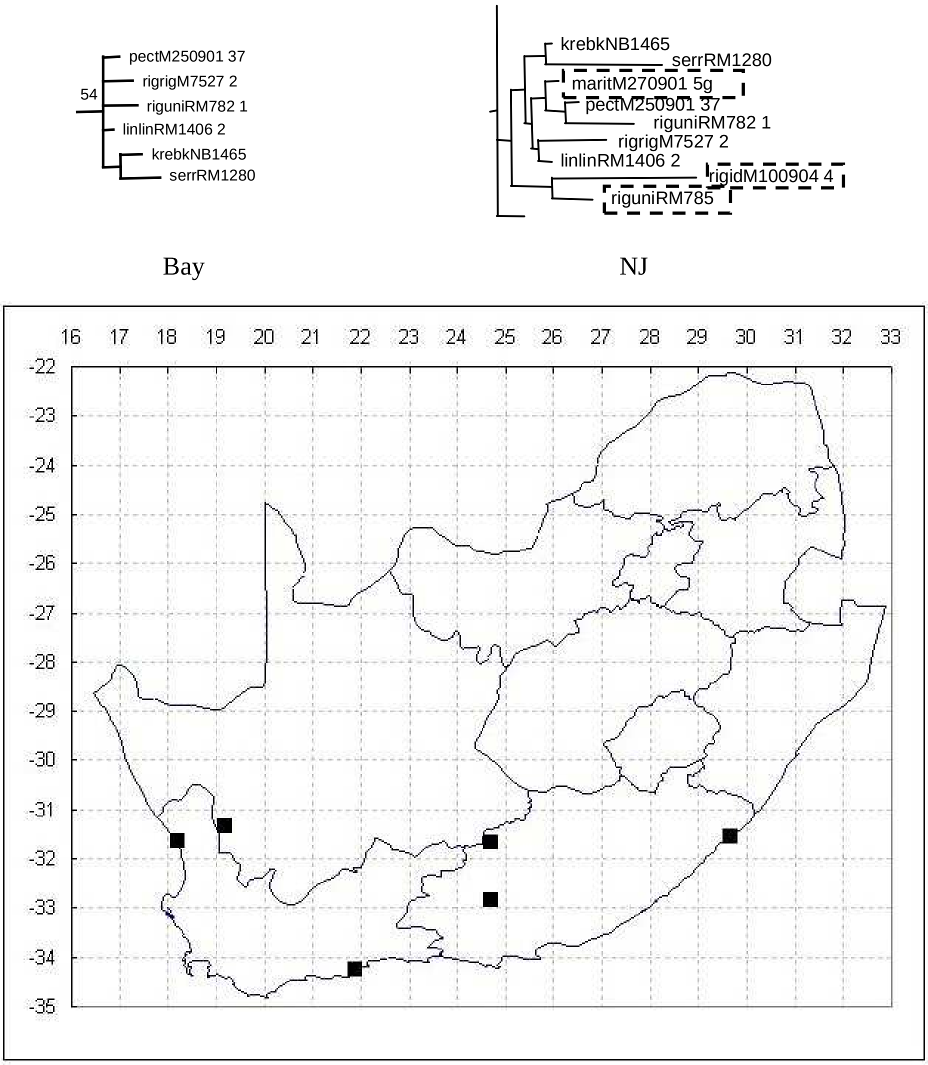


Figure 4.3.23: Partial Branch 5 from Bayesian tree in detail (on left), entire branch 6 from NJ tree on right. Dashed outlines indicate samples missing in the Bayesian branch. The map shows geographical origins of each sample in the Bayesian branch.

- The Bayesian version of Branch 6 is missing five samples found in the NJ version of the same branch (see Figure 4.3.24 for detailed comparison).

- The terminal section of the NJ Branch 7 retains it structure in the Bayesian analysis (with the addition of SH115, found in Branch 12 in the NJ analysis). The smaller partial Bayesian Branch 7 shows much tighter geographical grouping than the large NJ Branch 7 (Figure 4.3.25).

- The Bayesian version of Branch 10 has three samples found in the NJ version of the same branch, and has one additional sample included (see Figure 4.3.26 for detailed comparison).

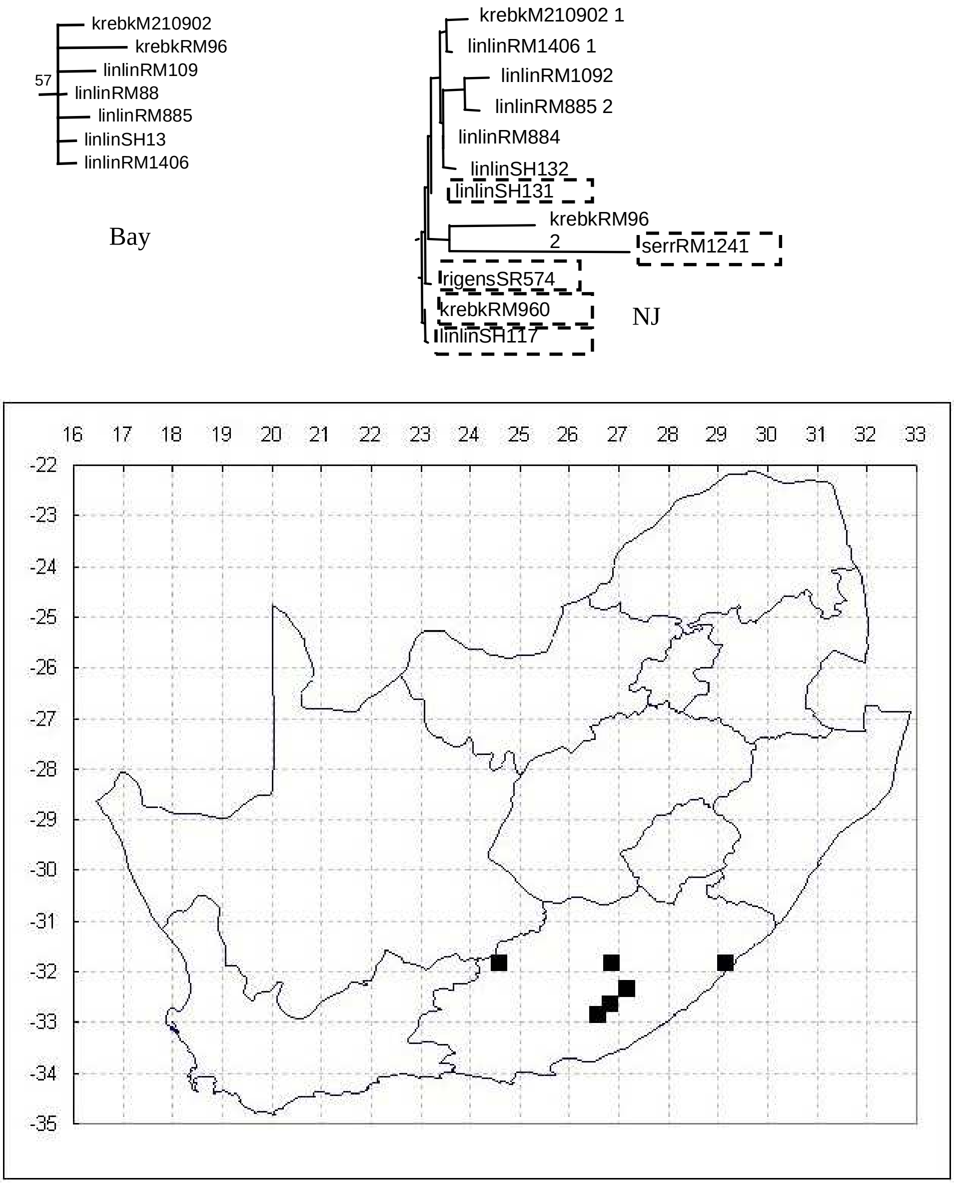


Figure 4.3.24: Partial Branch 6 from Bayesian tree in detail (on left), entire branch 6 from NJ tree on right. Dashed outlines indicate samples missing in the Bayesian branch. The map shows geographical origins of each sample in the Bayesian branch.

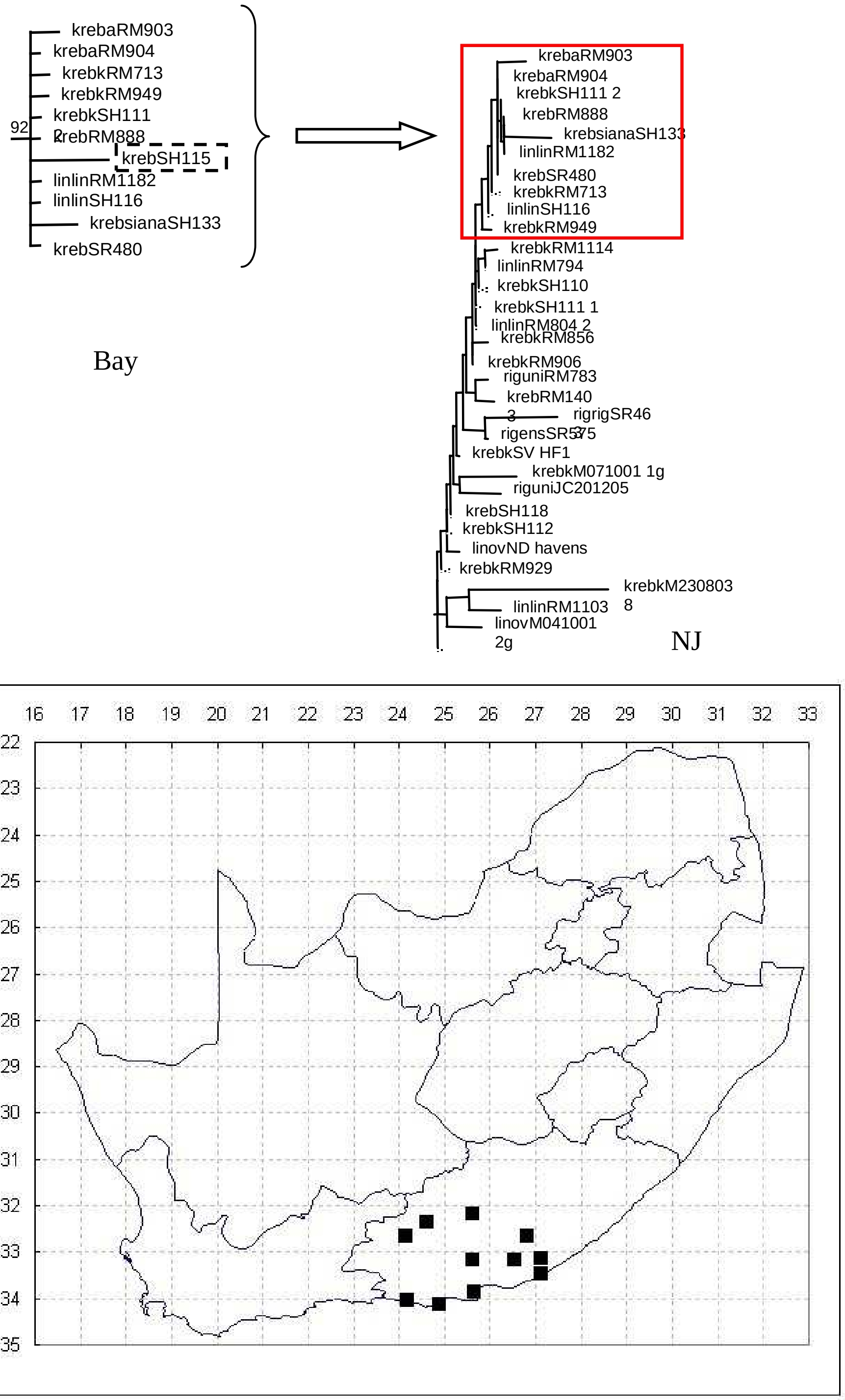
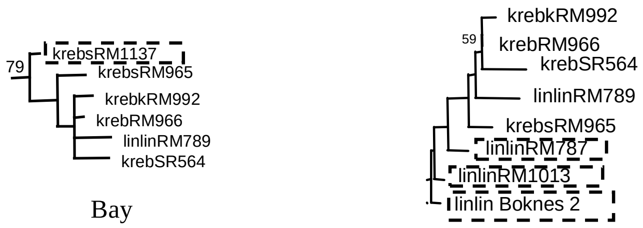


Figure 4.3.25: Partial Branch 7 from Bayesian tree in detail (on left), entire branch 7 from NJ tree on right. The map shows geographical origins of each sample in the Bayesian branch.



Bay

NJ

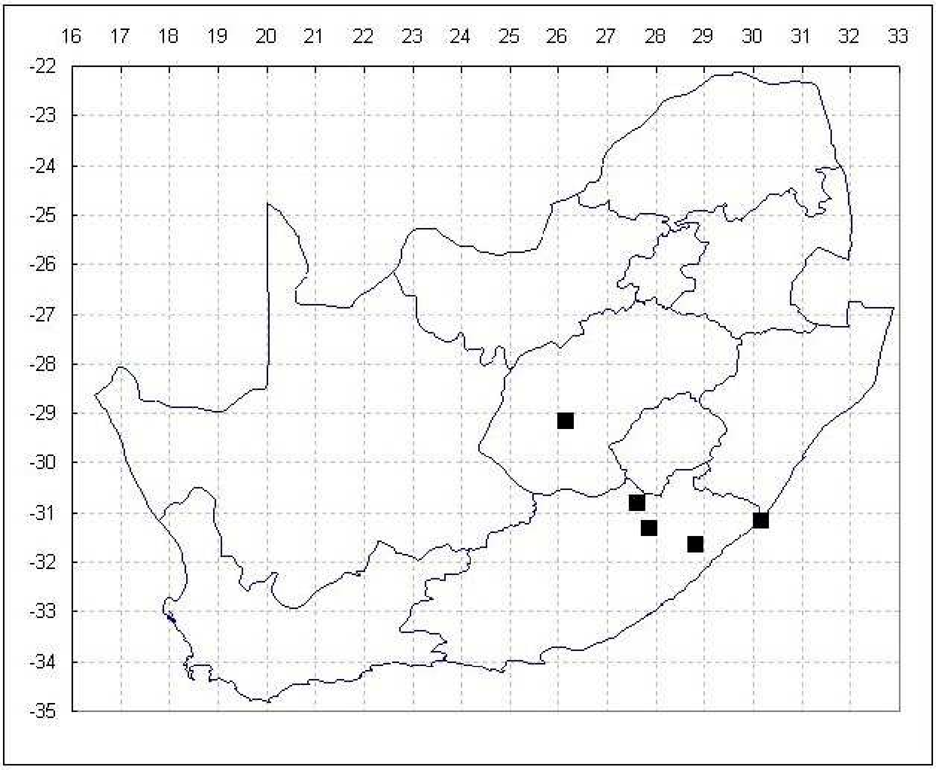
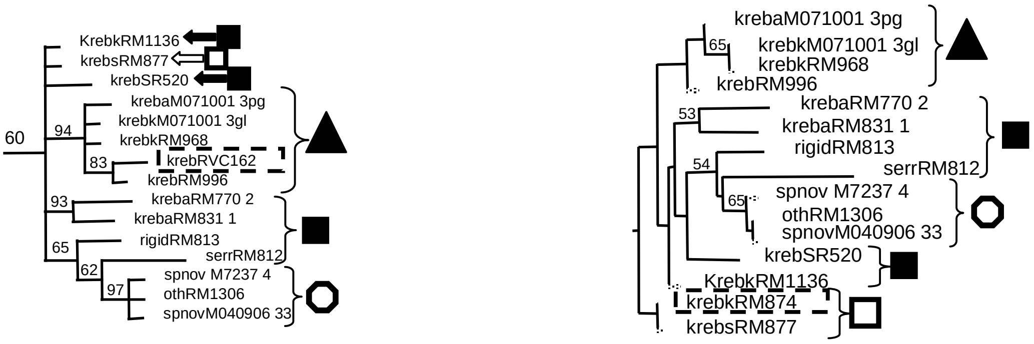


Figure 4.3.26: Partial Branch 10 from Bayesian tree in detail (on left), entire branch 10 from NJ tree on right. Dashed outlines indicate samples missing in the other branch. The map shows geographical origins of each sample in the Bayesian branch.

- The Bayesian version of Branch 11 (Figure 4.3.27) retains the same samples found in the NJ branch, although the Bayesian version of the branch is missing RM874 and now contains RVC162 (present in Branch 12 in the NJ analysis).

The Bayesian consensus tree also contains some branches that have no equivalent in the NJ tree. “Partial Branch A” (Figure 4.3.28) is made up of samples that fall into Branch 12 on the NJ tree, as well as some samples that are connected directly to the basal polytomy in the NJ tree.



Bay NJ

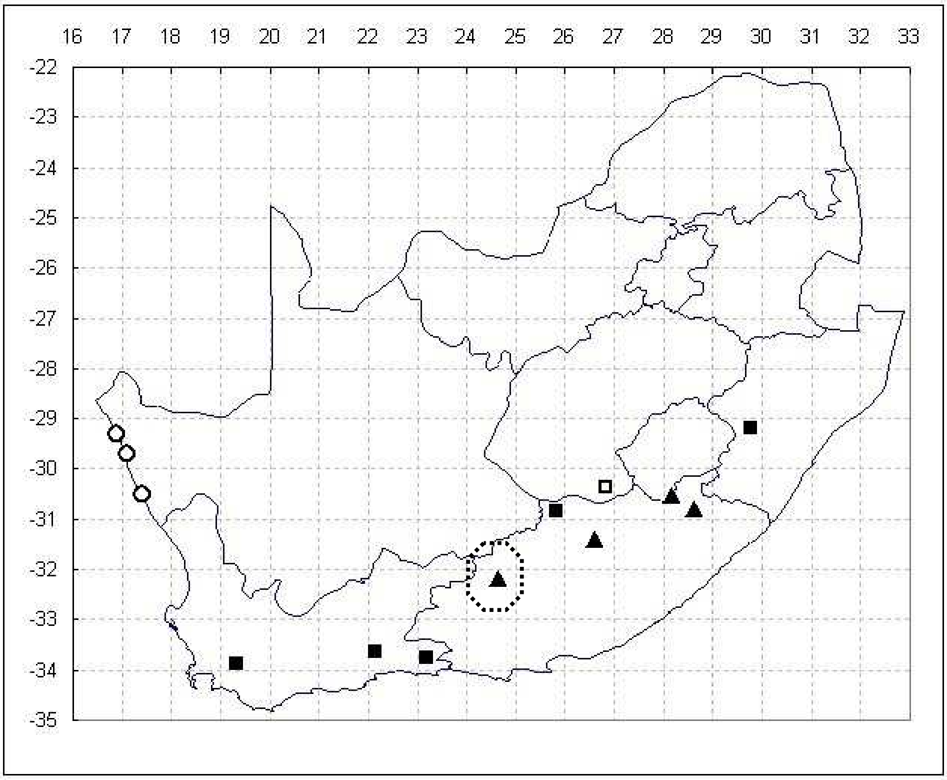
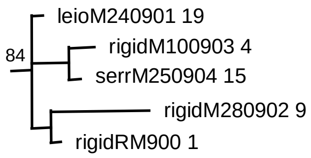


Figure 4.3.27: Branch 11 in detail with bootstrap support (Bayesian branch to left, NJ branch to right). Dashed outline indicates samples not found in the other analysis branch. The map shows the geographical origins of each sample, dotted line indicates locality for RVC162.



Bay

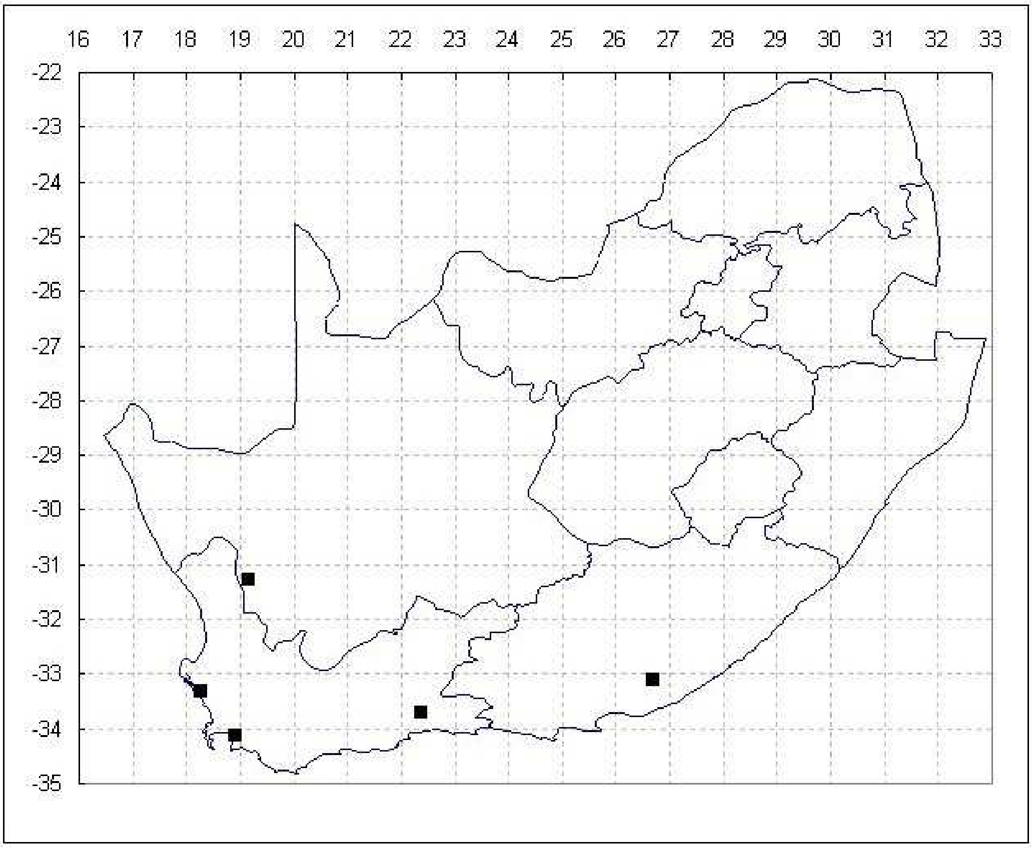


Figure 4.3.28: Partial Branch A from Bayesian tree in detail. The map shows geographical origins of each sample.

Neighbor-Net analysis

The Neighbor-Net analysis (Figure 4.3.29) shows a starlike topology. There is reticulation at the base of each branch (see the expanded centre in Figure 4.3.29.C), and a radiation of short branches from a central connection point. The branches (circled and numbered in Figure 4.3.29.B) correspond to the numbered branches in the NJ tree in Figure 4.3.9. There is no correlation between Neighbor-Net branch length and geographical origin of samples, other than that the two longest branches correspond to Western Cape samples. The Eastern Cape branches with clear geographical signal (7, 8 and 10) do not stand out among the other branches that show no geographic signal.

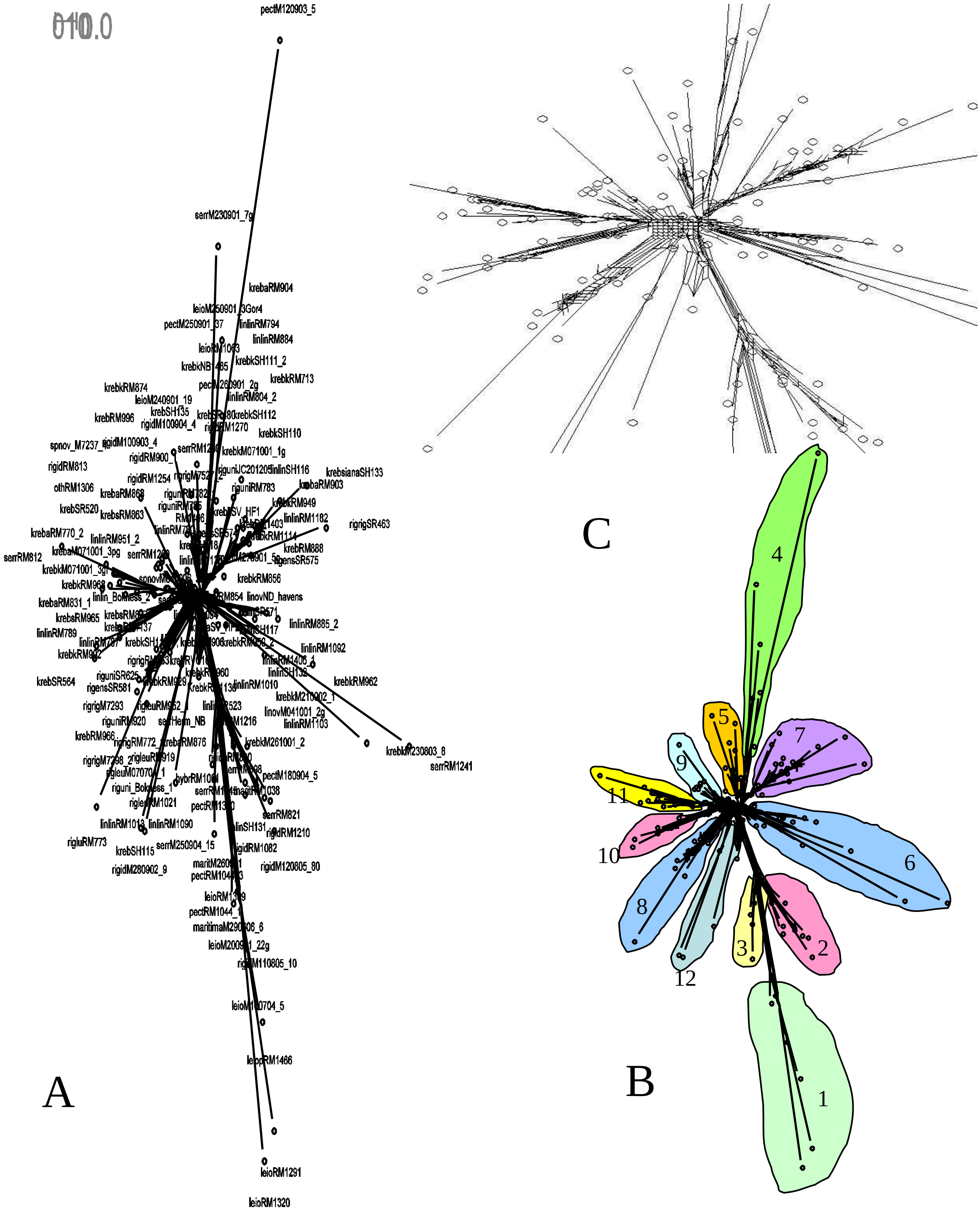


Figure 4.3.29: Neighbor-net network of KR clade, with labels (A) and without labels (B) Outlined areas with numbers indicate branches on NJ tree (B). C is an expansion of central core of network, showing reticulation.

Morphometric comparison

Figure 4.3.30 is a comparison between genetic distance and morphometric distance between each pair of samples. The correlation between the two is very poor ($r^2 = 0.0086$), indicating that there is little relationship between genetic distance and the morphological differences between pairs of samples.

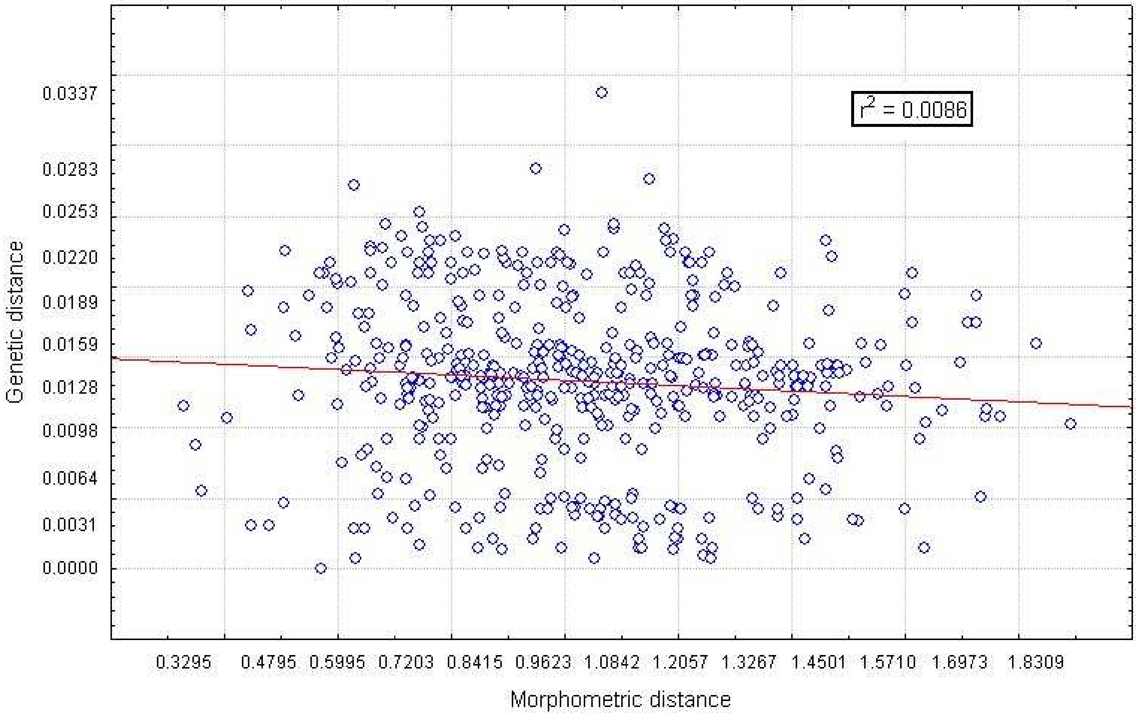


Figure 4.3.30: Scatterplot of genetic distance against morphometric distance between pairs of samples in K-R clade. Correlation r^2 value in box.

Figures 4.3.31 – 4.3.36 illustrate the comparison between NJ clades and morphometric clusters. The only two branches that show any sort of correlation between phylogenetic clade and morphometric clustering are Branch 1 (where four of six samples cluster together) and Branch 8 (where all the *G. rigens* samples cluster together).

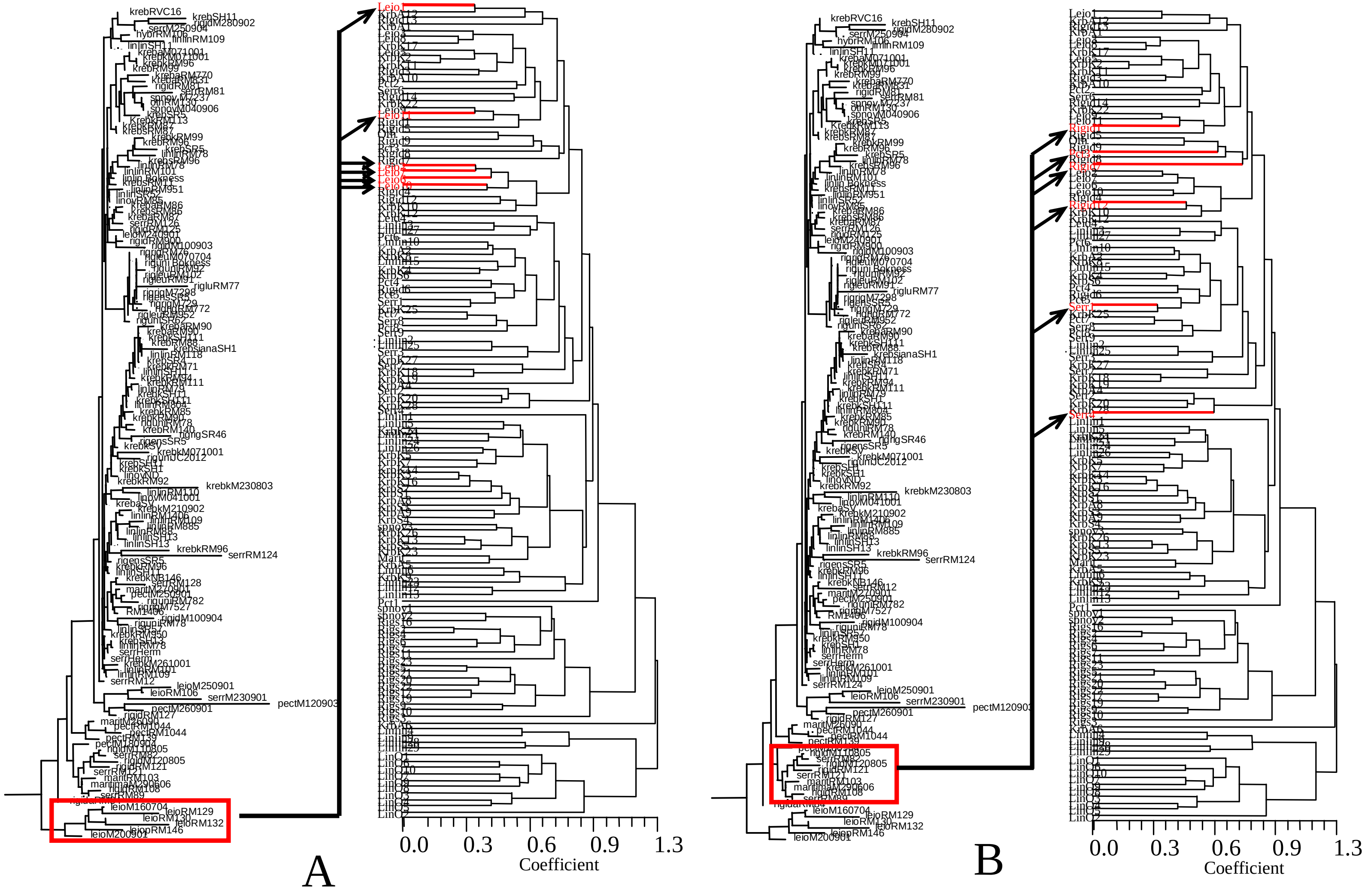


Figure 4.3.31: Comparisons between nrDNA phylogeny (left) and morphometric CA dendrogram (right). Arrows indicate positions of morphometric samples (in red) that correlate with genetic samples in Branch 1(A) and 2(B).

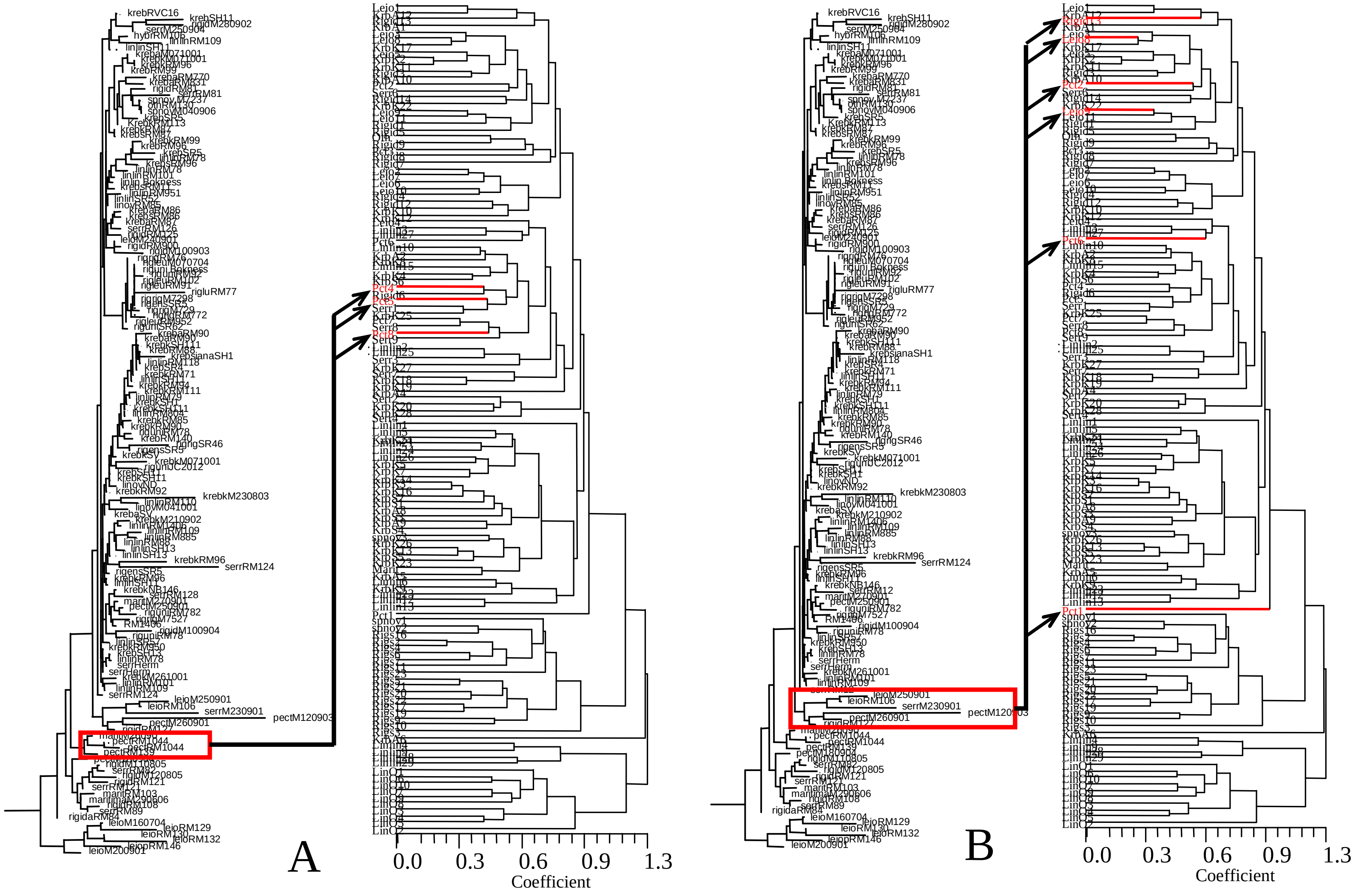


Figure 4.3.32: Comparisons between nrDNA phylogeny (left) and morphometric CA dendrogram (right). Arrows indicate positions of morphometric samples (in red) that correlate with genetic samples in Branch 3 (A) and 4 (B).

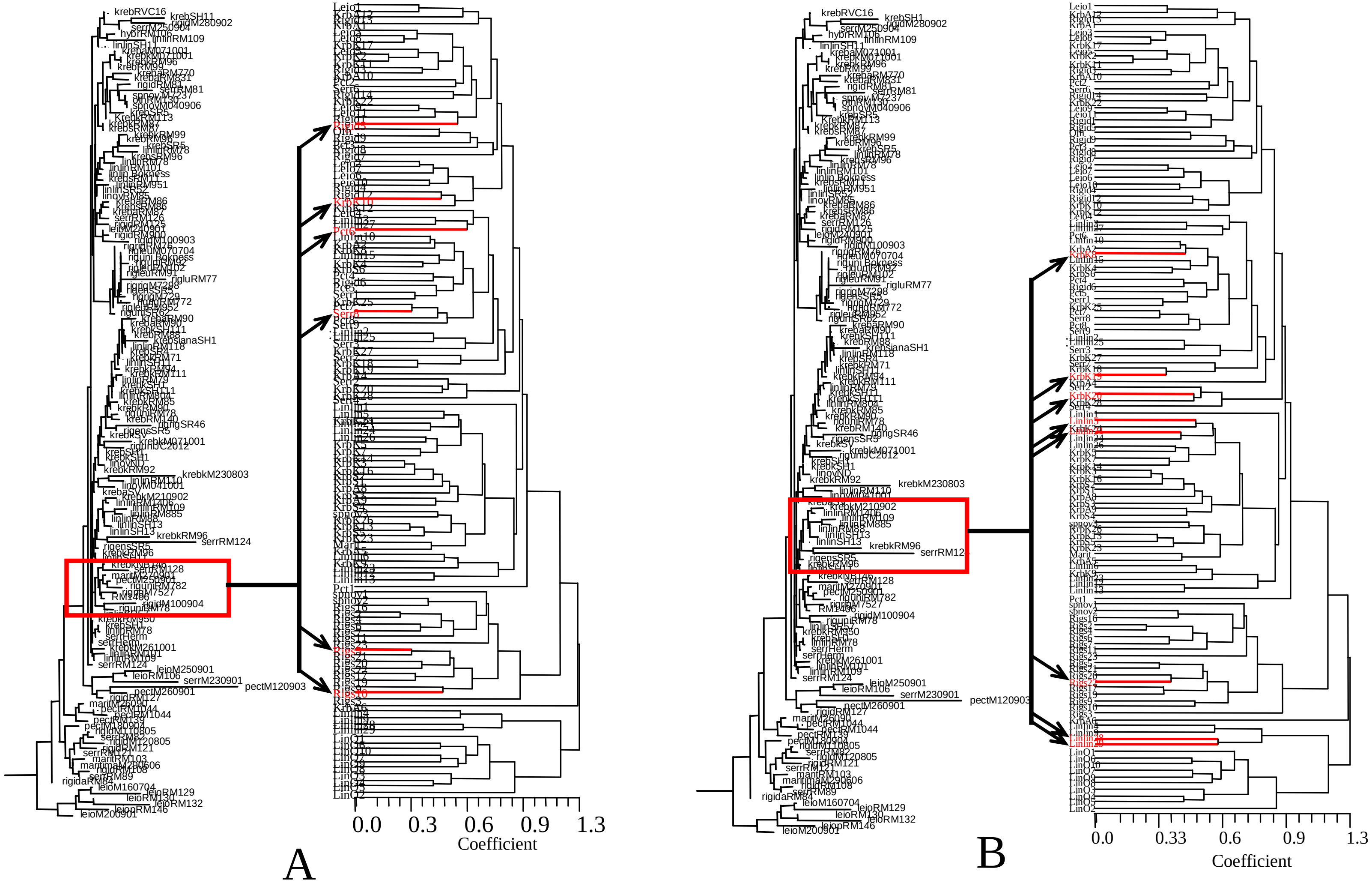


Figure 4.3.33: Comparisons between nrDNA phylogeny (left) and morphometric CA dendrogram (right). Arrows indicate positions of morphometric samples (in red) that correlate with genetic samples in Branch 5 (A) and 6 (B).

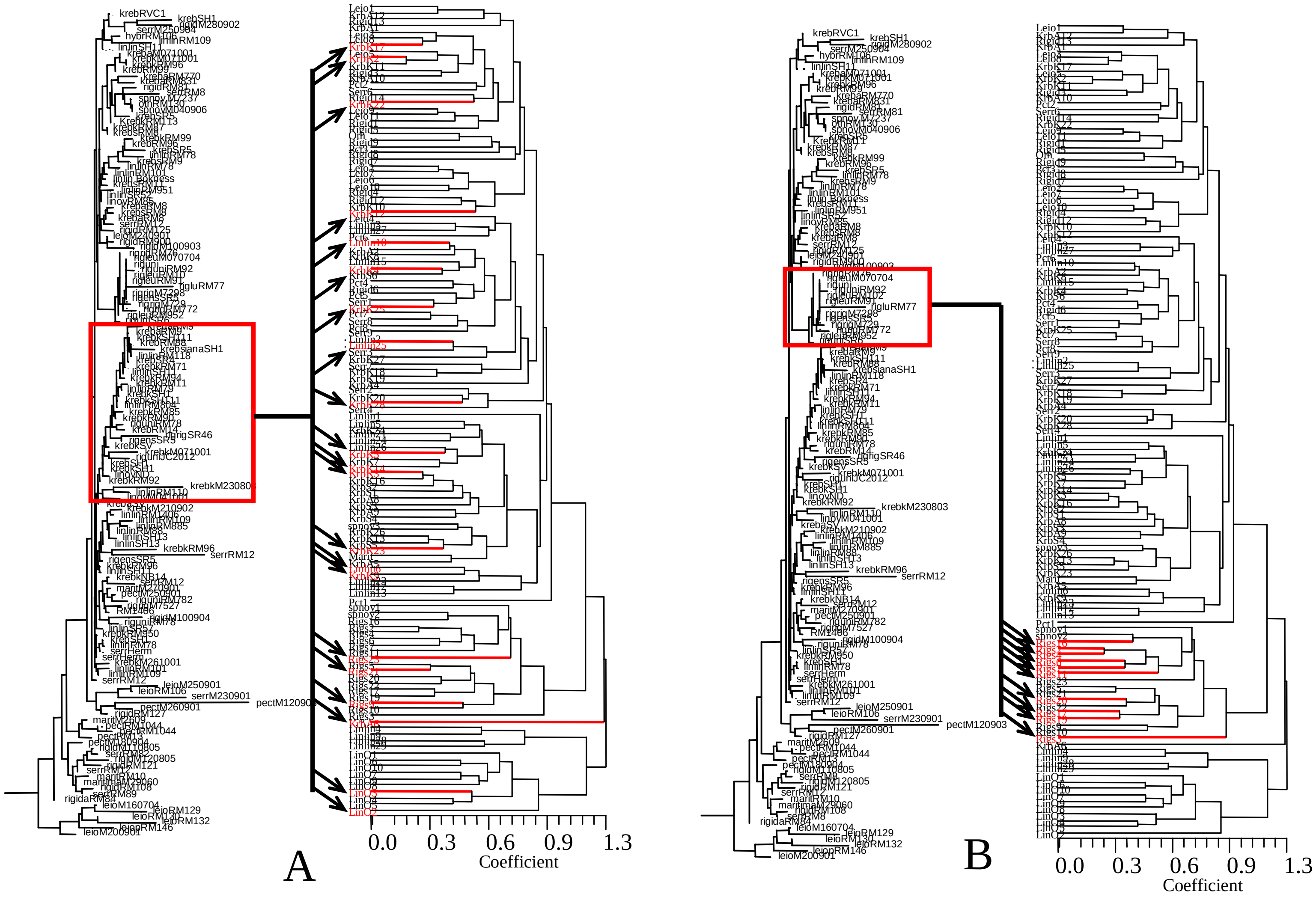


Figure 4.3.34: Comparisons between nrDNA phylogeny (left) and morphometric CA dendrogram (right). Arrows indicate positions of morphometric samples (in red) that correlate with genetic samples in Branch 7 (A) and 8 (B).

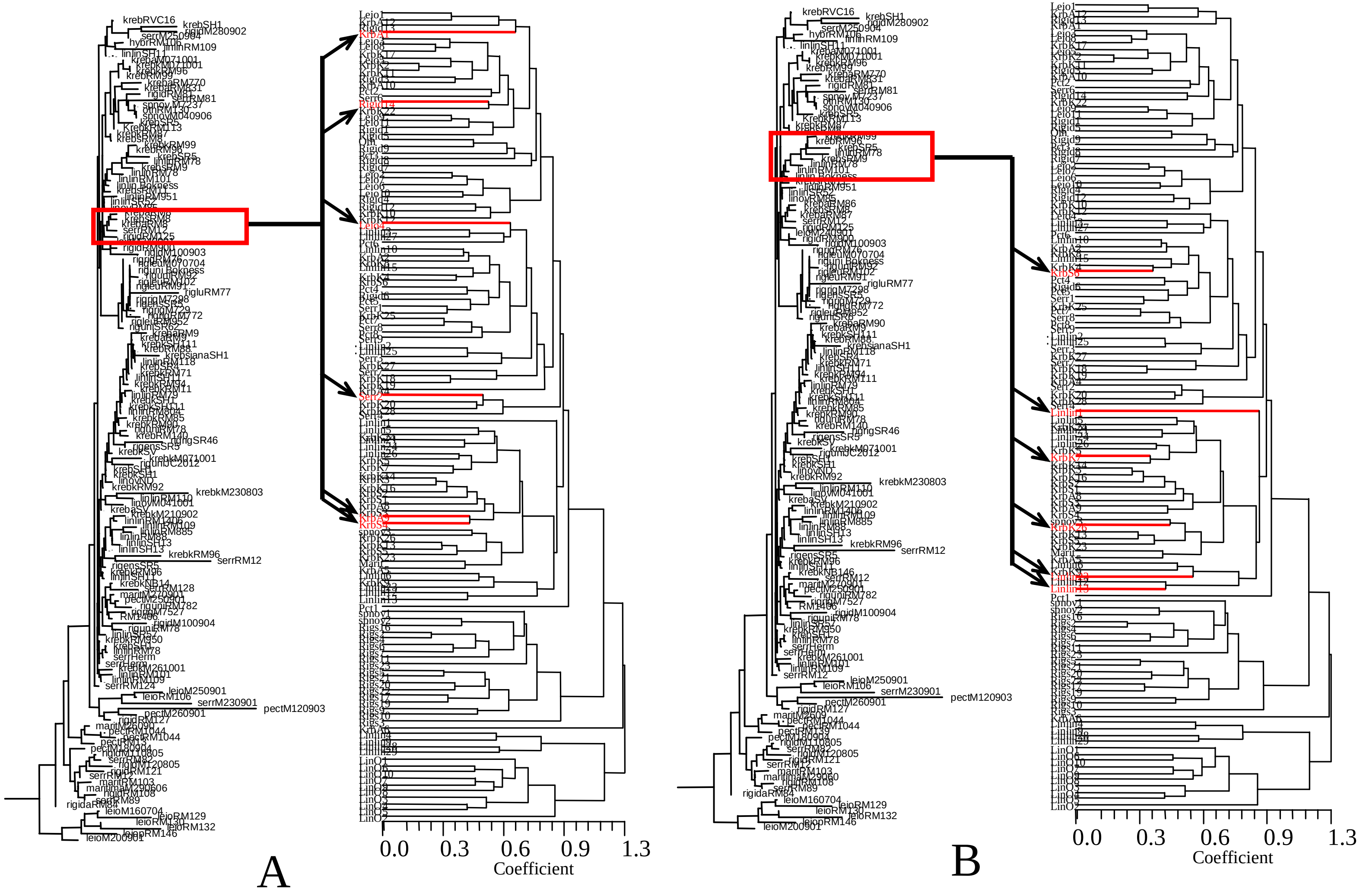


Figure 4.3.35: Comparisons between nrDNA phylogeny (left) and morphometric CA dendrogram (right). Arrows indicate positions of morphometric samples (in red) that correlate with genetic samples in Branch 9 (A) and 10 (B).

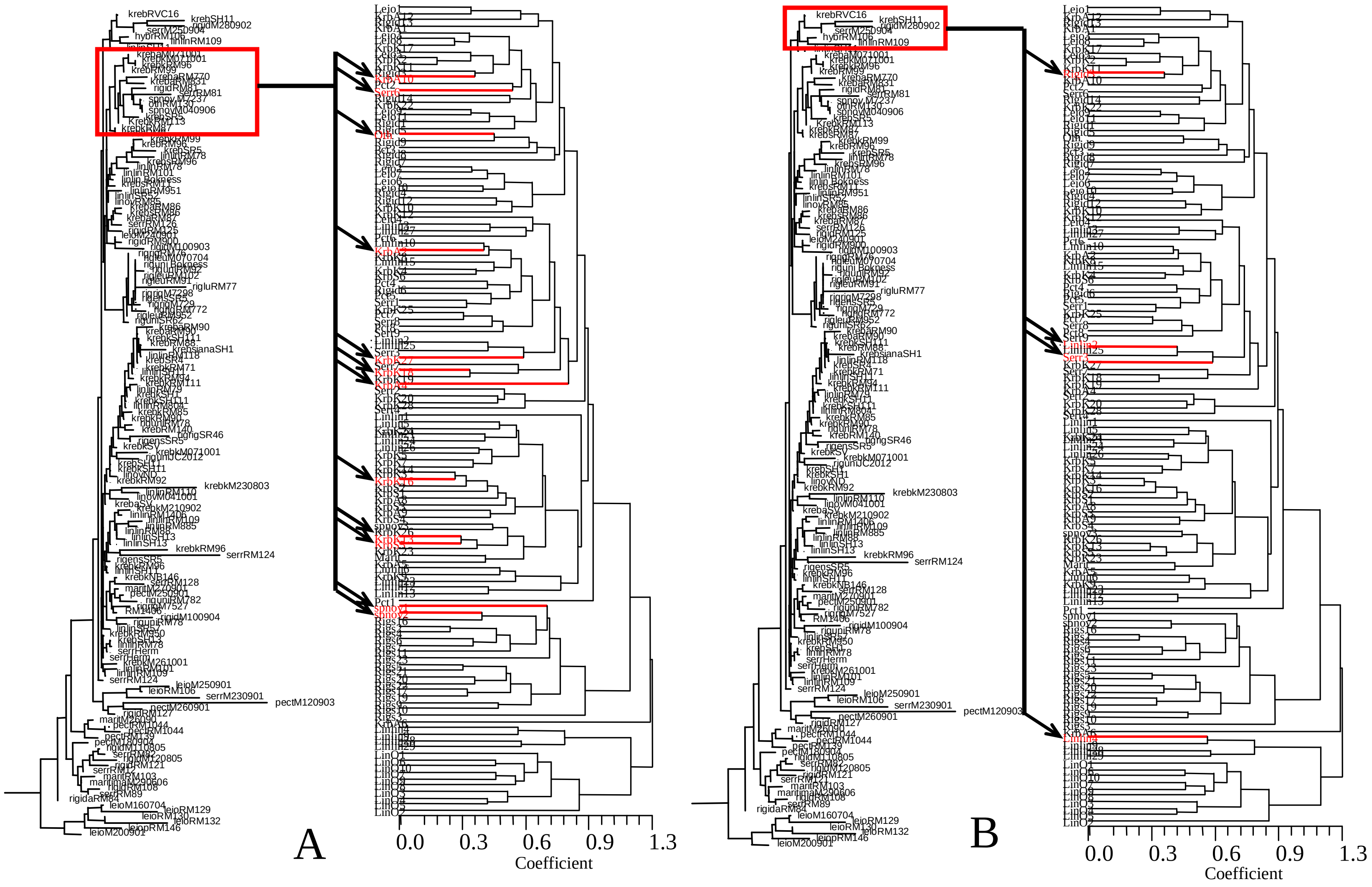


Figure 4.3.36: Comparisons between nrDNA phylogeny (left) and morphometric CA dendrogram (right). Arrows indicate positions of morphometric samples (in red) that correlate with genetic samples in Branch 11 (A) and 12 (B).

Caveats

The presence of reticulation in the Neighbor Net analysis, along with the presence of ambiguous base calls in the sequence data, suggest that some due caution must be applied to the assumption of accuracy of these nuclear phylogenies. Likewise, the lack of correlation between genetic and morphological data, and between genetic and geographical data, could also suggest that reticulation is affecting the retrieval of accurate phylogenies.

Conclusions

The presence in the K-R phylogeny of short terminal branches in a polytomy subtended by a much longer branch is a clear indication of a recent origin and a rapid radiation (Grant & Bowen, 1998). In combination with a star-shaped phylogeny and low levels of nucleotide diversity, this is evidence of recent expansion from a small number of ancestors (Grant & Bowen, 1998).

Within the K-R clade, there are three groups that show some species and phylogeographical cohesion:

1) *G. leiopoda*, (localised to the Namaqualand centre of endemism, around 30º S 18º E)
2) *G. rigens*, (localised to the south eastern cape coast), and
3) *G. othonnites/sp. nov.*, (localised to an area around Port Nolloth, this is a variable but distinctive group, showing mild succulence and pale grey leaves. The difference between *G. othonnites,* which is glaborous, and *G. sp. nov.*, which is occasionally hispid, may be a result of an initially poor description of morphological variation within *G. othonnites* by Roessler).

Two of these groups (*G. leiopoda* and *G. rigens*) also show some morphometric cohesion (*G. rigens* in particular). The rest of the samples in the K-R clade fall into a fourth paraphyletic group, with no species cohesion or clear phylogeographic signal.

In order for species to be useful units for evolutionary and ecological studies, they need to be recognizably identifiable as distinct entities (Riddle & Hafner, 1999). When biologists use species as a framework to study evolving entities in nature there may be uncertainty caused by the inherently ambiguous correspondence between a species and the entity or entities for which it is used as a hypothesis (Hey *et al*., 2003).

Species taxa are devised by investigators and are partly a function of the investigator's tools, circumstances and inclinations, and for species that have distinguishing morphological characters, this subjective element will seem remote and biologists can agree on the organisms to be included in a species (Hey *et al.*, 2003). For more problematic taxa, two investigators working with a common sample of organisms may disagree on the importance of a particular pattern of variation, and thus also on the designations and descriptions of these species, a type of uncertainty that can be difficult to mitigate (Hey *et al.*, 2003).

The three cohesive entities in the K-R clade may perhaps not be discrete enough to qualify as species. They are evolutionary lineages, and could perhaps be classified as Evolutionary Significant Units (ESU; Ryder, 1986), but their status as “species” is questionable, as is the status of all the K-R clade morphologically defined taxa. The cohesive lineages are perhaps best classified as distinct varieties. If the cohesive lineages were classified as species, they would render the remainder of the K-R clade paraphyletic. However, Goldstein & DeSalle (2000) note that the concepts of paraphyly and monophyly (which rests on the identification of common ancestry) can become meaningless when applied to nonhierarchical systems where common ancestry is confounded by reticulating networks of interconnected parentage. Ultimately, ranking in this context (i.e. whether the cohesive lineages are species or varieties) may perhaps be arbitrary.

The reasons for this lack of taxonomic clarity and the historical and evolutionary causes that lead to this situation are investigated in Chapter 5.

Chapter 5.
Recent evolutionary history of *Gazania*

> “The probability of a large amount of hybridization between the species and a resultant mixture of characters is very high… perhaps right here lies the actual difficulty of the taxonomic treatment of this genus.” (Roessler, 1959, pp 101, translated from the original German).

Aim: To explain the phylogenetic and phylogeographic distribution of the taxonomic entities within *Gazania*.

Geography and climate as driving factors in speciation

Ayoub & Riechert (2004) note that continental drift and mountain uplifting (and other such geological events) have predictable consequences for evolutionary lineages: they can create physical obstacles to gene flow. This leads to the formation of monophyletic groups on either side of the barrier (Ayoub & Riechert, 2004). A less understood but equally important type of historical event is climate change: generalization about the effects of climate change on evolutionary lineages is difficult as species may respond in different ways to changes in climate (Ayoub & Riechert, 2004). Ayoub & Riechert, (2004) cite examples where, since the last glacial maximum, range expansion or contraction of populations occurred at varying tempos and in different directions for individual species. Responses to climate change are species specific, which means that biogeographical studies searching for general patterns have focused on geological historical events, often ignoring the effects of climate change (Ayoub & Riechert, 2004).

Cheng *et al.* (2005) note that the present status of species distributions represents the effects of various geographical barriers, dispersal behaviours and abilities, and colonization competition with resultant nonsynchronous migration. Heuertz *et al.* (2004) likewise note that it is well established that species co-occurring today may have undergone very different responses to climate change and thus can show different evolutionary history patterns.

Population growth history

The analysis of variation in DNA sequences has the potential for providing insight into population genetic processes (Slatkin & Hudson, 1991). Episodes of population growth and decline leave characteristic signatures in the distribution of nucleotide site differences between pairs of individuals

(Rogers & Harpending, 1992), and the numbers of differences in sequences between all pairs of individuals can be used to summarise information in the data, while the shape of the graph can point to patterns of population growth and expansion (Slatkin & Hudson, 1991). A single (unimodal) distribution of pairwise distances (reflecting similarity in the amount of divergence among all pairs of haplotypes) can be indicative of populations which have gone through a period of rapid expansion or growth, while a multimodal distribution that has multiple peaks is indicative of populations which have been stable over time (Mahoney, 2004). In this type of distribution graph, an episode of growth generates a wave that travels from left to the right; the smaller the initial population, the steeper will be the leading face of the wave (Rogers & Harpending, 1992). If there have been any recent population expansions within *Gazania*, they should present as a star-like phylogeny associated with the unimodal mismatch distribution (Slatkin & Hudson, 1991; Mahoney, 2004).

In conjunction with information on the climatic history of Southern Africa, the data gathered in the previous chapters can now be utilised in unison to track the origin, and the evolutionary and biogeographical history of the various taxonomic entities within *Gazania*.

Methods

Geographical mapping

Each terminal node in the major branches of the genetically distinct clades in the phylogenetic trees generated in Chapter 3 was plotted onto maps of Southern Africa in an attempt to elucidate any biogeographical patterns that may exist. Likewise, the geographical origins of the terminal nodes in the expanded K-R clade from Chapter 4 are also mapped.

Maps of Roessler's original taxa collection sites and his species distributions, the collection locality data from the PRECIS database, and the locality data from the DNA samples collected for this project are also mapped out for comparative purposes. The possibility of erroneous species determinations or database entry errors with the PRECIS data suggests that reasonable caution should be exercised with any localities that appear to lie far outside the distributions for all other samples of each entity.

Divergence time estimation

A "molecular clock" model assumes that there is a global rate of mutation across all lineages in a phylogeny (Rutschmann, 2006). However, a clock is not always a good model for the process of molecular evolution, with variation in rates of nucleotide substitution pervasive, both along a lineage and between different lineages (Li, 1997).

To test if there is a constant mutational rate constant across all lineages, the Likelihood Ratio Test (Felsenstein, 1981) was conducted in PAUP*, comparing likelihoods obtained with and without an enforced molecular clock. The difference between the two likelihoods was doubled and then used in conjunction with Chi squared tables to determine if the difference between the two likelihoods was significant (degrees of freedom was calculated as Number of taxa – 2). A significant result ($p<0.05$) would reject the molecular clock hypothesis for the data under investigation.

The dates of sequence divergence can be calculated manually. To obtain an approximate dating of branching events between species and species groups, the average sequence divergence values were calculated for highly supported sister groups. Only ITS sequence data was utilised for these calculations, as rates of change for other regions are not well studied or published. The uncorrected pairwise distances were determined using PAUP*. The pairwise sequence divergence values between two sister groups were determined as the average of all pairwise sequence divergence values between species from the two clades. These average sequence divergence values were calculated from the uncorrected pairwise distance to accommodate the divergence rates previously calibrated in other studies (Richardson *et al*., 2001). Divergence time between a pair of species was calculated as half of the divergence value divided by the rate of change in substitutions per site per year (Yuan *et al.*, 2005).

A variety of ITS rates of divergence are listed in Richardson *et al.* (2001). Rates for ITS divergence generally fall into a range from 1.72 x 10^{-9} substitutions per site per year (s/s/y) in the Saxifragaceae (Vargas *et al.*, 1998) to 7.83 x 10^{-9} s/s/y in the Compositae (Sang *et al.*, 1995). The mutation rates for annuals (1-2 years) are the fastest, and additionally the rates for the Asteraceae tend to be fairly high. Since *Gazania* is a small herbaceous perennial member of the Asteraceae that can go from seed to seed set in under a year, an average for the Asteraceae mutation rates can be calculated as 5.21 x 10^{-9} s/s/y, with a lower extreme of 3 x 10^{-9} s/s/y (from the Hawaiian Silverswords; Baldwin & Sanderson, 1988), and a higher extreme of 7.83 x 10^{-9} s/s/y (from *Robinsonia*; Sang *et al.*, 1995).

Apart from manual calculation, there are a number of software packages that can perform dating estimates, and some can employ both strict and relaxed molecular clocks (Drummond *et al.,* 2006). BEAST (Drummond *et al.,* 2003) implements a Bayesian Markov chain Monte Carlo method to estimate phylogenies and divergence times in the face of uncertainty in evolutionary rates and calibration times (Drummond *et al.,* 2006). The molecular clock assumption can either be enforced strictly, or relaxed by allowing the rate to vary throughout the tree in an autocorrelated manner (Ho *et al.,* 2005).

A relaxed clock can either use a lognormal distribution (with the variance scaled relative to the length of the branch in units of time, implying that the evolutionary rate changes continuously along the branch) or an exponential distribution (which implies that changes occurred at the nodes, with the size of the change being independent of the branch length) (Drummond *et al.,* 2006). The variable rate methods implemented in BEAST use Bayesian inference and the MCMC procedures to derive the posterior distribution of rates and times, and they do not require a starting tree topology (Rutschmann, 2006). Following a burn-in of 500,000 cycles, rates were sampled once every 1000 cycles from 5,000,000 Markov Chain Monte Carlo (MCMC) steps. Rates were estimated under a GTR model and the average mutation rate calculated above was utilised. Both the lognormal and the exponential relaxed clocks were used for comparative purposes.

Pairwise sequence divergences

Pairwise sequence divergences were tabulated using PAUP*. Frequencies of each pairwise sequence divergence distance were plotted against the number of differences between each pair of sequences.

Results

Maps of genetically cohesive species

Figures 5.3.1 to 5.3.8 are maps of the genetically discrete species found in Chapter 3. They layer three different sets of distribution data together: Roessler's original species distributions (represented by irregular shaped areas within solid outlines); the PRECIS database locality data (represented by squares); and the localities for samples collected for this study (represented by open circles).

In most cases, the species distributions mapped by Roessler do not map the true extent of the occurrences of these species across South Africa as indicated by the specimens in PRECIS. The addition of the locality data from the PRECIS database extends almost all of these species' distribution limits. The potential drawback with using PRECIS locality data is the danger of mistaken species determinations or erroneous database entries for locality data. A possible example of this is the presence of a *G. jurineifolia* subsp *scabra* sample at 3022AA (Figure 5.3.3), which lies well outside the subspecies's normal distribution, but lies well within the distribution of the other subspecies of *G. jurineifolia* (Figure 5.3.4).

There are two further major extensions of these species distributions. One occurred with the discovery of a *G. ciliaris* (Figure 5.3.7) population in the Eastern Cape at Seven Seas, near the Fish River (sampled as SR705). The other occurred with the discovery of extensive populations of the putatively rare *G. caespitosa* (Figure 5.3.8) on the high altitude areas of the Sneeuberg, Koudeveldberg, Meelberg and Toorberg mountain ranges (R. Clark, pers. comm., represented by RVC448 and RVC307). *G. caespitosa* was collected once in 1872 from the Sneeuberg and described from this exemplar. According to the PRECIS data base it was collected only twice more (in 1897 and 1976) from widely different localities (Garcia's Pass and Nuwerus) (although these may be erroneous species determinations or localities). The subsequent 2006 collections by Clark suggest that *G. caespitosa* is "very common" in the high altitude regions (around 2000 m) of the eastern and southern cape mountains (R. Clark, pers. comm.). But as this region is poorly collected, this is not entirely unexpected.

All but one of the genetically discrete species found in Chapter 3 occur in either the western half of South Africa (towards the more northern reaches of this area), or in the south-western regions of Namibia. The exception to this is *G. caespitosa*, which occurs in the high altitude regions of the mountain ranges in the eastern and southern cape. *G. ciliaris* usually occurs in the south-western cape (but a recent find has extended this range to the Eastern Cape; Figure 5.3.7).

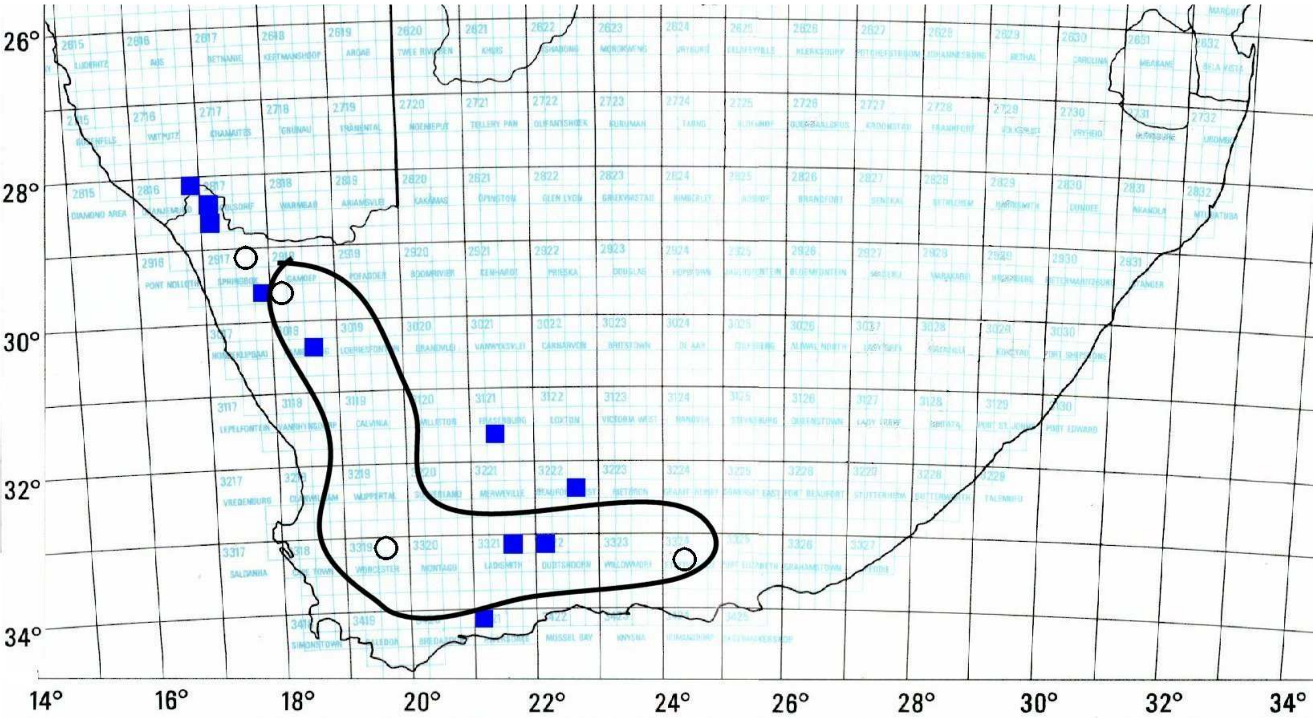


Figure 5.3.1: Distribution map for *G. heterochaeta*. Solid outline indicates Roessler's distribution, solid squares indicate PRECIS localities, and hollow circles indicate samples collected for this study.

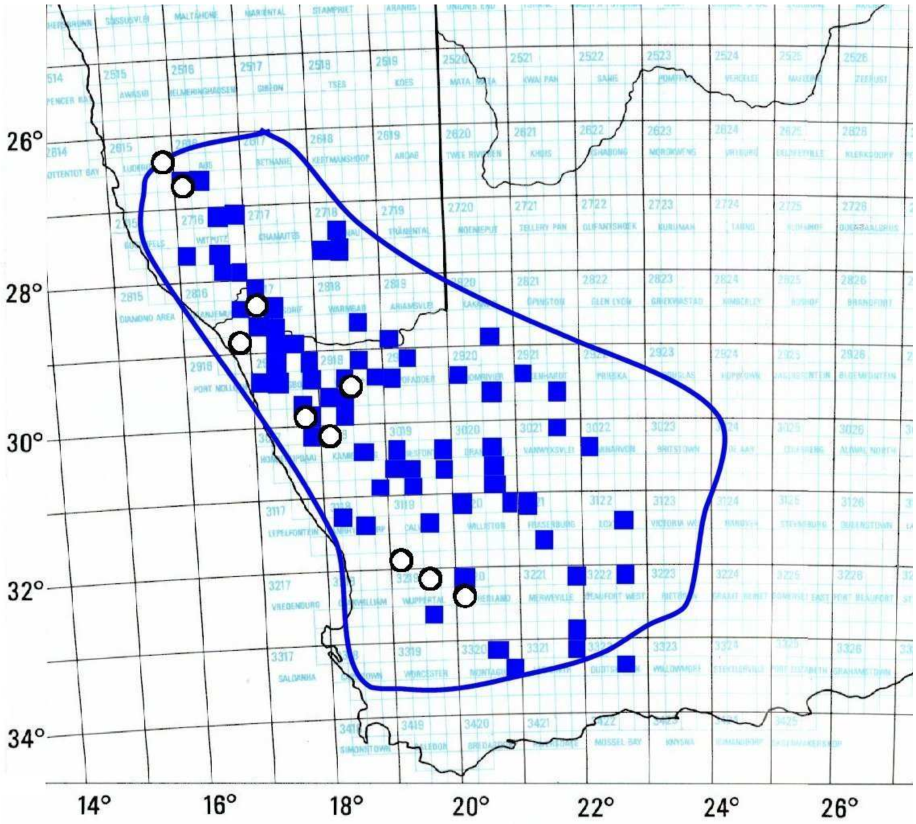


Figure 5.3.2: Distribution map for *G. lichtensteinii*. Solid outline indicates Roessler's distribution, solid squares indicate PRECIS localities, and hollow circles indicate samples collected for this study.

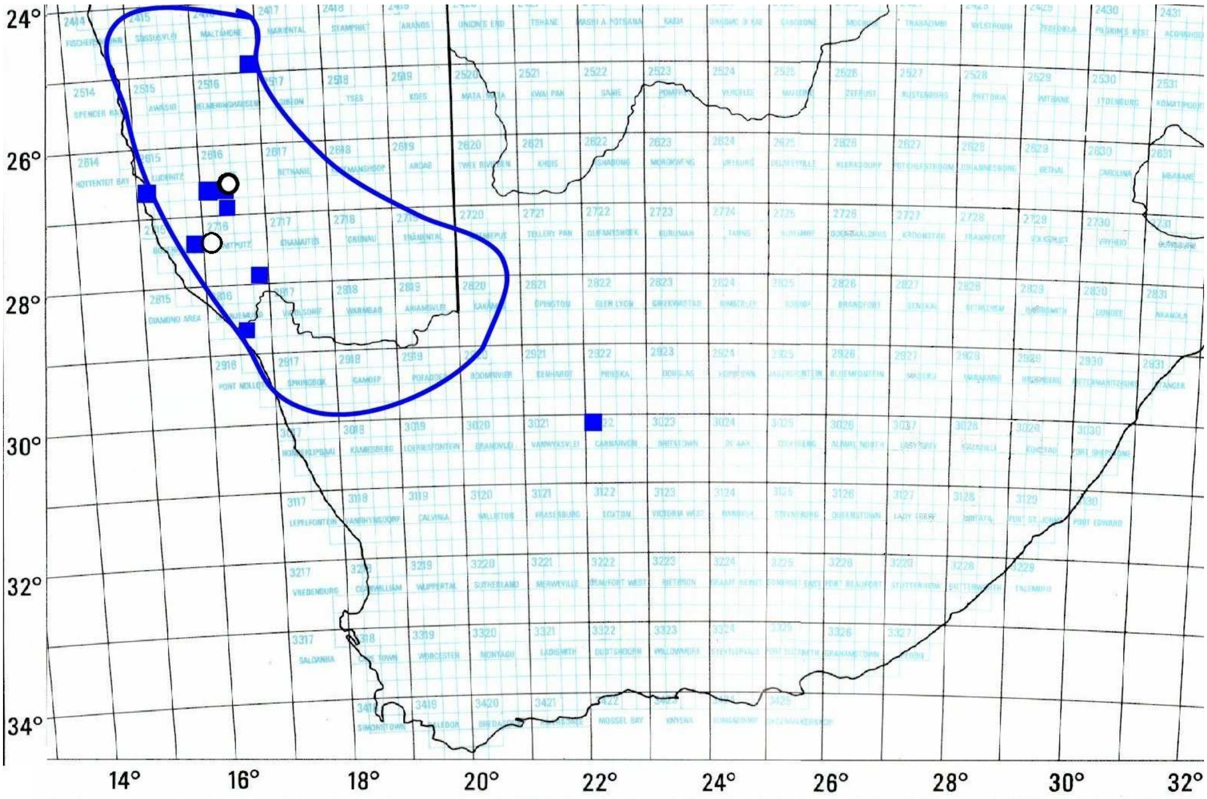


Figure 5.3.3: Distribution map for *G. jurineifolia* subsp *scabra*. Solid outline indicates Roessler's distribution, solid squares indicate PRECIS localities, and hollow circles indicate samples collected for this study.

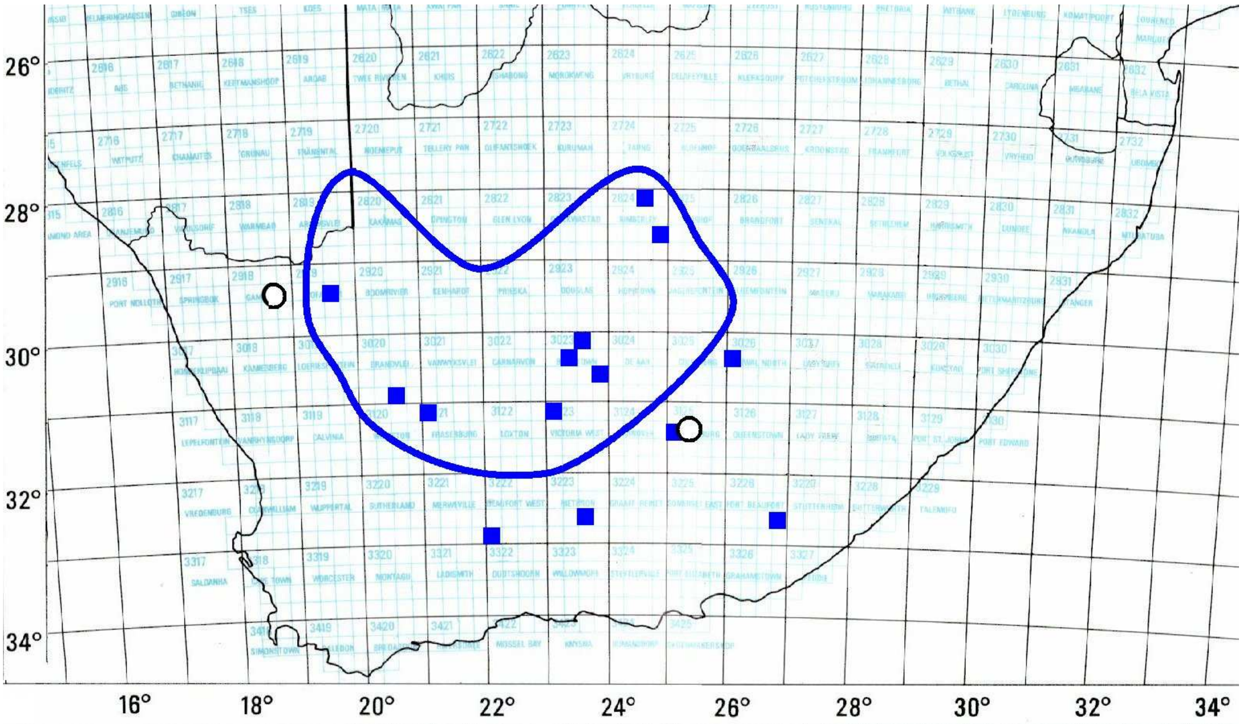


Figure 5.3.4: Distribution map for *G. jurineifolia* subsp *jurineifolia*. Solid outline indicates Roessler's distribution, solid squares indicate PRECIS localities, and hollow circles indicate samples collected for this study.

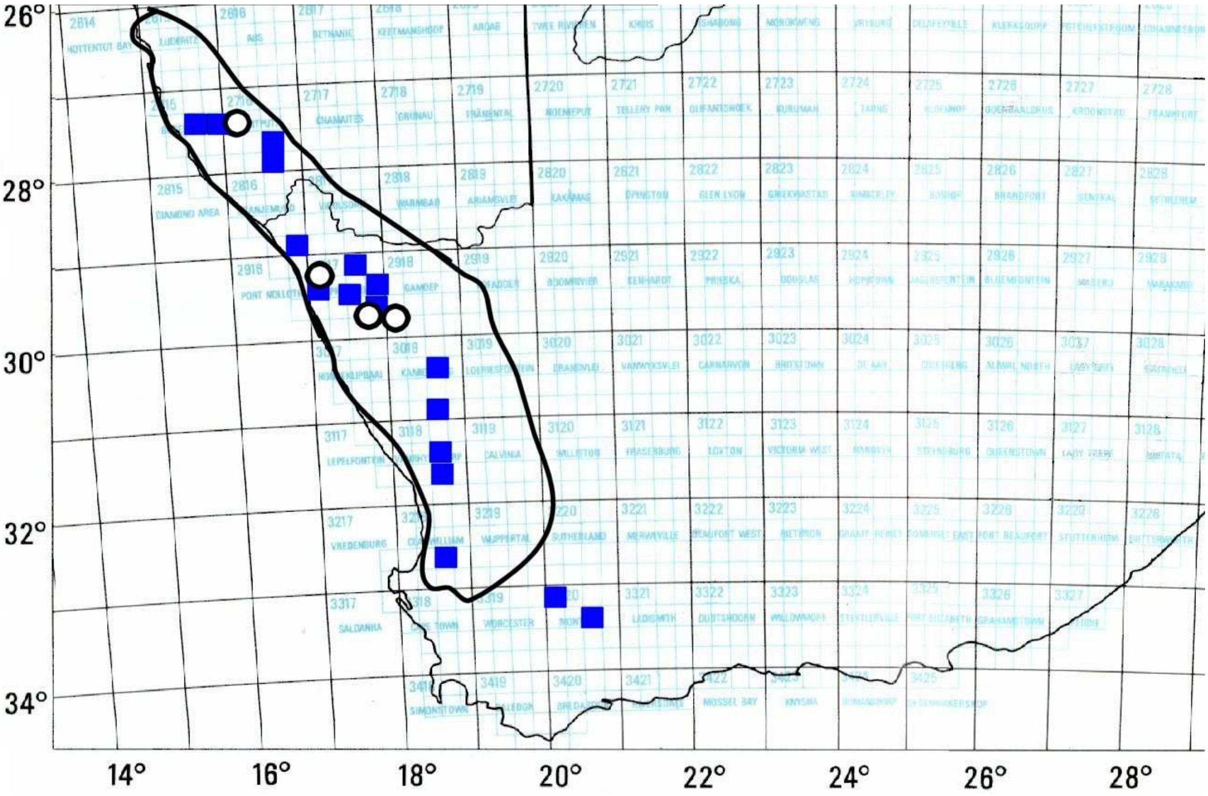


Figure 5.3.5: Distribution map for *G. tenuifolia*. Solid outline indicates Roessler’s distribution, solid squares indicate PRECIS localities, and hollow circles indicate samples collected for this study.

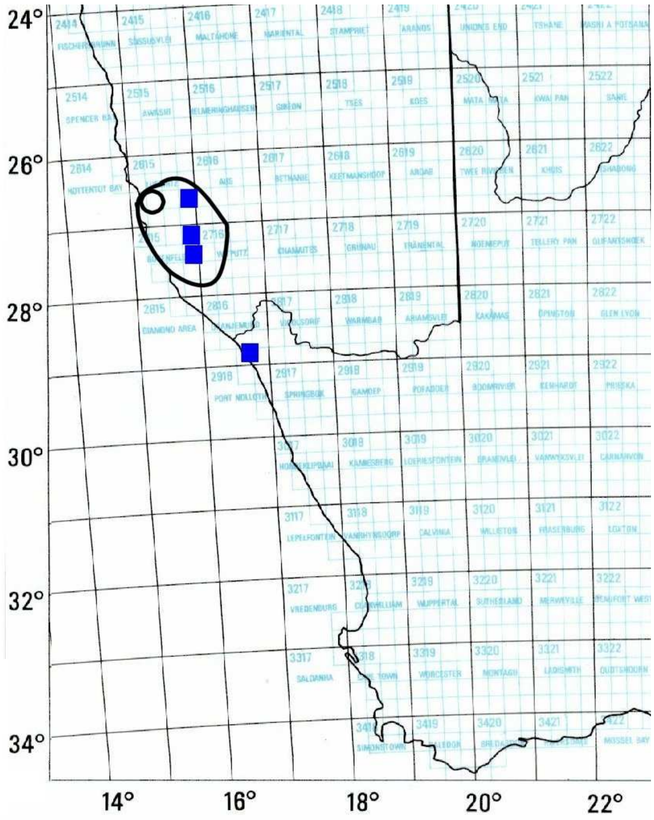


Figure 5.3.6: Distribution map for *G. schenckii*. Solid outline indicates Roessler’s distribution, solid squares indicate PRECIS localities, and hollow circles indicate samples collected for this study.

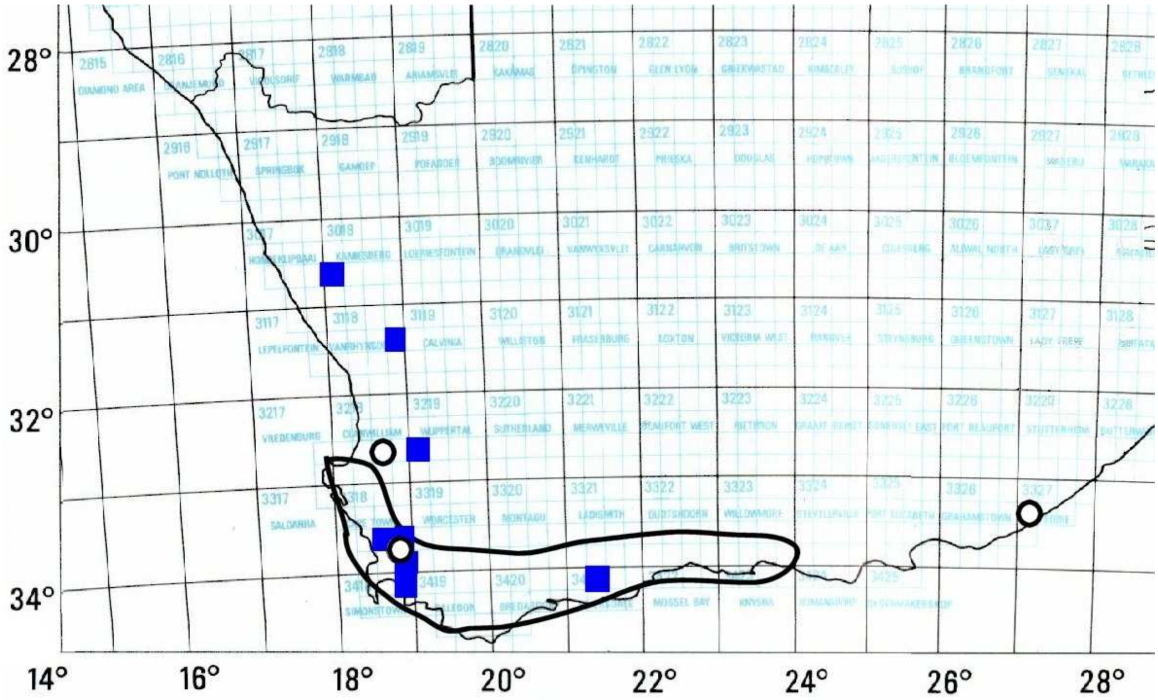


Figure 5.3.7: Distribution map for *G. ciliaris*. Solid outline indicates Roessler's distribution, solid squares indicate PRECIS localities, and hollow circles indicate samples collected for this study.

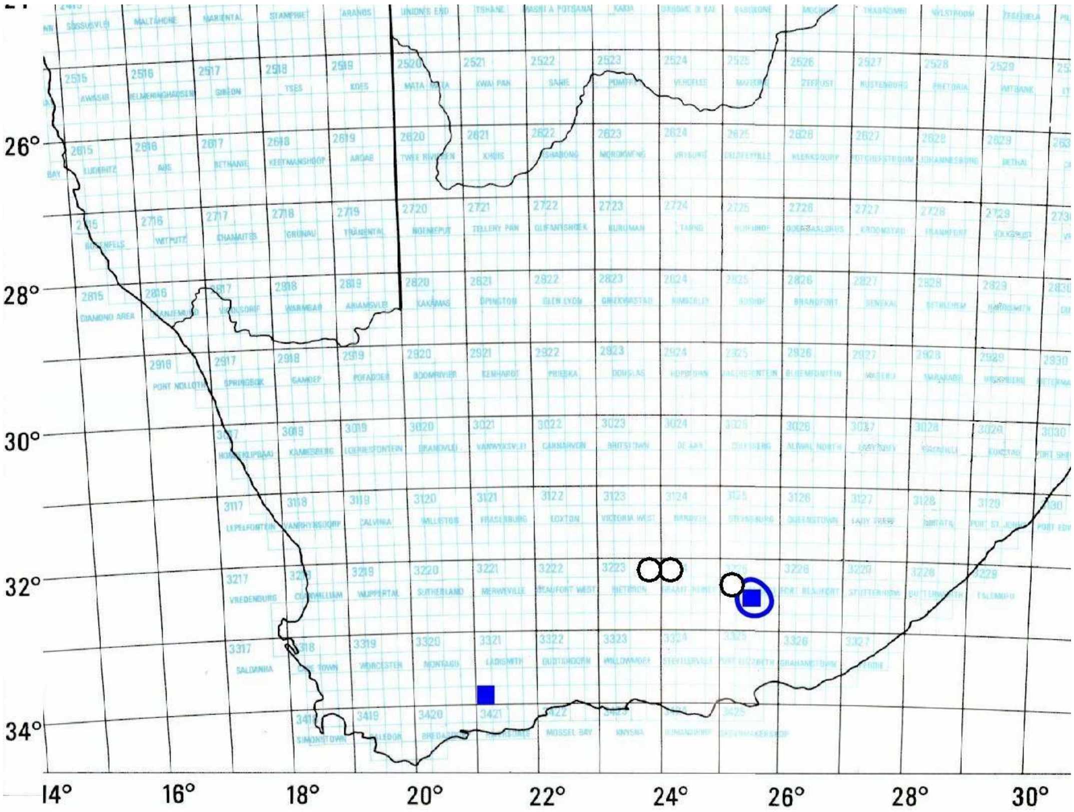


Figure 5.3.8: Distribution map for *G. caespitosa*. Solid outline indicates Roessler's distribution, solid squares indicate PRECIS localities, and hollow circles indicate samples collected for this study.

Figure 5.3.9 illustrates the distributions for each major branch in the phylogeny of Chapter 3. *G. jurineifolia* (including both subspecies) has a distribution that extends from southern Namibia into northern central South Africa (Figure 5.3.9-A). Figure 5.3.9-B overlays the newly expanded species distributions for *G. lichtensteinii*, *G. schenckii*, *G. tenuifolia* and *G. heterochaeta* onto the same map. These species all group together with high support in the phylogenies of Chapter 3 (Figures 3.3.2 and 3.3.6), and are also sister to the K-R clade. Although these five genetically discrete species do not show any major geographical disjunctions, they nevertheless maintain their genetic separation.

The central area of overlap of these five species distributions is southern Namibia. This centre of diversity points to a possible refugial area, out of which *Gazania* radiated in the form of the K-R clade.

There is, however, a sharp disjunction with the high altitude mountainous *G. caespitosa* distribution, and a lesser disjunction with the south cape *G. ciliaris* distribution (Figure 5.3.9-A). Both these species occur together on the same branch, and share a unique 327 bp deletion in their *psbA-trnH* spacer. This suggests either dispersal to the mountain regions or a vicariance event.

K-R clade

Figure 5.3.9-C illustrates the distribution of the K-R clade as a whole, spread across much of South Africa, and showing no real pattern. When the clade is broken down into evolutionary lineages (Figures 5.3.10 and 5.3.11) (rather than “species” groupings) some patterns becomes apparent. Figure 5.3.10 overlays the widely distributed lineages that showed no clear geographic signal. Figure 5.3.11 overlays the geographical distributions for evolutionary lineages in the K-R clade that show some geographical localization, along with a summarised phylogeny of the K-R clade.

The most basal branch of the K-R clade (Branch 1) is strongly localised to the Namaqualand centre of endemism. The other basal branches (2, 3 and 4) are centred in the south western cape. The rest of the polychotomous branches either centre along the east coast or show generalised distributions that range across South Africa.

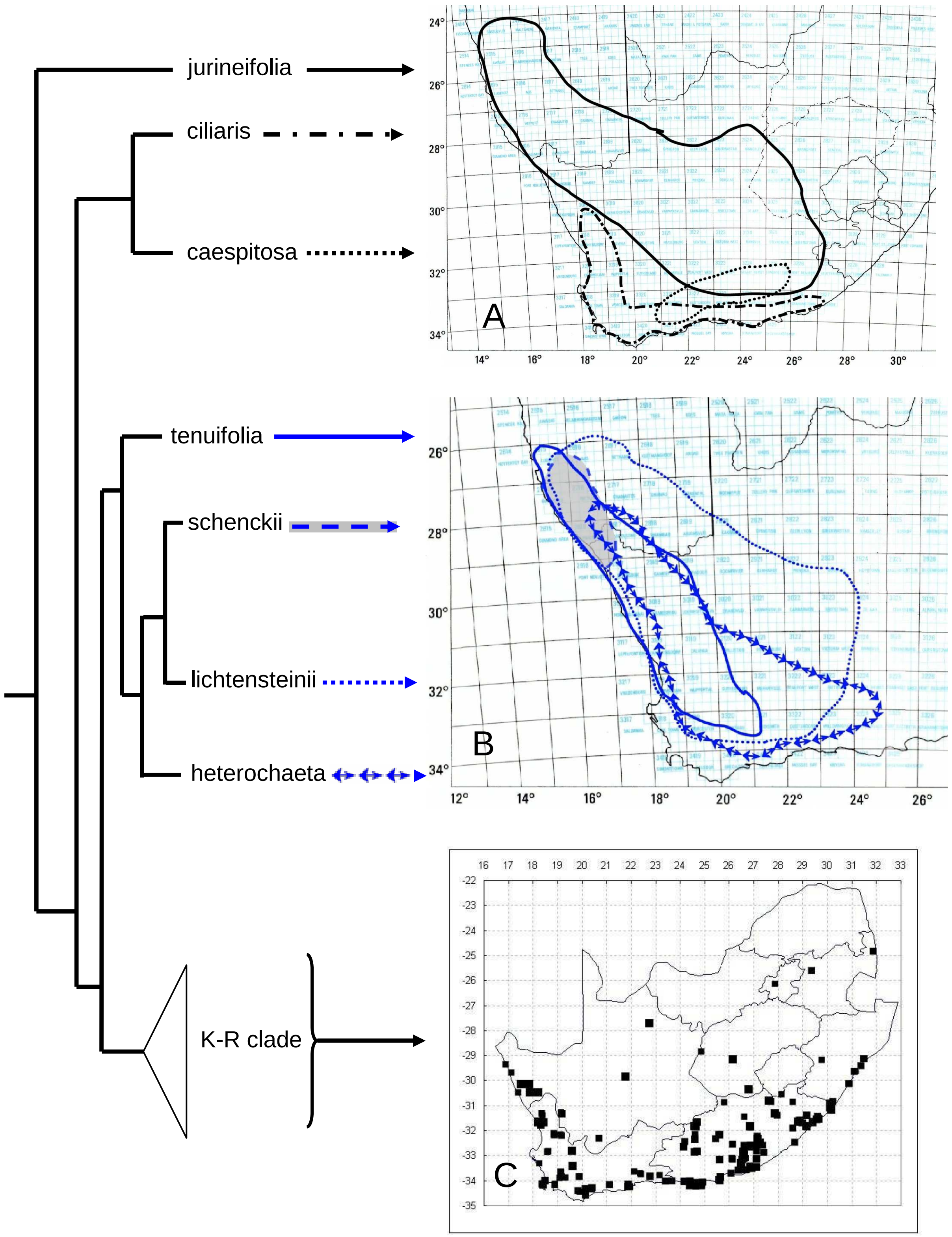


Figure 5.3.9: Summary tree of major branches in Gazania species-level phylogeny in conjunction with distributional overlays for each of the major branches in the phylogeny. Arrow line pattern indicates respective outline on accompanying map (*G. schenckii* is additionally shaded in grey in B to highlight distribution area).

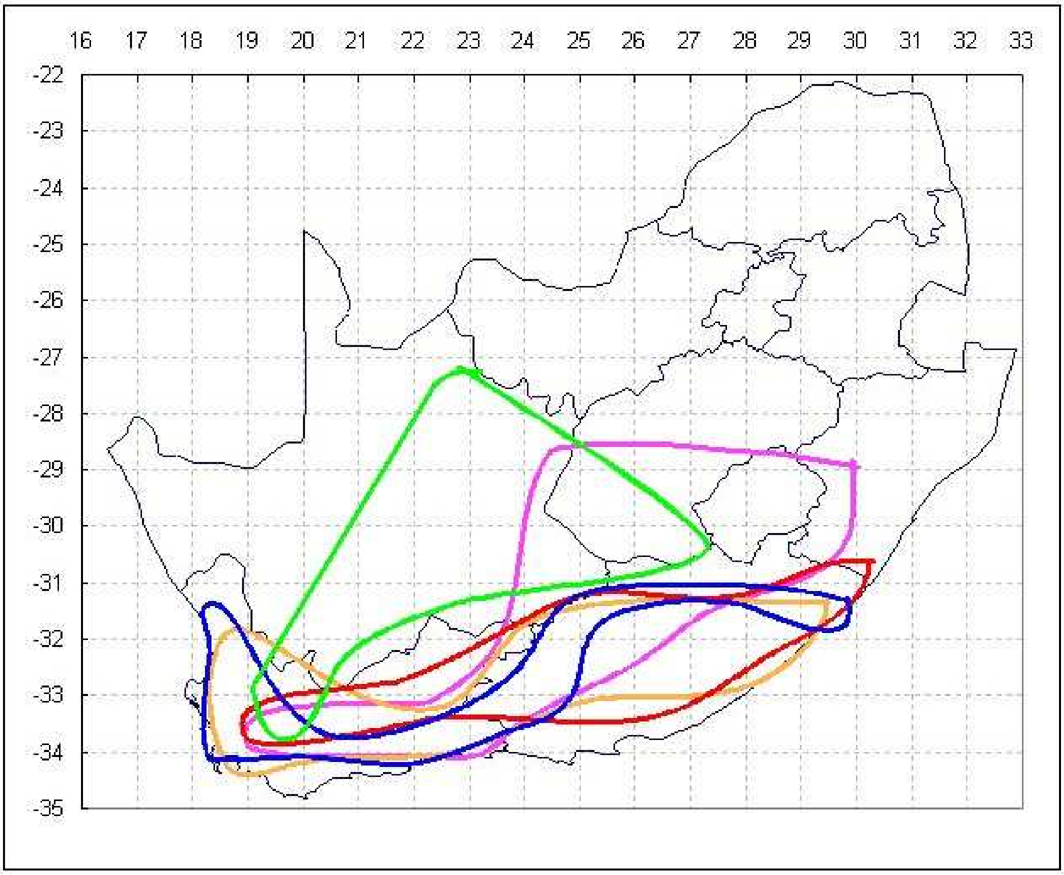


Figure 5.3.10: Overlays of distributions for geographically widespread clades in the K-R clade (outlines based on distributions mapped in Chapter 4 for branches 5, 6, 9, 11 and 12).

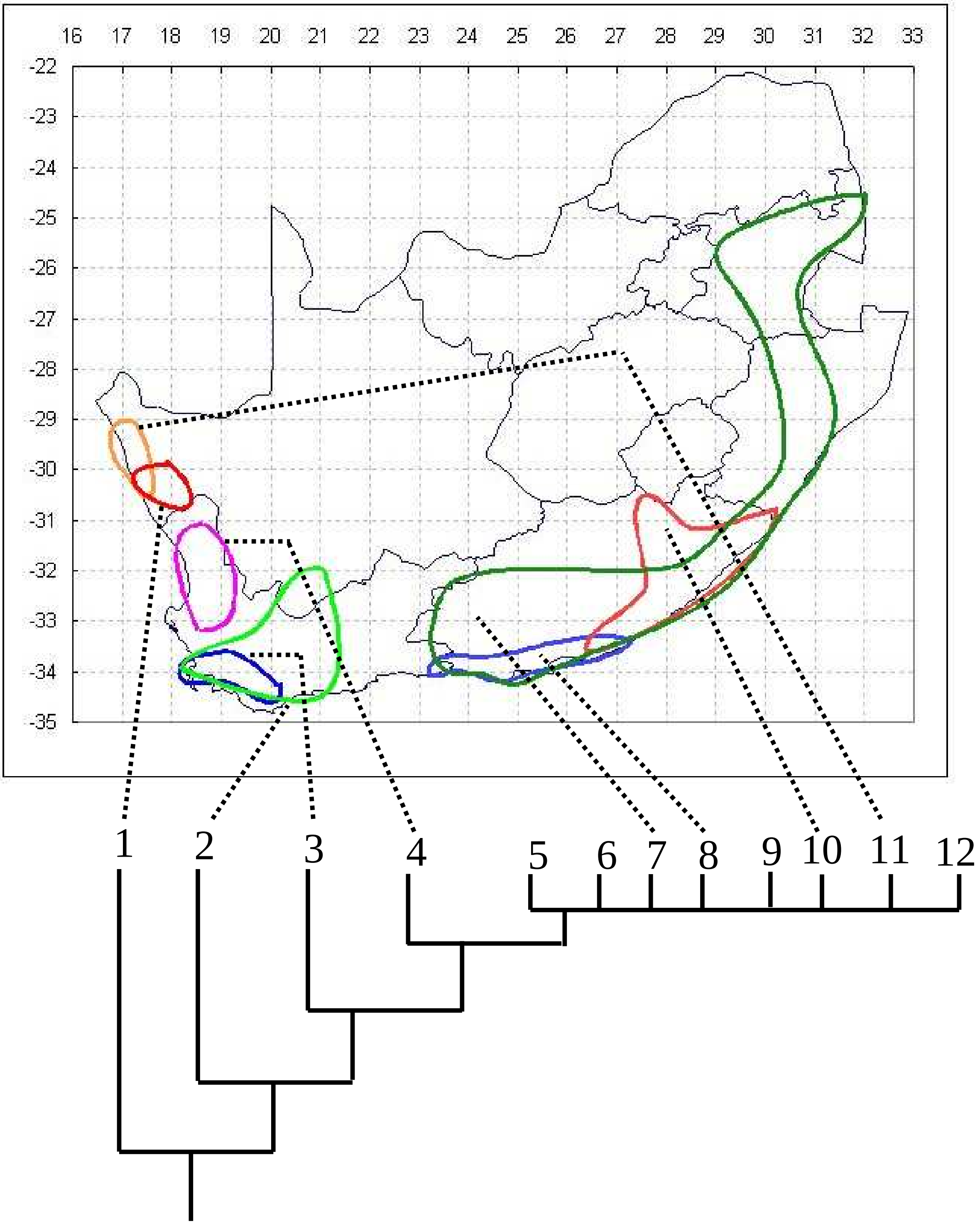


Figure 5.3.11: Overlays of distributions for geographically limited clades in the K-R clade (outlines based on distributions mapped in Chapter 4 for branches 1, 2, 3, 4, 7, 8, 10 and *G. othonnites*/*sp. nov.* clade), correlated with summary of branch positions in the K-R clade phylogeny.

Divergence date estimates

There are a number of important caveats and limitations to using mutation rates to estimate divergence dates, including substitution rate heterogeneity among lineages (which the LRT tests), uncertainties regarding clock calibration, and unknown but presumable large estimation errors

(Seelanen *et al.*, 1997). The molecular clock hypothesis was rejected by the Likelihood Ratio Test (2285.0211 vs 2250.2555, $p<0.0084$). Therefore, any attempts at calculating dates from ITS mutation rates can only be regarded as estimates.

The date estimates for the lognormal relaxed clock model were the closest to the results of the manual calculations, with seven out of nine dates in close agreement (the dates estimated for the lognormal clock fell within the margin of standard deviation for seven of the results of the manual calculations). The exponential relaxed clock model dates were mostly in conflict with those calculated manually and using the lognormal relaxed clock model. For the purposes of further discussion below, the manual calculation dates are utilised.

Figure 5.3.12 is a replication of the totalDNA Bayesian tree from Chapter 3 (Figure 3.3.7), with the four major clades numbered for ease of reference in the following paragraphs. The average pairwise distances between and within sister clades are given in Table 4.3.1. The estimated time since divergence between each pair of lineages are also given in this table, with a possible lower and upper extreme. These estimates must, by necessity, be tentative at best, as comparative ITS mutation rates are not necessarily constant across the family or genus. Accurately estimating dates of divergence from molecular data is a challenging process (Arbogast & Slowsinki, 1998). It should be noted that a phylogeny based on ITS sequences only has a slight change in branching order (Clade 1 is sister to Clade 3, rather than to Clade 2) as compared to the branching order of the total DNA phylogeny. In addition, the divergence of populations from the ancestral population is necessarily defined by the cessation of gene flow, but whether this cessation coincides with particular geological events or occurs some time after such events is usually not known (Edwards & Beerli, 2000). None the less, these dates give a rough estimate to focus an investigation into the past factors that may have led to the current phylogeny of *Gazania*.

Gazania is estimated to have diverged from *Gorteria* and *Hirpicium* anywhere from 4.3 to 11.4 Mya, with an average estimate of 6.6 (±0.5) Mya. The next divergence dates are 4.6 (±0.5) Mya as an average estimate for the divergence of *G. jurineifolia*, and 4.4 (±1) Mya as an average estimate for the divergence of Clades 1, 2 and 3. The average date for all three of these splits range around the start of a period of great climatic change that took place over the last several million years in southern Africa (and the rest of the world). The Miocene period extended from 50 Mya to the start of the Pliocene period at 5 Mya. This Miocene-Pliocene border correlates with the major estimated divergences of *Gazania* as a genus (6.6 Mya) and also of major lineages within *Gazania* (4.6 and 4.4 Mya).

Table 4.3.1: Divergence time estimates for each major split, including average, slowest and fastest rate of divergence for manual calculations, and comparative results for exponential and lognormal relaxed clock estimates from BEAST calculations.

		Manual calculations				**Beast timing (Mya)**	
Taxa splits	**Clade splits**	**Average pairwise distance**	**Estimated average time of divergence**	**Estimate time of divergence at slowest rate**	**Estimate time of divergence at fastest rate**	**Relaxed clock (Exp)**	**Relaxed clock (Log)**
jur. scabra - jur. jurineifolia	within 4	0.001928903	0.37 (±0.4) Mya	0.6 Mya	0.25 Mya	0.99 (±0.028)	0.7 (±0.008)
divergence within K-R clade	within 1	0.002849533	0.6 (±0.4) Mya	1 Mya	0.4 Mya		
	split of 1 + 2	0.023085066	4.4 (±0.5) Mya	7.7 Mya	2.9 Mya	4.8 (±0.05)	4.5 (±0.02)
KR-clade - ciliaris	split of 1 + 3	0.021972915	4.2 (±0.6) Mya	7.3 Mya	2.8 Mya	4.7 (±0.05)	4.3 (±0.02)
tenuifolia - (lichensteinii / schenckii / heterochaeta)	Within 2	0.015022028	2.8 (±0.6) Mya	5 Mya	1.9 Mya	3.7 (±0.02)	3.0 (±0.01)
heterochaeta - (schenckii/lichensteinii)	Within 2	0.012662289	2.4 (±0.5) Mya	4.2 Mya	1.6 Mya	2.9 (±0.02)	2.0 (±0.01)
lichensteinii - schenckii	Within 2	0.008297585	1.6 (±0.1) Mya	2.8 Mya	1.1 Mya	2.2 (±0.01)	1.5 (±0.007)
ciliaris - caespitosa	Within 3	0.007213994	1.4 (±0.1) Mya	2.4 Mya	0.9 Mya	2.4 (±0.04)	1.5 (±0.01)
	(1+2+3) from 4	0.023954036	4.6 (±0.5) Mya	7.9 Mya	3.1 Mya	5.1 (±0.04)	5.1 (±0.02)
Gazania - (Gorteria/Hirpicium)		0.034180443	6.6 (±0.5) Mya	11.4 Mya	4.3 Mya	15.5 (±0.1)	8.0 (±0.02)

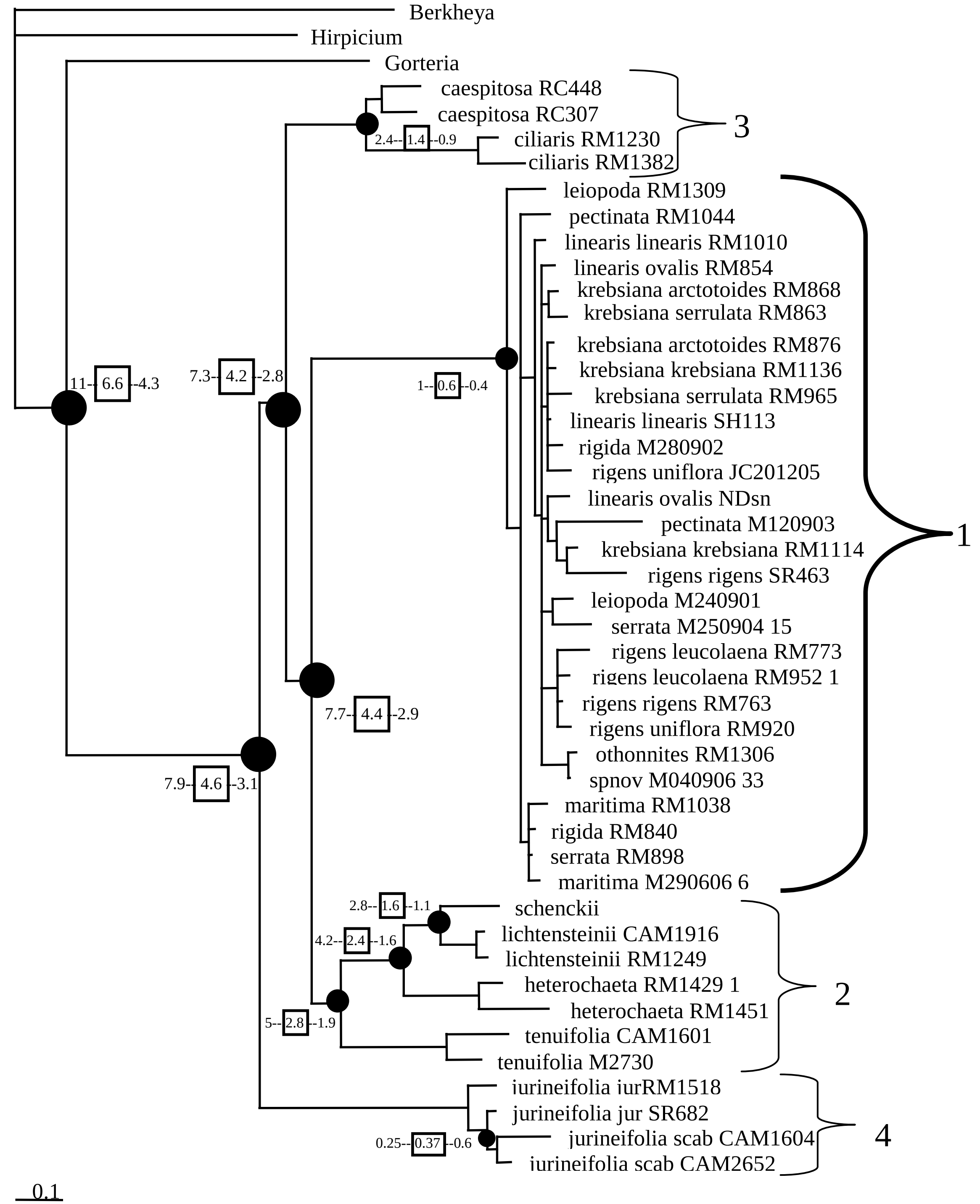


Figure 5.3.12: Total DNA Bayesian consensus tree from Figure 3.3.7, numbered brackets indicate major clades for reference in divergence dating table. Numbers next to black circles and ellipses indicate proximate dates of divergence (maximum -- average -- minimum) in millions of years.

The Pliocene began at the peak in global cooling which occurred at approximately 5 Mya, in response to a pulse in Antarctic ice growth (Schnitker, 1980; Lindesay, 1998). Pickford (2004) notes that the early onset of arid biotopes in the Namib arose well before they occurred anywhere else in Africa, and this started a long period of adaptation to semi-arid conditions. The isolation of the Namib promoted a high degree of isolation of the Namibian gene pool, and once having adapted to conditions in the Namib arid areas, these lineages were pre-adapted to spread into neighbouring areas as they, in turn, became arid during climate change cycles (Pickford, 2004). The peak in global cooling at 5 Mya, and a consequential change in rainfall patterns, could have paved the way for the diversification of *Gazania* in Namibia and/or Namaqualand, and subsequent southerly and easterly spread out of this region.

Apart from the peak in cooling at 5 Mya, there were further cold peaks evident between 4.2 and 3.2 Mya, when Arctic ice sheets began to develop (Kennett, 1982; Lindesay, 1998). During glacial periods a substantial lowering in temperature, the influx of polar air and a change to winter rainfall caused major shifts in vegetation (van Zinderen Bakker, 1978). The first of these peaks coincides with the divergence estimates for the Clade 3 from Clade 1 at around 4.2 Mya.

The next divergence date at 2.8 (±0.6) Mya is for the divergence of the *G. tenuifolia* from the three other species in Clade 2. There is evidence from faunal diversity studies that suggest that there was the first of three peaks of aridity and faunal speciation at 2.9-2.4 Mya concurrent with key junctures in hominid evolution (deMenocal, 2004). This shift in aridity at 2.8 Mya is the result of remote forcing by cold North Atlantic sea-surface temperatures associated with the onset of Northern Hemisphere glacial cycles (deMenocal, 1995). This date also coincides with a pulse of change in species composition in African fauna (with the emergence of more arid-adapted species) and a key juncture in hominid evolution (the first occurrence of *Paranthropus*) around 2.8 Mya (deMenocal, 2004).

Relatively close to this date is the estimate of 2.4 (±0.5) Mya for the divergence of the *G. heterochaeta* from *G. lichtensteinii* and *G. schenckii*. There have been multiple instances of geographic uplift of the southern African continent, including a period of geographic uplift in the Miocene, ranging from 300 m on the east coast, to 150 m on the inland of the west coast (Partridge & Maud, 1987; Lindesay, 1998). There was a second, far greater geographic uplift at about 2.5 Mya, where the South-East region elevation increased by 600 – 900 m, the south rose by 200 m and the west by 100 m, which corresponded with a decline in temperatures in these newly elevated regions (Partridge & Maud, 1987; Lindesay, 1998).

Both sediment evidence and faunal species compositions point to wetter conditions in the mid-Pliocene (3.5 Mya) followed by increasingly episodic rainfall and drier conditions after 2.5 Mya when cooler conditions prevailed (Butzer, 1984; Vrba & Denton, 1995; Lindesay, 1998). This change from wet to dry conditions in the interior near 2.5 Mya has been considered to be of “remarkable magnitude” (Partridge & Maud, 1987; Lindesay, 1998). All of these dates of significant climate change towards a drier climate correlate with the estimated dates of divergence of several clades in the *Gazania* phylogeny, suggesting that the changes in conditions lead to the rapid divergence and emergence of new entities within *Gazania* (including the split of *G. heterochaeta* from G. *lichtensteinii* and *G. schenckii*, as well as the upper estimate for the divergence of *G. caespitosa* from *G. ciliaris*.).

The remaining divergence events for genetically discrete species within clades 2 and 3 are at 1.6 (±0.1) Mya, and 1.4 (±0.1) Mya, both of which are in the Pleistocene. The divergence dated to 1.6 Mya also coincides with a second peak in climatic variability and increasing aridity that provoked faunal diversification (including a higher percentage of grazing animals) and also coincides with another juncture in hominid evolution (the extinction of *Homo habilis* and the first occurrence of *Homo erectus*) at around 1.8-1.6 Mya (deMenocal, 2004). The Pleistocene (which spans 1.8 Mya – 0.8 Mya) has been described as an important time for genetic diversification and speciation, based on the premise that climatic conditions in this period fostered the isolation of populations and, in some instances, allopatric speciation (Willis & Niklas, 2004).

The effects of Pleistocene climate change

During the last 2 Mya there have been periodic (or near periodic) alternations of glacial and interglacial conditions at approximately 100 000 year intervals, with each interglacial period lasted about 10 000 years (Jansson & Dynesius, 2002; Lindesay, 1998). These 100 000 year fluctuations are termed Milankovitch oscillations, which are caused by periodical changes in the orbit of the Earth, and are thought to contribute to large changes in the size and location of species’ geographical distributions (Dynesius & Jansson, 2000).

The Pleistocene ice ages were environmentally distinctive and are presumed to have caused unusual patterns in organisms that many could consider are uncharacteristic of most of the Earth’s history (Willis & Niklas, 2004). The repeated isolation and reexpansion of plants and animals in refugia (favorable locations with controlled microenvironments) during unfavourable conditions had important implications for evolutionary patterns (Willis & Niklas, 2004). An ideal refugium prevents extinction of genetic lineages and acts as a genetic reservoir by providing habitats for survival of plant populations during slow and abrupt climatic changes (Tribsch & Schönswetter, 2003). Besnard *et al.* (2002) note that during the Pleistocene ice ages, many species could survive only in favourable refugia, and genetic patterns of differentiation among existing populations are often due to survival in different refugia, combined with genetic drift and founder effects during re-colonisation. Due to the periodic oscillations of the climate over the Pleistocene, resultant range contractions and expansions are believed to have played a central role in shaping the genetic and ecological diversity of many species (Excoffier, 2004).

Glacial cycles cause changes in distribution, and this can result in two different but typical genetic patterns emerging: a reduction in genetic diversity and/or genetic structuring on a regional basis (Ayoub & Riechert, 2004). This regional genetic structuring (ultimately leading to eventual monophyly) occurs when isolated populations in refugia arise during glacial maxima, and a reduction in genetic diversity is seen in populations that have expanded from glacial refugia into previously unoccupied areas (Ayoub & Riechert, 2004). Both of these phenomena are present in the K-R clade in *Gazania*: the K-R clade has a limited quantity of sequence diversity, and it also demonstrates regional genetic structuring in some lineages (i.e. the correlation between geographical locality and branches 1, 2, 3, 4, 6, 8, and 10 of the K-R phylogeny), most of which are confined to the south western cape.

Average speciation rate that can be calculated from the fossil record is roughly one new species every 10% of the average species lifetime (Niklas, 1997). Niklas (1997) calculates that if one assumes that the average generation time of an individual (from seed to sexual maturity) is about 5 years, a speciation event occurs roughly once in every 76000 generations, which is an ample number of sexual reproductive cycles for genetic divergence to have occurred in isolated plant populations during the Quaternary. There are herbaceous species where molecular and morphological evidence indicate genetic divergence leading to speciation in the last 100 kyrs (Willis & Niklas, 2004).

The divergence time for the various taxonomic entities sampled in the K-R clade can be estimated at 0.6 (±0.4) Mya. This coincides with yet another pulse of change in species composition of certain African fauna at ±0.7 Mya, suggesting widespread climatic change effects (deMenocal, 2004). The relatively large standard deviation in the dating estimate is due to the wide range of levels of divergence between samples in the unresolved branch. If one compares the distribution maps of the geographically limited evolutionary lineages in the unresolved K-R clade (Figure 5.3.13), one can see that only three lineages are endemic to the eastern cape, whereas six lineages are endemic to the western half of South Africa, and four of these six are confined to a southern area that corresponds with the Cape Floristic Region (CFR). These geographically limited clades could be evidence of refugia, out of which lineages have subsequently expanded and possibly hybridized to result in a mixture of characters (both morphological and genetic).

South Africa’s CFR is very rich in plant species, most of which are the product of explosive speciation in the late Tertiary (Cowling & Lombard, 2002). The CFR has about 9000 species in an area of 90 000 km^2, of which 68.8% endemism at the species level (Linder & Hardy, 2004). The southern tip of Africa contains a number of plant lineages that are thought to have undergone recent and rapid speciation, and it could be argued that the whole flora might be the result of such a recent burst of speciation (Linder & Hardy, 2004). In southern Africa, there is an east–west gradient in the severity of the summer drought and for several groups, the greatest diversity, and apparently the most recent radiations, is situated in the more arid west; but there are no large recent radiations in the more mesic east (Linder, 2005).

Cowling & Lombard (2002) suggest that the disparity in taxa numbers between east and west (common to many lineages, and observed in the K-R clade lineages) is a consequence of higher speciation rates (promoted by enhanced opportunities for isolation of populations) and lower extinction rates (associated with more refugia) in the topographically complex montane regions of the west, which would explain the large number of rare species found there. Mountain areas in general are important refugial areas, as the high habitat diversity in mountain areas creates buffers, during not only alternations of cold and warm periods, but also of wetter and drier periods, which guarantees long-term ecological stability (Tribsch & Schönswetter, 2003). However, in the eastern mountains, differences in contemporary and historical climatic regimes reduced rates of speciation and elevated extinction rates, leading to lower steady state diversities, irrespective of landscape ruggedness (Cowling & Lombard, 2002).

Linder (2005), commenting on rapid radiations in the CFR, notes that for some lineages, the presence of a long basal branch in the phylogeny indicates that the group was present in the region for a longer period but that only one lineage from this period survives. This is likely to be the case for *Gazania* as well, with the long lineage of the K-R clade.

Population history

The graph of pairwise sequence divergence (Figure 5.3.13) shows that when the frequencies of all pairwise sequence divergences are plotted, there are two peaks. These can be correlated with two pulses of population expansion, the smaller shallower right peak correlating with an older expansion (the genetically discrete species) and the larger narrower left peak correlating with a much more recent expansion (the K-R clade). If the sequence divergence frequencies that make up the two peaks are plotted separately (Figures 5.3.14 and 5.3.15) then one can see that the K-R clade peak consists of only one peak with generally very low sequence divergence, while the genetically cohesive species peak consists of multiple peaks with a range of divergences (both low and high). A very recent population expansion will result in a peak at the left side of the graph, comprising the comparisons among identical and highly similar sequences (Rogers & Harpending 1992), which is clearly seen for the K-R clade distribution in Figure 5.3.14. The fairly steep leading slope of the peak could also suggest an initially small founding population that lead to the K-R clade (Rogers & Harpending, 1992). The multimodal distribution for the genetically cohesive species clades seen in Figure 5.3.15 suggests long-term population stability resulting in substantial phylogenetic structure (Slatkin & Hudson, 1991).

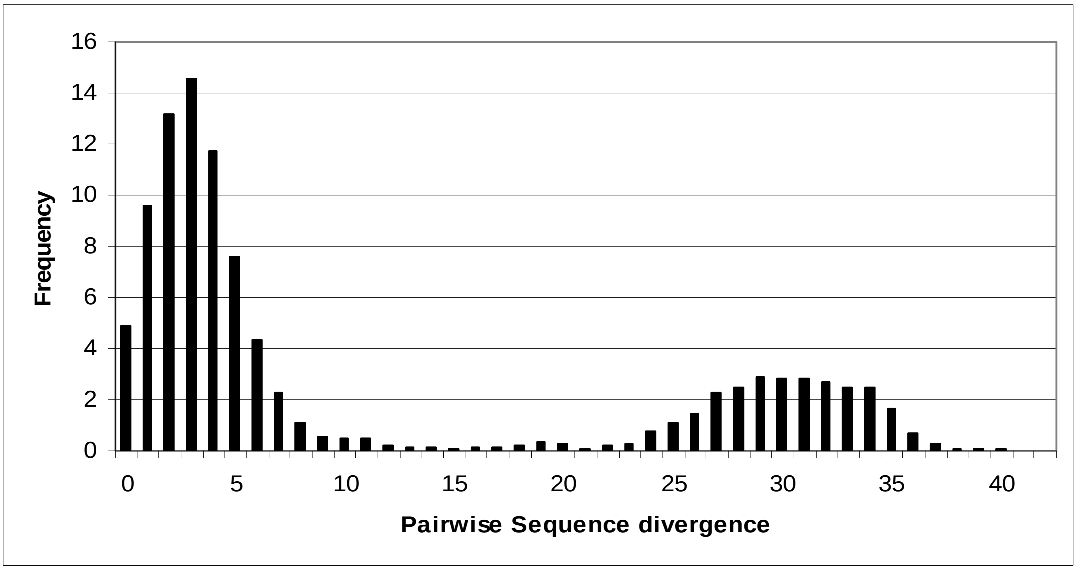


Figure 5.3.13: Frequency of pairwise sequence divergences for all samples.

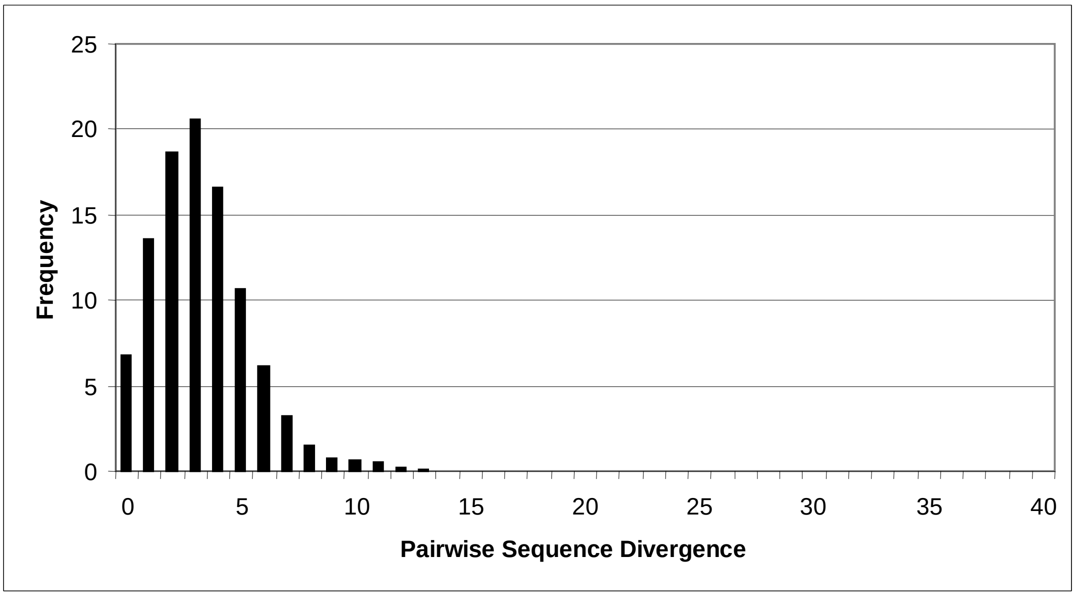


Figure 5.3.14: Frequency of pairwise sequence divergences for all samples from the K-R clade.

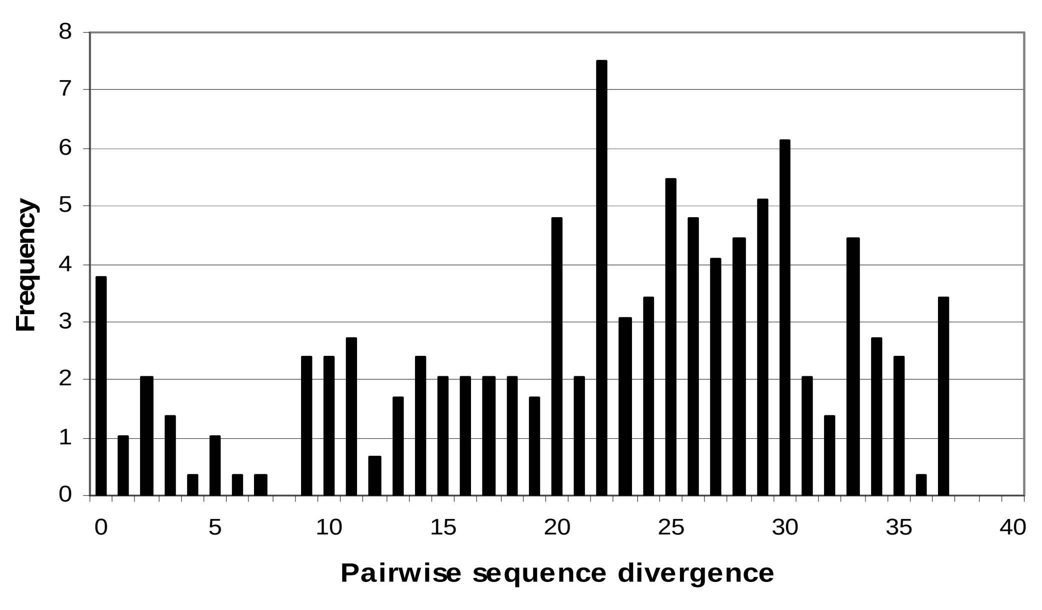


Figure 5.3.15: Frequency of pairwise sequence divergences for nrDNA data set for all samples from the six genetically cohesive species.

The Neighbor-Net analysis of the samples in the K-R branch has a starlike topology (Chapter 4, Figure 4.3.29), which is indicative of population expansion (Slatkin & Hudson, 1991). Mahoney (2004) observed a very similar pattern in *Plethodon*, noting that "in addition to poorly supported resolution among haplotypes, the similar length of the branches suggests descent from a single coalescent event at the base of the clade with subsequent divergence among lineages also proposed to correlate with rapid expansion". The small short branches in Figure 4.3.29 that radiate out from the central area are most likely indicative of refugial evolutionary lineages from previous periods of climate change.

Congruent patterns in SA fauna/flora

Since the climatic changes that are hypothesised to have lead to the current phylogeographic patterns of *Gazania* taxa were of a large magnitude, it is reasonable to assume that other southern African endemic organisms (both plant and animal) may echo the geographical disjunctions and phylogenetic structure in *Gazania*. Unfortunately, there are relatively few such detailed phylogeographic studies of taxa in South Africa.

East-West split

Griffieon (1995), in an unpublished thesis on *Chrysanthemoides*, recognised 16 intraspecific taxonomic entities. Of these, 10 were found in the western half of South Africa (seven were confined to the south western cape, and three to the north-western and western cape, including one in the Namaqualand centre), while only five were confined to the eastern half of South Africa (three in the south eastern and eastern half, and two in the north eastern half). A similar East-West split is found between distributions of varieties of *Cotyledon orbiculata* (Figure 5.3.16, Mort *et al*., 2005)

Multiple papers have explored the regional plant diversity patterns in the Cape Floristic Region (e.g Cowling & Lombard, 2002; Linder & Hardy, 2004). Species-area analyses of the CFR by Cowling & Lombard (2002) have shown that the western winter-rainfall landscapes (east of “about 21ºE”) have more than double the number of species than eastern nonseasonal-rainfall landscapes. Ritz *et al*. (2003) in a paper on Karoo *Euphorbia*, notice this same split, but consider the split between rainfall landscapes in South Africa to fall closer to 22.5ºE, and attribute this split to western winter rainfall and eastern summer (rather than nonseasonal) rainfall landscapes. Regardless of the exact location of this rainfall zone of transition (Cowling & Lombard note that there is more likely a gradual transition over more than 100 km rather than a sharp disjunction anyway), there is a higher proportion of range-restricted, habitat-specialist species in the western floras, suggestive of a higher tempo of speciation in the west (Cowling & Lombard, 2002). *Gazania* clade distributions across the east/west divide appear to echo this pattern of speciation.

A similar pattern was found by Bakker *et al.* (2000), who investigated the phylogeny of *Pelargonium* species and found two major clades. One of these clades (comprising eight species, all of which were distinguished by small chromosomes) was confined to the south western cape, while the second clade (containing the remaining species with large chromosomes) was more widely spread across the Eastern Cape (and several other areas outside of South Africa). Bakker *et al*. (2000) credit the increase in the number of western cape clades as having been triggered by the late Pliocene aridification and the establishment of a winter rainfall climate in the Western Cape region.

Tolley *et al*. (2004) investigated the phylogeography of the southern African dwarf chameleons *Bradypodion*. They found two major clades, one of which was confined to the south western cape and southern cape, as well as a second larger more widespread clade that occurred mostly in the eastern half of South Africa (Figure 5.3.17). This second clade was a large well-supported clade with low sequence divergence, composed of several species, and they also found a strong correlation between the various clades in their phylogeny and the geographical origins of the samples in those clades. The authors suggest that repeated bouts of isolation and subsequent contact were responsible for promoting the phylogenetic diversity observed in these animals.

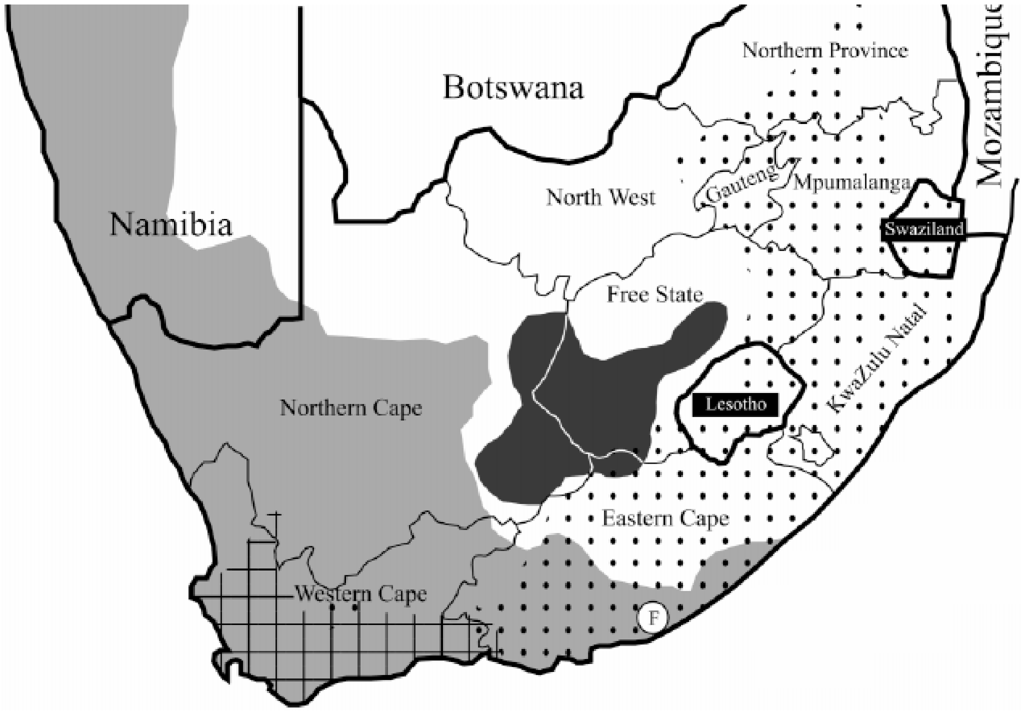


Figure 5.3.16: Distributions of five varieties of *Cotyledon orbiculata* (from Mort *et al*., 2005: Figure 1).

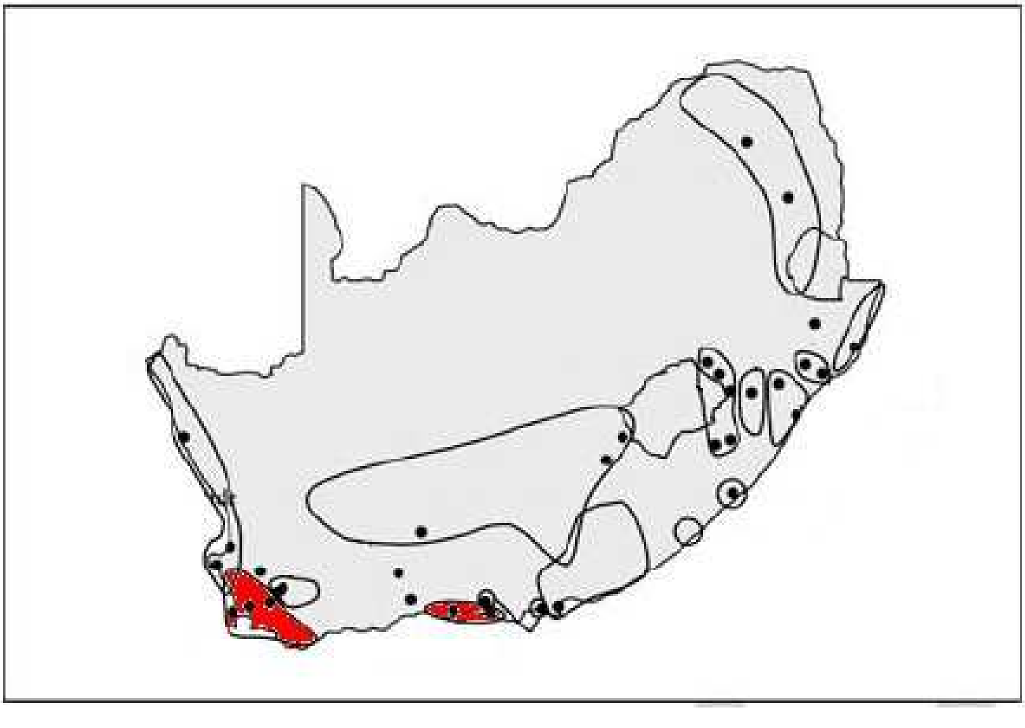


Figure 5.3.17: Distributions of two major *Bradypodion* genetic clades (from Tolley et al., 2004). Areas in the south west shaded in red belong to one clade, all other unshaded areas belong to second clade.

North-South split

Matthee & Flemming (2002) investigated the population fragmentation in the rock agama (*Agama atra*) in southern Africa. They found three geographical disjunctions that correlated with three clades in their phylogeny (Figure 5.3.18). One of these clades occupies an area in southern Namibia that roughly correlates with the area that *G. schenckii* is restricted to, and *G. lichtensteinii*, *G. heterochaeta* and *G. jurineifolia* show distributional overlaps with. The other two clades are confined to South Africa, with a split between a northern central clade and a more southerly central clade that is spread countrywide. The geographical patterns observed in *A. atra* (congruent with the general patterns seen in *Gazania*) are attributed to vicariance caused by cyclical changes in temperature and rainfall over the last 3 million years (Matthee & Flemming, 2002).

A study of *Scarabaeus* dung beetles by Sole (2005) shows a similar three-part disjunction. The dung beetle phylogeny (Figure 5.3.19) shows three clades, the most basal being distributed in Namibia, and the other two derived sister clades being distributed in more southern areas. This pattern of disjunction between a north clade and a south clade is also seen (Figure 5.3.20) in the red rock rabbit (*Pronolagus rupestris*; Matthee & Robinson, 1996).

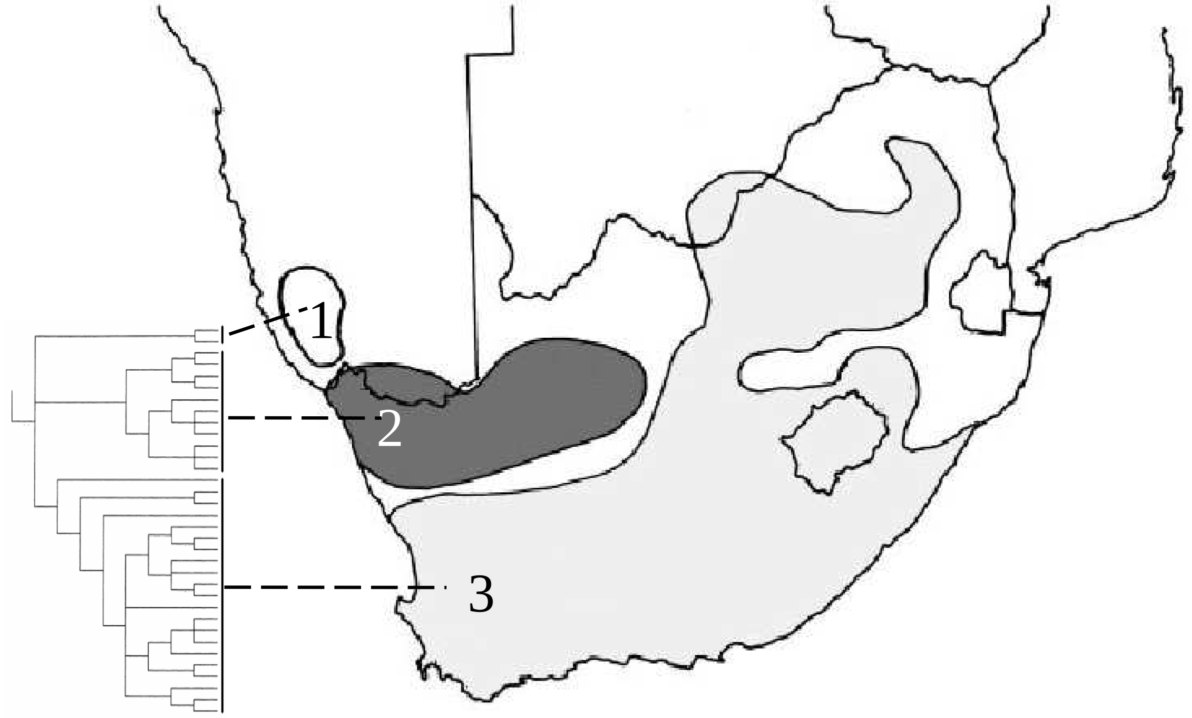


Figure 5.3.18 Distributions of three major *Agama atra* genetic clades (from Matthee & Flemming, 2002), 1- Namibian clade, 2 - northern central clade, 3 - eastern and central clade.

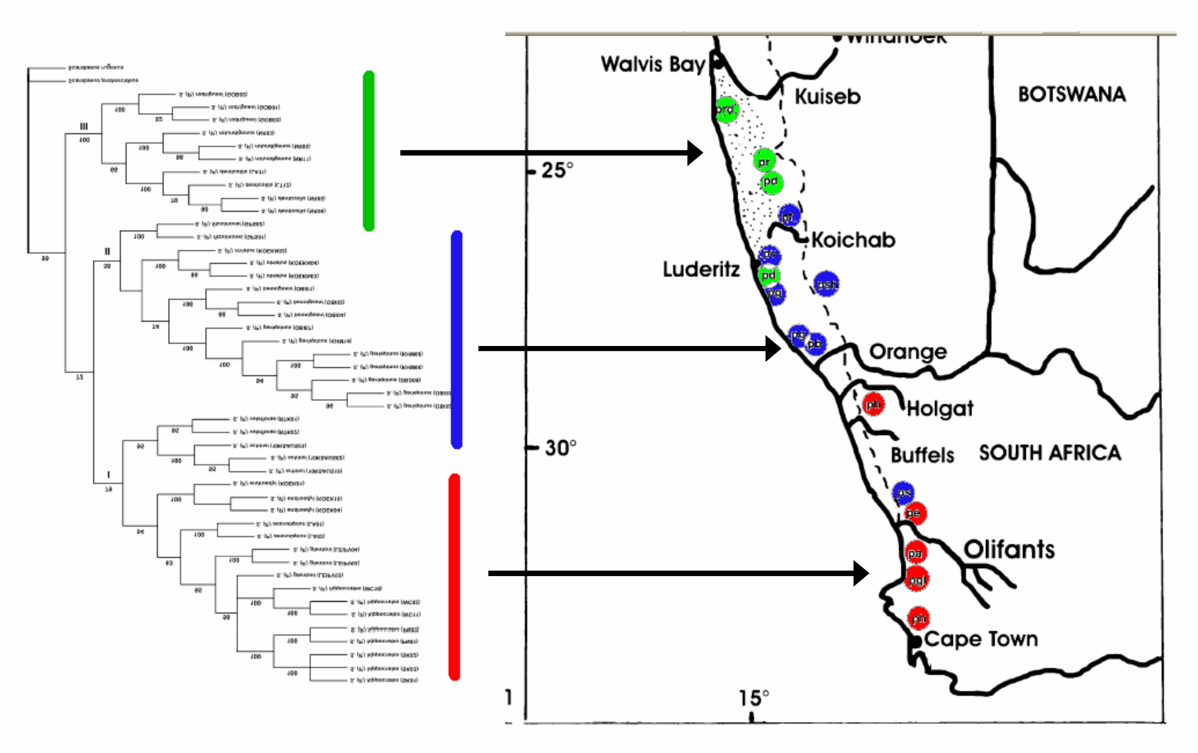


Figure 5.3.19: Distributions of three major *Scarabaeus* genetic clades (from Sole, 2005: Figure 1 and Figure 2).

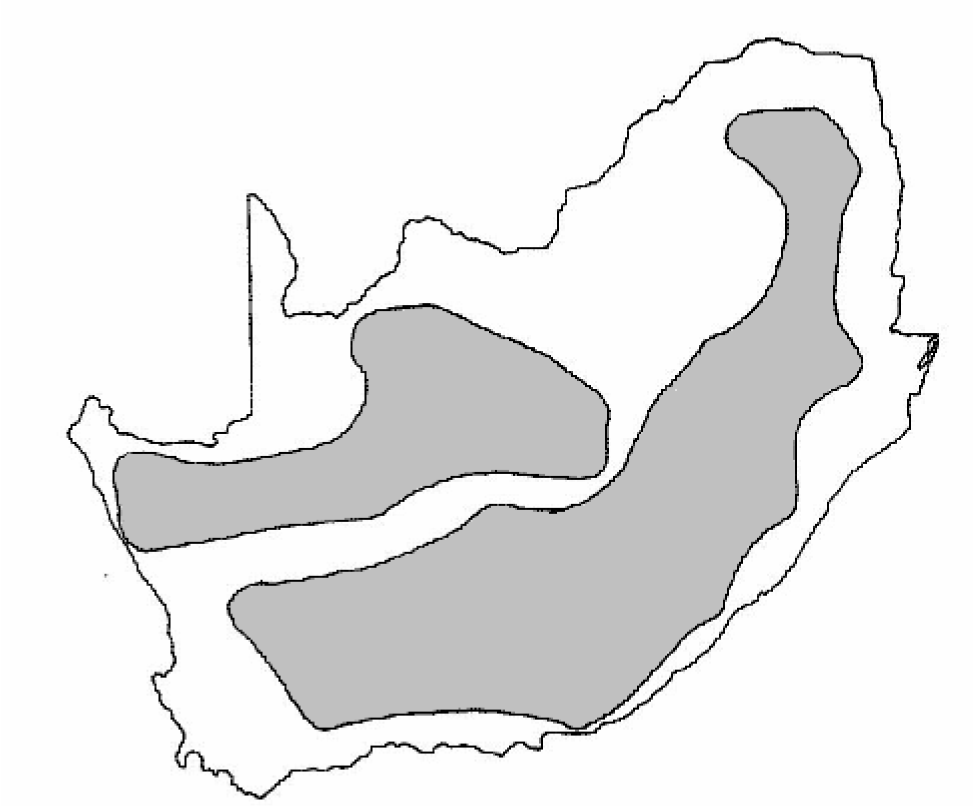


Figure 5.3.20: Distributions of two major *Pronolagus rupestris* genetic clades (from Matthee & Robinson, 1996).

Lamb & Bauer (2000) also found a similar pattern in *Pachydactylus* geckos. Here too is a north-south split between one basal taxon (located in Namibia) and the common ancestor for other more southerly located species. Like the other animal species mentioned above, the divergence between the two occurs around the Knersvlakte (Lamb & Bauer, 2000). Although the Namibian-centred *Gazania* species have spread out of their putative northern ancestral area (most likely due to their wind-dispersed seeds and ability to thrive on disturbed areas in poor soil), the historical split between the ancestors of the northern species and the ancestor of the more widely distributed eastern species remains detectable in the present day distributions of species.

Gazania is not unique in southern African plants, as these genetic disjunctions between Namibian and South African clades exist in other plant taxa. Touloumenidou *et al.* (2007) found geographic disjunctions between two sister clades of *Monsonia* (Geraniaceae), with one confined to Namibia and the other to South Africa. Jűrgens (1997) summarised an overall similarity in North-South disjunction patterns that have been found in at least 15 plant taxa (Figure 5.3.21).

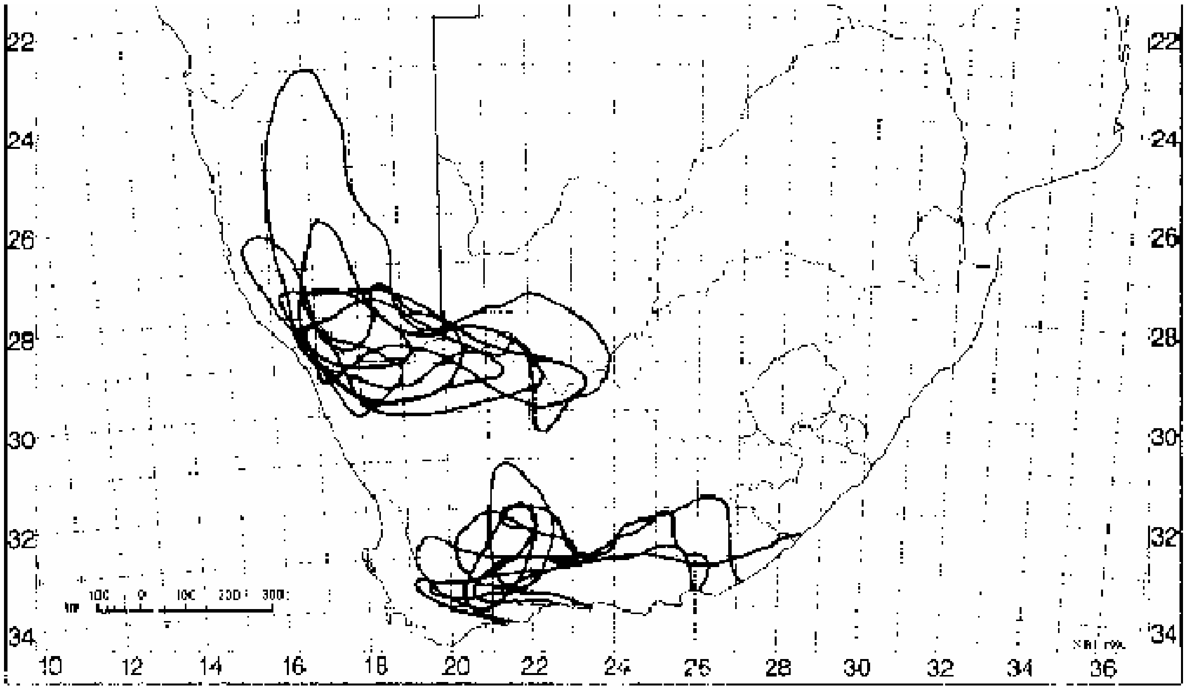


Figure 5.3.21: Summary of disjunct distributions of 15 plant taxa (from Jűrgens, 1997: Figure 16).

Caveats

As mentioned in the previous chapters, some caution must be applied to these results. The choice of a bi-parentally inherited non-hierarchical nuclear marker for a phylogeographic study (in contrast to the usual choice of maternally inherited cpDNA markers) could invite some criticism as to the accuracy of the phylogeny used in this phylogeographic study. The effect that reticulation and paralogy could have had on the phylogeny is not known, and is hard to quantify, without a comparative organellar phylogeny. The lack of sequence diversity found in the chloroplast markers used in Chapter 3 contraindicates the use of cpDNA spacer sequence data as a comparative measure of phylogeny retrieval. Further research could involve microsatellites or AFLP data as a means to test the nuclear phylogeny utilised in this study.

Conclusions

This phylogeographic investigation into *Gazania* suggests that there have been several instances of expansion and divergence within the genus. The older expansions and divergences have created the eight genetically cohesive taxa elucidated in Chapter 3. These species, even when occurring in sympatry, retain their genetic identity.

The most recent expansions and divergences in *Gazania* have lead to the formation of a number of widely distributed morphotypes (each of which could be a result of isolation in refugia), which Roessler delimited and named as nine distinct species. However, the phylogeographic data collected here illustrates that there has been insufficient time since their divergence for species cohesion to have materialised, either through means of geographical or reproductive isolation. Reproductive isolation itself, between geographically isolated populations, evolves as an incidental outcome of genetic changes in the populations (Foster *et al.*, 1998) and insufficient time had elapsed within the isolation of refugia for enough of these incidental changes to either take place or become fixed across the population prior to re-expansion.

While some of Roessler’s nine noncohesive species do show a certain amount of taxonomic cohesion and geographical localization (e.g. *G. rigens*, *G. leiopoda*), the fact that some individuals of these species may group with geographically co-occurring members of other species, rather than their more geographically distant conspecifics, suggests that their isolation or speciation is not yet complete. The identities of these troublesome samples (based on Reossler’s key) have been rechecked and they are accurately identified according to Roessler’s delimitations. The recent cycles of climate change that could have lead to isolation and speciation within refugia, are just as responsible for subsequent geographical expansion out of these refugia.

The ability of an organism to survive climate change is dependant on several factors, most especially seed dispersal ability and ecological generalization (Dynesius & Jansson, 2000). For organisms to survive climate oscillation, they must have high enough seed dispersal ability to track their moving habitat, and a low enough level of ecological specialisation to not need to disperse rapidly to track their habitat and even to survive locally (Dynesius & Jansson, 2000). These factors would allow populations not only to survive climate change by moving with their shifting habitat, but also to expand out of refugia when conditions altered. *Gazania*, with its generalist pollinators (pers. obsv.), wind dispersed seeds (pers. obsv.), ability to colonise disturbed areas, and short period between germination and seedset (under a year) possesses the characters necessary to shift with climate change and expand out of refugia.

This expansion could have lead to secondary contact between and melding of incipient species, breaking down species boundaries before they were completely formed. This would have resulted in the morass of types and varieties that now exist in the south-western cape, some of which Roessler named as species, despite their often dubious status. (Roessler himself was unsure about the status of *G. serrata* as a species, referring to is as “a not quite characteristic unit, that is at best regarded provisionally as a type” (Roessler, 1959: pp 400)). The possibility that pollinators may have played a part in the diversification in *Gazania* (especially within the CFR and Namaqualand) cannot be discounted, but this has not been investigated within the scope of this research project.

Apart from the south western cape refugia, a second potentially more recent refuge is centred along the southern coast. Evidence of the South Coast refugial lineage theory is found in the presence of two localised specializations of more widely distributed morphotypes: 1) The broad-leafed form *G. linearis* subsp *ovalis*, confined to a few small localities along the southern cape coast; and 2) the grey-leafed hirsute form *G. rigens* subsp *leucolaena*, also confined to the southern cape coast. Both of these morphotype ranges overlap with the area that the genetically cohesive clade of the *G. rigens* variety occupies. Figure 5.3.22 overlays all three distributions, pointing to a possible climatic refuge, out of which the current distributions have expanded. The lack of genetic cohesion for these distinct morphotypes suggests that the isolation and differentiation was very recent, and could point to a recent refugial area that fosters the diversification of endemic lineages.

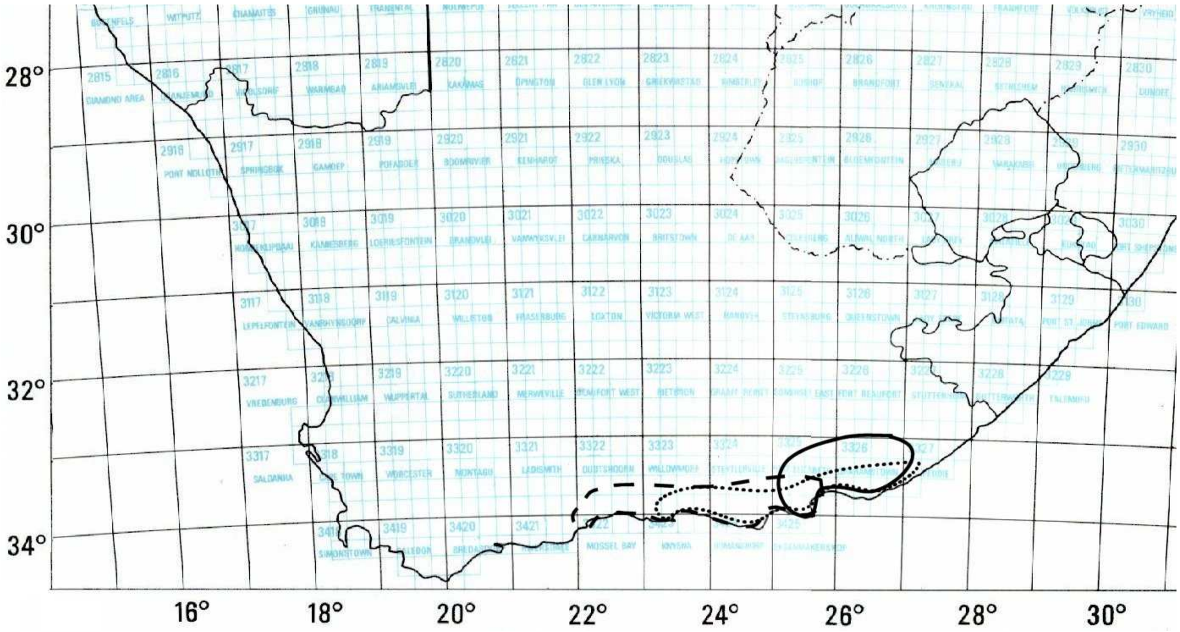


Figure 5.3.22: Distributions of two distinctive morphotypes and one genetically cohesive clade pointing to a possible Southern cape climatic refuge. Solid line = *G. linearis* subsp *ovalis*, dashed line = *G. rigens* subsp *leucolaena*, dotted line = genetically cohesive *G. rigens* clade in K-R clade.

Species

Just as there are multiple species concepts, so there are multiple ways to test species boundaries. Sites & Marshall (2003) list a number of these, both tree and non-tree based methods. Cladistic haplotype aggregation (CHA; Brower, 1999) is a tree based method that states that all members of a species form a contiguous section of an unrooted tree and are separated from all other populations by a branch along which character state change leading to a fixed character difference is inferred (Sites & Marshall, 2003). Under the CHA, genetic data defines eight species (*G. jurineifolia, G. tenuifolia, G. lichtensteinii, G. schenckii, G. caespitosa, G. ciliaris, G. heterochaeta* and the K-R clade. The exclusivity criterion (EXCL; Baum & Shaw, 1995) defines genealogical species by two criteria: species must be basal taxa (they must not themselves contain taxa), and unlinked genes should have concordant genealogical histories. Thus species are defined as exclusive groups; those in which all members are more closely related to each other than to any organism outside of the group (Sites & Marshall, 2003). The method requires the reconstruction of genealogies for unlinked loci collected from the same individuals, then a strict consensus of the trees is taken to define points of concordance (resolved nodes), and species are delimited by exclusive nodes (Sites & Marshall, 2003). This was accomplished in Chapter 3, and the same eight species are retrieved again.

What exist now in *Gazania* are seven distinct species, and an eighth entity, consisting of a collection of morphologically and geographically overlapping evolutionary lineages lacking any isolatory mechanisms. Three of these lineages could be genetically distinguished as named varieties, while the rest must be grouped under a fourth name. This fourth taxonomic entity is highly variable and widespread, and while there are certain morphotypes or ecotypes present, these lack any genetic cohesion. These are probably the remnants of previously isolated refugial lineages that failed to achieve true disjunction from other similar entities during their periods of isolation. Subsequent post-refugial expansion has further sabotaged their chances of attaining recognisable status as species.

The Ochlospecies concept (White, 1998) describes a very variable (polymorphic) species with chaotic infraspecific variation (only partly correlated with ecology and geography) which is of such a complex pattern as to be intractable to formal taxonomic treatment (Cronk, 1998). Cronk (1998) lists 10 traits for the diagnosis of an ochlospecies (diagnosis as an ochlospecies requires only six), these include:

1) Non-hierarchical polymorphic variation;
2) Character-state distribution that is only partially correlated with geography and ecology;
3) Characters vary independently, and not in a correlated fashion;
4) Complexity of variation is not due to hybridization between currently recognisable species;
5) Geographically and ecologically widespread, occurring in several climatic zones;
6) At a particular locality two distinct and non-intergrading forms may be found, and other forms may be found at other localities, but taken together all the forms intergrade and the classification breaks down;
7) Have closely related, but morphologically distinct and monotypic satellite species;
8) Similar variants may occur in widely separate localities and appear to be polytypic in origin;
9) Often have long synonymies, the variation has driven a proliferation of names that eventually proves untenable.
10) They tend to occur in medium to large genera usually with more than 50 species.

The K-R clade of *Gazania* meets nine of those requirements (the tendency for ochlospecies to occur in large genera of 50 or more species does not fit *Gazania*, but seems a rather trivial character anyway).

One of the two proposed mechanisms that creates an ochlospecies is based on refugial isolation, re-expansion and subsequent hybridization after glacial-related climate change (the Prance hypothesis); the other proposed mechanism is based on the rapid population expansion of a colonising eco-generalist, without any allopatric isolation stages (the rapid expansion hypothesis; Cronk, 1998). While *Gazania* is a colonising generalist (often found growing in disturbed areas in poor soil, and with wind dispersed seeds), the recent cycles of climate change in South Africa, and the concentration of localised genetic lineages in the western cape mountain areas, both suggest that the Prance hypothesis is more likely. Cronk (1998) considers the presence of clades that show more geographical structuring of genetic haplotypes than morphotypes to be an indicator of the refugial hypothesis.

The situation in the K-R clade of *Gazania* is not that rare, with a number of recent phylogeographic studies having yielded data that are consistent with the hypothesis that many plant species may have fractured into isolated, independently evolving populations that then came back into contact during interglacial periods (Comes and Kadereit, 1998; Noyes, 2006.). The principal effects of global climate change may thus have been to increase genetic variance within plant species, with population subdivision during recent climactic events contributing to genetic diversity, but not to speciation. (Noyes, 2006).

In conclusion, recent climate-driven radiation within *Gazania* has given rise to eight genetically distinct species, seven of which (*G. jurineifolia, G. heterochaeta, G. tenuifolia, G. caespitosa, G. ciliaris, G. lichtensteinii* and *G. schenckii*) are diagnosable by both the Morphological and the Phylogenetic species concepts. The eighth entity (following repeated cycles of refugial isolation and possible range expansion hybridization) is an ochlospecies that is clearly genetically distinct from the other seven species. It also possesses some lineages within it that show some partial genetic, morphological and geographical cohesion, but not sufficient to warrant full species status. The general conclusions from this investigation, each of the previous chapters and the proposed changes in status of species in *Gazania* are discussed in further detail in the final Chapter.

Chapter 6.
General conclusions

This study of the systematics of *Gazania,* its recent evolutionary history, and the identification of refugia in the arid inland of southern Africa is novel research, and is in a field of plant species-level phylogeographic research that seems rarely attempted by other researchers who focus on the systematics of South Africa endemic genera. Given the difficulty in defining taxonomic entities within this genus, the possible reluctance of other researchers to approach the subject is understandable.

Recent evolutionary history

The genus *Gazania* is yet another example of a South African endemic clade that has undergone rapid and recent cladogenesis (see Linder, 2003, for other examples). This rapid cladogenesis in *Gazania* is hypothesised to be in response to fluctuating climatic conditions over the last few million years.

There are several other possible reasons for the diversification of the many lineages that comprise the CFR flora; among them, Linder (2003) lists:

1) adaptation to fire, (*Gazania* does not appear to show any specialised adaptations to the frequent fires that burn the fynbos of the CFR);

2) edaphic specialization, (edaphic specialization cannot be ruled out, but it was not investigated in this study. It should be noted that *Gazania* is a wide-spread colonising generalist that grows easily in a variety of soil types, so soil specialization may not be an important factor);

3) microhabitats in the mountainous regions, (*Gazania* may have diversified within the microhabitats of the mountainous regions of the CFR that could have acted as refugia in the past, but it is not localised or limited to them now);

4) pollinator selection, (the pollination of *Gazania* was not investigated in this study, but *Gazania* seems to attract generalist pollinators. However, regional variations in UV reflectance patterns could reveal further information and is suggested as a future avenue of research);

5) flowering seasonality, (flowering time in *Gazania* is not narrowly limited to a short period of the year);

6) and climatic specialization driven by steep gradients, (this cannot be ruled out without further detailed investigation into climatic data for *Gazania*).

However, it should be noted that unlike many other endemic CFR genera that have undergone rapid cladogenesis, *Gazania* does not contain hundreds of distinct localized species. This is most likely due to a lack of specialization (ecological, morphological or pollinator) in *Gazania* in combination with wind-dispersed seeds and a tendency to easily colonise disturbed sites with poor soil, leading to a wide distribution.

The taxonomic confusion that plagues this genus is most likely a result of alternating cycles of climate driven refugial isolation and subsequent expansion and hybridization events. Roessler's reservations about the status and validity of some of the taxonomic entities within this genus are proven well-founded by the results of the morphometric, phylogenetic and phylogeographic study of hundreds of samples from across southern Africa.

Caveats

Prior to a full reorganization of the genus *Gazania*, further research involving other genetic markers should be undertaken. Use of low copy nuclear markers, chloroplast microsatellites and AFLP could provide more clarity on the confusing taxonomic situation within *Gazania*. A much greater morphological sampling, including type specimens, is necessary before any meaningful nomenclatural analysis can be undertaken. As such, the taxonomic suggestions that follow are best regarded as preliminary until further more detailed research can be undertaken.

Morphological characters and species phylogeny

Figure 6.1 is a summary phylogeny of the species within *Gazania*, with various autapomorphic and synapomorphic morphological characters mapped onto the branches. Most of the characters (e.g. habit, obovate leaves) appear in multiple places in the phylogeny. The morphological characters are homoplasious when interpreted in context of the phylogeny.

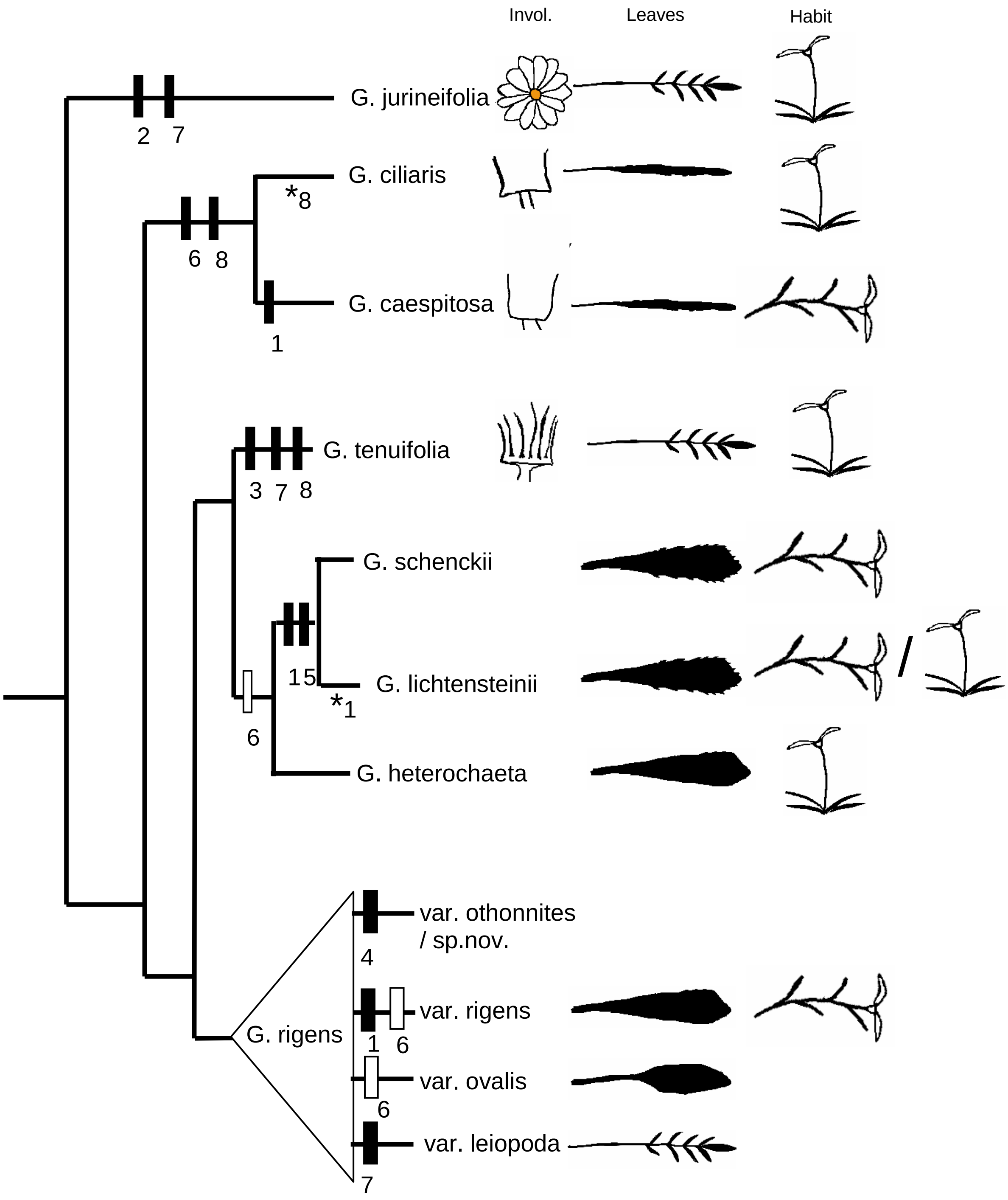


Figure 6.1: Summary DNA species phylogeny of Gazania with morphological character states mapped onto branches. 1 = Developed stem habit, 2 = White flowers, 3 = Multiple rows of involucral parietal scales, 4 = Mild succulence, 5 = Leaf margins dentate, 6: black bar = Linear leaf (< 4mm wide), 6: hollow bar = obovate leaf (>4 mm wide), 7 =All leaves dissected, 8 = involucral base truncate. Asterisks indicate partial presence of numbered character, i.e. some individuals may not show it.

Valid taxonomic entities with genetic and morphological distinction

The results of the investigations undertaken on *Gazania* in the previous chapters suggest that there are a number of genetically and morphologically distinct taxonomic entities that correlate with Roessler's species and that are without difficulty considered as valid taxa. Those considered valid under the Phylogenetic and Morphological species concepts are:

1) *G. jurineifolia*
2) *G. tenuifolia*
3) *G. heterochaeta*
4) *G. lichtensteinii*
5) *G. schenckii*
6) *G. caespitosa*
7) *G. ciliaris*

Problematic "species" lacking genetic and morphological distinction

The remaining nine species as delimited by Roessler are more challenging to assign taxonomic ranks to. One entity (*G. linearis* subspecies *ovalis)* has clear easily recognisable morphological distinction and geographic localization, yet does not show any evidence of genetic isolation. Another entity (*G. rigens*) shows clear morphological distinction, as well as geographical and ecological localization, but only incomplete evidence of genetic cohesion. Yet another (*G. leiopoda*) shows partial genetic cohesion and geographical localization, but little clear morphological distinction. A fourth entity (*G. othonnites/sp. nov*.) shows genetic cohesion, geographical localization and ecological specialization (by the presence of mild succulence).

For the rest of the taxonomic entities, as defined by Roessler, there are few informative morphological characters and those that do exist show large amounts of intra-specific variability. In conjunction with either recent or ongoing gene flow between these entities, there seems little chance of distinguishing discrete species within this impenetrable complex. The oldest species name for all nine of Roessler's species that fall within the K-R complex is that of *G. rigens* L. (1763), indicating that this should be the name of the ochlospecies.

It would seem more practical to define the entities within the "K-R" complex as members of a widely spread and highly variable ochlospecies. Within this ochlospecies are some consistently distinguishable varieties:

1) *G. rigens* var. *leiopoda* (formerly *G. leiopoda* under Roessler),
2) *G. rigens* var *ovalis* (formerly G. *linearis* subspecies *ovalis* under Roessler),
3) *G. rigens* var *rigens* (formerly *G. rigens* under Roessler),

4) *G. rigens* var *othonnites* (formerly *G. othonnites* under Roessler, and now including the putative new species *G. sp. nov.*).

However, the presence of these lineages within a larger clade will render that larger clade a paraphyletic or metaphyletic. Archibald (1994) illustrates the difference between paraphyletic and metaphyletic in Figure 6.2. The genetically distinct branches within the K-R clade (those numbered 1-12 in Chapter 4) are rendered paraphyletic, while the samples that cluster along the backbone of the clade are rendered metaphyletic. This distinction becomes important when attempting to apply the Metaspecies/Mixotaxic concepts to the K-R clade. A metaspecies is a previously named portion of a polytomy for which positive evidence of monophyly or paraphyly is lacking (Figure 6.2). A mixotaxon one is where some (but not all) constituent clades may possess autapomorphies (Figure 6.2), which describes the K-R clade.

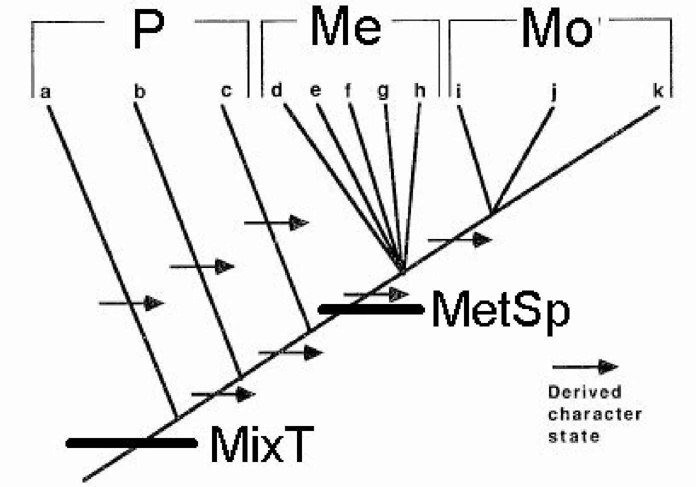


Figure 6.2: An illustration of the difference between paraphyletic taxa (P), metaphyletic taxa (Me) and monophyletic taxa (Mo), “MixT” marks the base of a mixotaxon, “MetSp” marks the base of a metaspecies. (Based on Archibald, 1995: Figure 1).

The remainder of the entities within the K-R complex (those not identified in the four varieties named above) lack sufficient genetic signal or morphological distinctiveness to warrant separate names. For just this situation, Olmstead (1995) proposes the concept of an apospecies which possesses a unique derived character, while an associated Plesiospecies lacks any uniquely derived character (Figure 6.3 illustrates the relationship between the two). In the K-R clade of *Gazania*, the four genetically recognisable lineages could be considered apospecies, whilst the remaining mixture of samples forms a plesiospecies. Despite describing extremely similar entities, the metaspecies concept is dismissed by Olmstead (1995) as "a conditional statement of lack of knowledge concerning relationships".

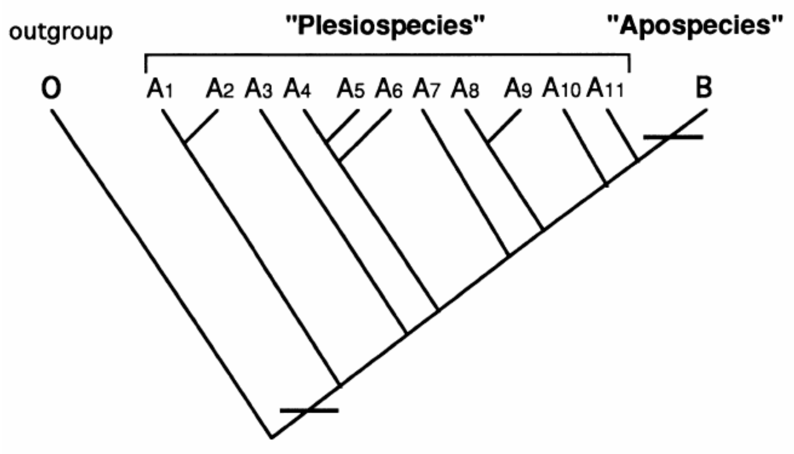


Figure 6.3: Diagrammatic illustration of the relationship between Plesiospecies and Apospecies (From Olmstead, 1995, Figure 2). Horizontal bars indicate unique characters that diagnose each clade.

Whether one chooses to define the greater unresolved portion of the K-R clade as a plesiospecies, or as para/metaphyletic members of a mixotaxon is a matter of personal taste. Species concepts are difficult to apply in a practical diagnostic sense in *Gazania*, as those based purely on morphology will conflict with those based purely on genes. Samples of *G. rigens* (*sensu* Roessler) diagnosed by morphology may or may not fall into the genetically monophyletic apospecies of *G. rigens* var. *rigens* diagnosed in this investigation. The contradiction between morphometric species designation and genetic species designation is yet another example of the problems incurred when investigating low-level phylogeny.

Sites & Marshall (2003) observe that speciation processes create fuzzy boundaries under which all methods of diagnosing species will occasionally fail or be discordant with each other (as clearly observed in *Gazania,* where application of the morphological and phylogenetic species concepts within the K-R clade are in conflict). It is these “problematic” taxa that should be of particular interest to evolutionary biologists, because these taxa are the most promising candidates for providing unique insights into the crucial early stages of the speciation process (Shoemaker *et al.*, 2006). Studies of differentiated populations have rarely been incorporated into research on speciation, even though population differentiation is envisioned as the first stage in speciation in the most widely favoured speciation models (Foster *et al.,* 1998).

The current taxonomic situation in *Gazania* is a complex mix of seven species that are distinct under the Morphological and Phylogenetic Species concepts, and an eighth ochlospecies mixotaxon, with four diagnosable apotaxa.

Morphological key to taxonomic entities within *Gazania*.

Below is the morphological key to those taxonomic entities within *Gazania* that show genetic and morphological distinction as species. *G. lichtensteinii* appears twice in the key due to the presence of both the developed and rosette stem habits. *G. rigens* appears in multiple places in the key due to the broad range of morphological variation that is found within this ochlospecies. Three of the four morphologically identifiable varieties within *G. rigens* are present in the key, except for *G. rigens* var *leiopoda*, which shows no clear morphological distinction, despite some geographical and genetic cohesion.

1) Stem developed with leaves spaced along entire length.
  2) Leaves linear (< 2 mm wide) ***G. caespitosa***
  2) Leaves obovate/obovate-lanceolate/lanceolate (> 2 mm wide)
    3) All leaves deeply pinnatifid (1-5 lacinae) ***G. rigens***
    3) Leaves entire or some few leaves pinnatifid (1-3 lacinae)
      4) Leaf margin entire ***G. rigens*** var. ***rigens***
      4) Leaf margin dentate/denticulate
        5) Involucre tomentose, older stems woody ***G. schenckii***
        5) Involucre glabrous, stem not woody ***G. lichtensteinii***
1) Stem shortened with leaves crowded at base in rosette.
  6) Leaf abaxial surface glabrous, succulent glaucous leaves. ***G. rigens*** var ***othonnites/sp. nov.***
  6) Abaxial surface tomentose.
    7) Leaf margins dentate/denticulate. ***G. lichtensteinii***
    7) Leaf margins entire or ciliate
      8) Multiple rows of linear parietal scales upwards from truncate involucre base ***G. tenuifolia***
      8) Most involucral scales terminal, some few single parietal.
        9) Inner involucre scales greatly and finely acuminate (> 8 mm long)
          10) Inner involucral scale margins entire
            11) Leaves lanceolate/elliptic, entire leaves > 10 mm wide, lacinae of pinnatifid leaves > 4 mm wide. ***G. rigens*** var. ***ovalis***
            11) Leaves linear, lanceolate, entire leaves < 10mm wide, lacinae of pinnatifid leaves < 4 mm wide. ***G. rigens***

10) Inner involucral scale margins ciliate. ***G. ciliaris***

9) Inner involucre scales < 8 mm long.

12) Outer involucral scales < 4 mm long, inner > 4 mm long. Ray florets white. ***G. jurineifolia***

12) Outer involucral scales > 4 mm long, inner < 4 mm long. Ray florets yellow / orange.

13) Leaf obovate ***G. heterochaeta***

13) Leaf linear/lanceolate ***G. rigens***

References

Abdel Khalik, K., van der Maesen, L.J.G., Koopman, W.J.M. & van den Berg, R.G. 2002. Numerical taxonomic study of some tribes of Brassicaceae from Egypt. *Plant Syst. Evol*. 233: 207-221.

Ackerfield, J. & Wen, J. 2002. A morphometric analysis of *Hedera* L. (the ivy genus, Araliaceae) and its taxonomic implications. *Adansonia.* 24(2):197-212.

Albach, D.C. & Chase, M.W. 2004. Incongruence in *Veronicaea* (Plantaginaceae): evidence from two plastid and a nuclear ribosomal DNA region. *Mol. Phylogenet. Evol.* 32: 183-197.

Albrecht, G.H. 1978. Some comments on the use of ratios. *Syst. Zool.* 27(1): 67-71.

Arbogast, B.S & Kenagy, G.J. 2001. Comparative phylogeography as an integrative approach to historical biogeography. *J. Biogeogr.* 28(7): 819-825.

Arbogast, B.S. & Slowsinki, J.B. 1998. Pleistocene speciation and the mitochondrial DNA clock. *Science*. 282:1955a.

Archibald, J.D. 1994. Metataxon concepts and assessing possible ancestry using phylogenetic systematics*. Syst. Biol*. 43(1): 27-40.

Atchley, W.R. & Anderson, D. 1978. Ratios and the statistical analysis of biological data. *Syst. Zool*. 27(1):71-78.

Atchley, W.R., Nordheim, E.V., Gunsett, F.C. & Crump, P.L. 1982. Geometric and probabilistic aspects of statistical distance functions. *Syst. Zool*. 31(4):445-460.

Avise, J.C. 2000. *Phylogeography: the history and formation of species*. Harvard University Press, Cambridge.

Avise, J.C. 2004. *Molecular markers, natural history and evolution.* (2nd Ed.) Sinauer Associates Inc. Sunderland.

Ayoub, N.A. & Riechert, S.E. 2004. Blackwell Publishing, Ltd. Molecular evidence for Pleistocene glacial cycles driving diversification of a North American desert spider, *Agelenopsis aperta*. *Mol. Ecol.* 13: 3453-3465

Bakker, F.T., Culham, A., Pankhurst, C.E. & Gibby, M. 2000. Mitochondrial and chloroplast DNA-based phylogeny of *Pelargonium* (Geraniaceae). *Am. J. Bot.* 87(4): 727-734.

Baldwin, B.G. & Markos, S. 1998. Phylogenetic utility of the external transcribed spacer (ETS) of 18S-26S rDNA: congruence of ETS + ITS trees of *Calycadenia* (Compositae*). Mol. Phylogenet. Evol.* 10(3): 449-463.

Baldwin, B.G. & Sanderson, M.J. 1998. Age and rate of diversification of the Hawaiian silversword alliance (Compositae). *Proc. Natl. Acad. Sci. USA* 95: 9402-9406.

Barker, F.K. & Lutzoni, F.M. 2002. The utility of the Incongruence Length Difference Test. *Syst. Biol.* 51(4): 625-637.

Barraclough, T.G., Vogler, A.P. & Harvey, P.H. 1998. Revealing the factors that promote speciation. *Phil. Trans. R. Soc. Lond. B.* 353: 241-249.

Baum, D.A. & Shaw, K.L. 1995. Genealogical perspectives on the species problem. In: *Experimental and Molecular Approaches to Plant Biosystematics*. (Eds) P.C. Hoch, & A.G. Stephenson. Missouri Botanical Garden.

Bayer, R.J., Soltis, D.E. & Soltis, P.S. 1996. Phylogenetic inferences in *Antennaria* (Asteraceae: Gnaphalieae: Cassiniinae) based on sequences from nuclear ribosomal DNA internal transcribed spacers (ITS). *Am. J. Bot.* 83(4): 516-527.

Bellarosa, R., Simeone, M.C., Papini, A. & Schirone, B. 2005. Utility of ITS sequence data for phylogenetic reconstruction of Italian *Quercus* spp. *Mol. Phylogenet. Evol.* 34: 355-370.

Bena, G., Jubier, M.-F., Olivieri, I. & Lejeune, B. 1998. Ribosomal External and Internal Transcribed Spacers: Combined Use in the phylogenetic analysis of *Medicago (*Leguminosae). *J. Mol. Evol.* 46:299–306.

Bermingham, E. & Moritz, C. 1998. Comparative phylogeography: concepts and applications. *Mol. Ecol.* 7: 367-369.

Besnard, G., Khadari, B., Baradat, P. & Bervillé, A. 2002. *Olea europaea* (Oleaceae) phylogeography based on chloroplast DNA polymorphism. *Theor. Appl. Genet.* 104: 1353-1361.

Bookstein, F.L. 1982. Foundations of morphometrics. *Ann. Rev. Ecol. Syst*. 13: 451-470.

Borazan, A. & Babac, M.T. 2003. Morphometric leaf variation in oaks (*Quercus*) of Bolu, Turkey. *Ann. Bot. Fennici*. 40: 233-242.

Boyd, A. 2002. Morphological analysis of sky island populations of *Macromeria viridiflora* (Boraginaceae). *Syst. Bot*. 27:116–126.

Brower, A.V.Z. 1999. Delimitation of phylogenetic species with DNA sequences: a critique of Davis and Nixon’s population aggregation analysis. *Syst. Biol*. 48:199–213.

Bryant, D. & Moulton, V. 2004. Neighbor-Net: an agglomerative method for the construction of phylogenetic networks. *Mol. Biol. Evol*. 21(2): 255-265.

Buckler, E.S., Ippolito, A. & Holtsford, T.P. 1997. The evolution of ribosomal DNA: Divergent paralogues and phylogenetic implications. *Genetics*. 145:821-832.

Butzer, K.W. 1984. Late Quarternary environments in South Africa. In: *Late Cainozoic Paleoclimates of the southern hemisphere*. (Ed.) J.C. Vogel. Balkema, Rotterdam.

Campbell, C.S., Wright, W.A., Cox, M., Vining, T.F., Major, C.S. & Arsenault, M.P. 2005. Nuclear ribosomal DNA ITS1 in *Picea* (Pinaceae): sequence divergence and structure. *Mol. Phylogenet. Evol*. 35: 165-185.

Carr GD, King RM, Powell AM, Robinson H. 1999. Chromosome numbers in Compositae. XVIII. *Am. J. Bot.* 86: 1003–1013.

Castro, S., Silveira, P., Pereira Coutinho, A. & Figueiredo, E. 2005. Systematic studies in *Tyloseam* (Leguminosae). *Bot. J. Linn. Soc*. 147: 99-115.

Chan, R., Baldwin, B.G. & Ornduff, R. 2001. Goldfields revisited: a molecular phylogenetic perspective on the evolution of *Lasthenia* (Compositae: Heliantheae sensu lato). *Int. J. Plant. Sci*. 162(6): 1347-1360.

Chandler, G.T., Bayer, R.J. & Crisp, M.D. 2001. A molecular phylogeny of the endemic Australian genus *Gastrolobium* (Fabaceae: Mirbelieae) and allied genera using chloroplast and nuclear markers. *Am. J. Bot.* 88(9): 1675-1687.

Chandler, G.T. & Crisp, M.D. 1998. Morphometric and phylogenetic analysis of the *Daviesia ulicifolia* complex (Fabaceae, Mirbelieae). *Plant Syst. Evol*. 209:93–122.

Chase, M.W. & Cox, A.V. 1998. Genes sequences, collaboration and analysis of large data sets. *Aust. Syst. Bot.* 11: 215-229.

Cheng, Y.-P., Hwang, S.-Y. & Lin, T.-P. 2005. Potential refugia in Taiwan revealed by the phylogeographical study of *Castanopsis carlesii* Hayata (Fagaceae). *Mol. Ecol.* 14: 2075–2085.

Clegg, M.T., Brown, A.D.H. & Whitfeld, P.R. 1984a. Chloroplast DNA diversity in wild and cultivated barley: implications for genetic conservation. *Genetic Research* 43: 339-343.

Clegg, M.T., Rawson, J.R.Y. & Thomas, K. 1984b. Chloroplast DNA variation in pearly millet and related species. *Genetics.* 106: 449-461.

Clegg, M.T., Gaut, B.S., Learn, G.H. & Morton, B.R. 1995. Rates and patterns of chloroplast DNA evolution. In: *Tempo and Mode in evolution: Genetics and Paleontology 50 years after Simpson.* (Eds) W.A. Fitch & F.J. Ayala. National Academy of Sciences.

Clevinger, J.A. & Panero, J.L. 2000. Phylogenetic analysis of *Silphium* and subtribe Engelmanniinae (Asteraceae: Heliantheae) based on ITS and ETS sequence data. *Am. J. Bot.* 87(4): 565-572.

Comes, H.P. & Kadereit, J.W. 1998. The effect of Quaternary climatic changes on plant distribution and evolution. *Trends Plant Sci*. 3(11):432-438

Cowling, R.M. & Lombard, A.T. 2002. Heterogeneity, speciation/extinction history and climate: explaining regional plant diversity patterns in the Cape Floristic Region. *Divers. Distrib.* 8: 163-179.

Creer, S., Malhotra, A. & Thorpe, R.S. 2003. Assessing the phylogenetic utility of four mitochondrial genes and a nuclear intron in the Asian pit viper genus, *Trimeresurus*: Separate, simultaneous, and conditional data combination analyses. *Mol. Biol. Evol*. 20(8):1240–1251.

Crisp, M.D. & Weston, P.H. 1993. Geographic and ontogenetic variation in morphology of Australian waratahs (Telopea: Proteaceae). *Syst. Biol*. 42: 49-76.

Crompton, C.W., Stahevitch, A.E. & Wojtas, W.A. 1990. Morphometric studies of the *Euphorbia esula* group in North America. *Can. J. Bot*. 68: 1978-1988.

Cronk, Q.C.B. 1998. The ochlospecies concept. In: *Chorology, taxonomy and ecology of the floras of Africa and Madagascar*. (Eds) C.R. Huxley, J.M. Lock & D.F. Cutler. Royal Botanic Gardens, Kew.

Crowe, T.M. 1994. Morphometrics, phylogenetic models and cladistics: means to an end or much ado about nothing? *Cladistics*. 10:77-84.

Cunningham, C.W. 1997. Can three incongruence tests predict when data should be combined? *Mol. Biol. Evol*. 14(7): 733-740.

Cupido, C.N. 2003. Systematic studies in the genus *Merciera* (Campanulaceae): A re-assessment of species boundaries. *Adansonia*. 25(1):33-44.

Davis, J.I. 1983. Phenotypic plasticity and the selection of taxonomic characters in *Puccinellia* (Poaceae). *Syst. Bot.* 8(4): 341-353.

Dawson, M.N. 2005. Incipient speciation of *Catostylus mosaicus* (Scyphozoa, Rhizostomeae, Catostylidae), comparative phylogeography and biogeography in south-east Australia. *J. Biogeogr*. 32: 515-533.

de Meeus, T., Durand, P. & Renaud, F. 2003. Species concepts: what for? *Trends in parasitology.* 19(10): 425-427.

deMenocal, P.B. 1995. Plio-Pleistocene African climate. *Science*. 270: 53-59.

deMenocal, P.B. 2004. African climate change and faunal evolution during the Pliocene-Pleistocene. *Earth Planet. Sc. Lett.* 220: 3-24.

Dobeš, C.H., Mitchell-Olds, T. & Koch, M.A. 2004. Extensive chloroplast haplotype variation indicates Pleistocene hybridization and radiation of North American *Arabis drummondii*, *A. X divaricarpa* and *A. holboelii* (Brassicaceae). *Mol. Ecol*. 13: 349-370.

Doebeli, M. & Dieckmann, U. 2003. Speciation along environmental gradients. *Nature.* 421: 259-264.

Downie, S.R., Hartman, R.L., Sun F.-J. & Katz-Downie, D.S. 2002. Polyphyly of the spring-parsleys (*Cymopterus*): molecular and morphological evidence suggests complex relationships among the perennial endemic genera of western North American Apiaceae. *Can. J. Bot.* 80(12): 1295-1324.

Dowton, M. & Austin, A.D. 2002. Increased congruence does not necessarily indicate increased phylogenetic accuracy – the behaviour of the Incongruence Length Difference test in mixed-model analyses. *Syst. Biol.* 51(1): 19-31.

Doyle, J.J. 1992. Gene trees and species tree: molecular systematics as one-character taxonomy. *Syst. Bot*. 17(1): 144-163.

Doyle, J.J. & Doyle, J.L. 1987. A rapid DNA isolation procedure for small quantities of fresh leaf material. *Phytochem. Bull.* 19(1): 11-15.

Drummond, A.J., Ho, S.Y.W., Phillips, M.J. & Rambaut, A. 2006. Relaxed phylogenetics and dating with confidence. *PLoS Biol.* 4(5):e88.

Drummond, A.J. & Rambaut, A. 2003. BEAST version 1.0. Available at http://evolve.zoo.ox.ac.uk/beast/

Dynesius, M. & Jansson, R. 2000. Evolutionary consequences of changes in species' geographical distributions driven by Milankovitch climate oscillations. *Proc. Natl. Acad. Sci. USA.* 97(16): 9115-9120.

Edwards, S.V. & Beerli, P. 2000. Perspective: gene divergence, population divergence, and the variance in coalescence time in phylogeographic studies. *Evolution.* 54(6): 1839-1854.

Edwards, K.J. & Gadek, P.A. 2001. Evolution and biogeography of *Alectryon* (Sapindaceae). *Mol. Phylogenet. Evol.* 20(1): 14-26.

Excoffier, L. 2004. Patterns of DNA sequence diversity and genetic structure after a range expansion: lessons from the infinite-island model. *Mol. Ecol*. 13:853-864.

Farris, J.S., Källersjö, M., Kluge, A.G. & Bult, C. 1994. Testing significance of incongruence. *Cladistics.* 10: 315-319.

Felsenstein, J. 1981. Evolutionary trees from DNA sequences: a maximum likelihood approach. *J. Mol. Evol.* 17: 368-376.

Fishbein, M. & Soltis, P.E. 2004. Further resolution of the rapid radiation of *Saxifragales* (Angiogperms, Eudicots) supported by mixed-model Bayesian analysis. *Syst. Bot*. 29(4): 883-891.

Foster, S.A., Scott, R.J. & Cresko, W.A. 1998. Nested biological variation and speciation. *Phil. Trans. Biol*. 353: 207-218.

Funk, V.A., Chan, R. & Keeley, S.C. 2004. Insights into the evolution of the tribe Arctoteae (Compositae: subfamily Cichorioideae s.s.) using trnL-F, ndhF, and ITS. *Taxon*. 53(3): 637-655.

Gielly, L., Yuan, Y.-M., Kupper, P. & Taberlet, P. 1996. Phylogenetic use of noncoding regions in the genus *Gentiana* L.: chloroplast *trnL*(UAA) intron versus nuclear ribosomal internal transcribed spacer sequences. *Mol. Phylogenet. Evol.* 5(3): 460-466.

Goertzen, L.R., Cannone, J.J., Gutell, R.R. & Jansen, R.K. 2003. ITS secondary structure derived from comparative analysis: implications for sequence alignment and phylogeny of the Asteraceae. *Mol. Phylogenet. Evol.* 29: 216-234.

Graham, S.W., Kohn, J.R., Morton, B.R., Eckenwalder, J.E. & Barrett, S.C.H. 1998. Phylogenetic congruence and discordance among one morphological and three molecular data sets from Pontederiaceae. *Syst. Biol*. 47(4): 545-567.

Grant, W.S. & Bowen, B.W. 1998. Shallow population histories in deep evolutionary lineages of marine fishes: insights from sardines and anchovies and lessons for conservation. *J. Hered.* 89(5): 415-425

Griffioen, R.C. 1995. *A taxonomic study of Chrysanthemoides Tourn. ex Medik. (Compositae).* Thesis, University of Cape Town.

Hamilton, M.B. 1999. Tropical tree gene flow and seed dispersal: deforestation affects the genetic structure of the surviving forest fragments. *Nature* 401: 129-130.

Harrison, R.G. 1991. Molecular changes at speciation. *Annu. Rev. Ecol. Syst.* 22: 281-308.

Harrison, R.G. 2001. Genealogies and geography: deciphering recent evolutionary history. *Evolution. 55*(3): 646-649.

Henderson, A. 2006. Traditional morphometrics in plant systematics and its role in palm systematics. *Bot. J. Linn. Soc*. 151(1): 103-111.

Hendry, A.P., Vamosi, S.M., Latham, S.J., Heilbuth, J.C. & Day, T. 2000. Questioning species realities. *Conservation Genetics* 1: 67-76.

Heuertz, M., Fineschi, S., Anzidei, M., Pastorelli, R., Salvinia, D., Paule, L., Frascaria-Lacoste, N., Hardy, O.J., Vekemans, X. & Vendramin, G.G. 2004. Chloroplast DNA variation and postglacial recolonization of common ash (*Fraxinus excelsior* L.) in Europe. *Mol. Ecol.* 13: 3437-3452.

Hey, J., Waples, R.S., Arnold, M.L., Butlin, R.K. & Harrison, R.G. 2003. Understanding and confronting species uncertainty in biology and conservation. *Trends Ecol. Evol.* 18(11): 597-603.

Hillis, M. 1978. On ratios - a response to Atchley, Gaskins and Anderson*. Syst. Zool*. 27(1): 61-62.

Hipp, A.L., Hall, J.C. & Sytsma, K.J. 2004. Congruence versus phylogenetic accuracy: revisiting the Incongruence Length Difference test. *Syst. Biol*. 53(1): 81-89.

Ho, S.Y.W., Phillips, M.J., Cooper, A. & Drummond, A.J. 2005. Time dependency of molecular rate estimates and systematic overestimation of recent divergence times. *Mol. Biol. Evol*. 22(7):1561–1568.

Holdregger, R. & Abbott, R.J. 2003. Phylogeography of the Arctic-Alpine *Saxifraga oppositifolia* (Saxifragaceae) and some related taxa based on cpDNA and ITS sequence variation. *AMJB* 90: 931-936.

Hollingsworth, M.L., Hollingsworth, P.M., Jenkins, G.I., Bailey, J.P. & Ferris, C. 1998. The use of molecular markers to study patterns of genotypic diversity in some invasive alien *Fallopia* spp. (Polygonaceae). *Mol. Ecol*. 7:1681-1691.

Huelsenbeck, J.P., Bull, J.J. & Cunningham, C.W. 1996. Combining data in phylogenetic analysis. *Trends Ecol. Evol.* 11(4): 152-158.

Humphries, J.M., Bookstein, F.L., Chernoff, B., Smith, G.R., Elder, R.L. & Poss, S.G. 1981. Multivariate discrimination by shape in relation to size. *Syst. Zool*. 30:291–308.

Hung, Y.-T., Chen, C.A., Wu, W.-J., Lin, C.-C. & Shih, C.-J. 2004. Phylogenetic utility of the ribosomal internal transcribed spacer 2 in *Strumigenys* spp. (Hymenoptera: Formicidae). *Mol. Phylogenet. Evol.* 32: 407-415.

James, F.C. & McCulloch, C.E. 1990. Multivariate analysis in ecology and systematics: panacea or pandora's box? *Annu. Rev. Ecol. Syst.* 21:129-166.

Jansson, R. & Dynesius, M. 2002. The fate of clades in a world of recurrent climate change: Milankovitch oscillations and evolution. *Annu. Rev. Ecol. Syst*. 33: 741-777.

Jeandroz, S., Roy, A. & Bousquet, J. 1997. Phylogeny and phylogeography of the circumpolar genus *Fraxinus* (Oleaceae) based on Internal Transcribed Spacer sequences of nuclear ribosomal DNA. *Mol. Phylogenet. Evol.* 7(2): 241-251.

Jensen, R.J. 2003. The conundrum of morphometrics. *Taxon.* 52: 663-671.

Johnson, L.A. & Soltis, D.E. 1995. Phylogenetic inference in Saxifragaceae sensu stricto and Gilia (Polemoniaceae) using matK sequences. *Ann. Miss. Bot. Gard*. 82: 149-175.

Jűrgens, N. 1997. Floristic biodiversity and history of African arid regions. *Biodivers. Conserv.* 6: 495-514.

Karis, P.O. 2006. Morphological data indicates two major clades of the subtribe Gorteriinae (Asteraceae-Arctotideae). *Cladistics.* 22(3): 199-221.

Kellogg, E.A., Appels, R. & Mason-Gamer, R.J. 1994. When genes tell different stories: the diploid genera of Triticeae (Gramineae). *Syst. Bot.* 21(3): 321-348.

Kennedy, M., Holland, B.R., Gray, R.D. & Spencer, H.G. 2005. Untangling long branches: Identifying conflicting phylogenetic signals using spectral analysis, Neighbor-Net, and consensus networks. *Syst. Biol.* 54(4): 620-633.

Kennett, J.P. 1982. *Marine geology*. Prentice-Hall, Englewood Cliffs.

Kim S.-C., Crawford, D.J., Jansen, R.K. & Arnoldo, S.-G. 1999 The use of a non-coding region of chloroplast DNA in phylogenetic studies of the subtribe Sonchinae (Asteraceae: Lactuceae). *Plant Syst. Evol.* 215: 85-99.

Kores, P.J., Molvray, M. & Darwin, S.P. 1993. Morphometric variation in three species of Cyrtostylis (Orchidaceae). *Syst. Bot*. 18(2):274-282.

Lamb, T. & Bauer, A.B. 2000. Relationships of the *Pachydactylus rugosus* group of geckos (Reptilia: Squamata: Gekkonidae). *Afr. Zool.* 35: 55–67.

Levasseur, C. & Lapointe, F.J. 2001. War and peace in phylogenetics: a rejoinder on total evidence and consensus. *Syst. Biol.* 50(6):881-891.

Lee, C., Kim, S.-C., Lundy, K. & Santo-Guerra, A. 2005. Chloroplast DNA phylogeny of the woody *Sonchus* alliance (Asteraceae: Sonchinae) in the Macronesian islands. *Am. J. Bot.* 92(1): 2072-2075.

Lee, J., Baldwin, B.G. & Gottlieb, L.D. 2002. Phylogeny of *Stephanomeria* and related genera (Compositae - Lactuceae) based on analysis of 18S-16S nuclear rDNA ITS and ETS sequences. 2002. *Am. J. Bot.* 89(1): 160-168.

Li, W.-H. 1997. *Molecular evolution*. Sinauer Press, Sunderland Massachusetts.

Lilliefors, H. 1967. On the Kolmogorov-Smirnov test for normality with mean and variance unknown. *J. Amer. Stat. Assoc.* 62: 399-402.

Linder, C.R., Goertzen, L.R., Vanden Heuvel, B., Francisco-Ortega, J. & Jansen, R.K. 2000. The complete external transcribed spacer of 18S-26S rDNA: amplification and phylogenetic utility at low taxonomic levels in Asteraceae and closely allied families. *Mol. Phylogenet. Evol*. 14(2): 285-303.

Linder, H.P. & Hardy, C.R. 2004. Evolution of the species-rich Cape flora. *Phil. Trans. R.. Soc. Lond. B*. 359: 1623-632.

Linder, H.P. 2005. Evolution of diversity: the Cape flora. *Trends Plant Sci*. 10(11): 536-541.

Lindesay, J. 1998. Past climates of Southern Africa. In: *Climates of the southern continents: Present, past and future*. (Eds) J.E. Hobbs, J. Lindesay & H.A. Bridgman. John Wiley & Sons Ltd..

Liston, A., Robinson, W.A., Oliphant, J.M. & Alvarez-Buylla, E.R. 1996. Length variation in the nuclear ribosomal DNA Internal Transcribed Spacer Region of non-flowering seed plants. *Syst. Bot*. 21(2): 109-120.

Maddison, D.R. 1991. The discovery and importance of multiple islands of most-parsimonious trees. *Syst. Biol.* 40: 315-328.

Mahoney, M.J. 2004. Molecular systematics and phylogeography of the *Plethodon elongatus* species group: combining phylogenetic and population genetic methods to investigate species history. *Mol. Ecol*. 13:149–166.

Manos, P.D., Doyle, J.J & Nixon, K.C. 1999. Phylogeny, biogeography and processes of molecular differentiation in *Quercus* subgenus *Quercus* (Fagaceae). *Mol. Phylogenet. Evol*. 12(3): 333-349.

Mantel, N. 1967. Ranking procedures for arbitrarily restricted observations. *Biometrics*. 23: 65-78.

Marcussen, T. 2003. Evolution, phylogeography, and taxonomy within the *Viola alba* complex (Violaceae). *Plant. Syst. Evol.* 237:51-74.

Matthee, C.A. & Flemming, A.F. 2002. Population fragmentation in the southern rock agama, *Agama atra*: more evidence for vicariance in Southern Africa. *Mol. Ecol*. 11: 465–471.

Matthee C.A. & Robinson, T.J. 1996. Mitochondrial DNA differentiation among geographical populations of *Pronolagus rupestris*, Smith's red rock rabbit (Mammalia: Lagomorpha). *Heredity*. 76: 514–523.

Mayden, R.L. 1997. A hierarchy of species concepts: the denouement in the saga of the species problem. In: *Species: The units of diversity*. (Eds) M. Claridge, H. Dawah, & M. Wilson Chapman and Hall, London.

Mayr, E. 1965. Numerical phenetics and taxonomic theory. *Syst. Zool.* 14(2): 73-97.

McDade, L.A. 1997. Hybrids and phylogenetic systematics III. Comparison with distance methods. *Syst. Bot*. 22(4):669-683.

Mehra, P.N. & Remananandan, P. 1969. IOPB chromosome number reports XXII. *Taxon.* 8: 433-442.

Mes, T.H.M. & t'Hart, H. 1994. *Sedum surculosum* and *S. jaccardianum* (Crassulaceae) share a unique 70bp deletion in the chloroplast DNA trnL(UAA)-trnF(GAA) intergenic spacer. *Plant Syst. Evol.* 206: 411-420.

Mickevich, M.F. & Farris, J.S. 1981. Implications of congruence in *Menidia*. *Syst. Zool.* 30: 351-320.

Mickevich, M.F. & Johnson, M.S. 1976. Congruence between morphological and allozyme data in evolutionary inference and character evolution. *Syst. Zool*. 25(3):260-270.

Mishler, B.D. & Theriot, E.C. 2000. A critique from the Mishler and Theriot phylogenetic species concept perspective. In: *Species concepts and phylogenetic theory* - *a debate*. (Eds) Q.D. Wheeler & R. Meier. Columbia University Press, New York.

Mort, M.E., Archibald, J.K., Randle, C.P., Levsen, N.D., O'Leary, T.R., Topalov, K., Wiegand, C.M. & Crawford, D.J. 2007. Inferring phylogeny at low taxonomic levels: utility of rapidly evolving cpDNA and nuclear ITS loci. *Am. J. Bot.* 94(2):173-183.

Mort, M.E., Levsen, N., Randle, C.P., Van Jaarsveld, E. & Palmer, A. 2005. Phylogenetics and diversification of *Cotyledon* (Crassulaceae) inferred from nuclear and chloroplast DNA sequence data. *Am. J. Bot.* 92(7): 1170-1176.

Muir, G., Fleming, C.C. & Schlötterer, C. 2001. Three divergent rDNA clusters predate the species divergence in *Quercus petraea* (Matt.) Liebl. and *Quercus robur* L. *Mol. Biol*. 18(2): 112-119.

Nielsen, L.R. 2004. Molecular differentiation within and among island populations of the endemic plant *Scalesia affinis* (Asteraceae) from the Gala´pagos Islands. *Heredity*. 93:434-442.

Niklas, K.J. 1997. *The evolutionary biology of plants*. University of Chicago Press.

Nixon, K.C. & Wheeler, Q.D. 1990. An amplification of the phylogenetic species concept. *Cladistics.* 6: 211-223.

Nordenstam, B. Chromosome Numbers in South African Compositae. *Aquilo Ser. Bot.* 6.

Noyes, R.D. 2006. Intraspecific nuclear ribosomal DNA divergence and reticulation in sexual diploid *Erigeron strigosus* (Asteraceae). *Am. J. Bot.* 93(3): 470-479.

O'Kane, S.L., Schaal, B.A. & Al-Shehbaz, I.A. 1996. The origins of *Arabidopsis suecica* (Brassicaceae) as indicated by nuclear rDNA sequences. *Syst. Bot*. 21(4): 559-566.

Okuyama, Y., Fujii, N., Wakabayashi, M., Kawakita, A., Ito, M., Watanabe, M., Murakami, N. & Kato, M. 2005. Nonuniform concerted evolution and chloroplast capture: heterogeneity of observed introgression patterns in three molecular data partition phylogenies of Asian *Mitella* (Saxifragaceae). *Mol. Biol. Evol*. 22(2): 285-296.

Olmstead, R.G. 1995. Species concepts and plesiomorphic species. *Syst. Bot*. 20(4): 623-630.

Olmstead, R.G. & Palmer, J.D. 1994. Chloroplast DNA systematics: a review of methods and data analysis. *Am. J. Bot.* 81(9): 1205-1224.

Oxelman, B., Liden, M. & Berglund, D. 1997. Chloroplast rps16 intron phylogeny of the tribe Sileneae (Caryophyllaceae). *Syst. Evol.* 206: 393-410.

Oxnard, C.E. 1978. One biologist's view of morphometrics. *Ann. Rev. Ecol. Syst*. 9: 219-241.

Palmer, J.D. 1987. Chloroplast DNA evolution and biosystematic uses of chloroplast DNA variation. *Am. Nat*. 130: S6-S29.

Palmer, J.D. & Zamir, D. 1982. Chloroplast DNA evolution and phylogenetic relationships in *Lycopsericon*. *Proc. Natl. Acad. Sci. U.S.A.* 79: 5006-5010.

Partridge, T.C. & Maud, R.A. 1987. Geomorphic evolution of southern Africa since the Mesozoic. *S. Afr. J. Geol*. 90: 179-208.

Perl-Treves, R. & Galun, E. 1985. The *Cucumis* plastome: physical map, intrageneric variation and phylogenetic relationships. *Theoret. Appl. Genet.* 71:417-429.

Peterson, A., John, H., Koch, E. & Peterson, J. 2004. A molecular phylogeny of the genus *Gagea* (Liliaceae) in Germany inferred from non-coding chloroplast and nuclear DNA sequences. *Plant Syst. Evol*. 245: 145-162.

Phillips, R.B. 1983. Shape characters in numerical taxonomy and problems with ratios. *Taxon*. 32:535-544.

Pickford, M. 2004. Southern Africa: a cradle of evolution. *S.A. J. Sci*. 100: 205-214

Pimentel, R.A. 1981. A comparative study of data and ordination techniques based on a hybrid swarm of sand verbenas (*Abronia* Juss.) *Syst. Zool.* 30: 250-267.

Popp, M. & Oxelman, B. 2001. Inferring the history of the polyploid *Silene aegaea* (Caryophyllaceae) using plastid and homoeologous nuclear DNA sequences. *Mol. Phylogenet. Evol.* 20(3): 474-481.

Presch, W. 1979. Phenetic analysis of a single data set: phylogenetic implications. *Syst. Zool.* 28(3): 366-371.

Provan, J., Murphy, S. & Maggs, C.A. 2005. Tracking the invasive history of the green alga *Codium fragile* ssp. *tomentosoides*. *Mol. Ecol*. 14:189-194.

Ramirez, M.J. 2006. Further problems with the incongruence length difference test: “hypercongruence” effect and multiple comparisons. *Cladistics*. 22: 289-295.

Reeves, G., Chase, M.W., Goldblatt, P., Rudall, P., Gay, M.F., Cox, A.V., Lejeune, B. & Souza-Chies. T. 2001. Molecular systematics of Iridaceae: evidence from four plastid DNA regions. *Am. J. Bot.* 88(11): 2074-2087.

Richardson, J.E., Pennington, R.T., Pennington, T.D. & Hollingsworth, P.M. 2001. Rapid diversification of a species-rich genus of neotropical rain forest trees. *Science*. 293: 2242-2245.

Riddle, B.R. & Hafner, D.J. 1999. Species as units of analysis in ecology and biogeography: time to take the blinders off. *Global Ecol.Biogeogr.* 8: 433-441.

Rieseberg, L.H., Beckstrom-Sternberg, S., Liston, A. & Arias, D.M. 1991. Phylogenetic and systematic inferences from chloroplast DNA and isozyme variation in *Helianthus* sect. *Helianthus* (Asteraceae). *Syst. Bot*. 16(1):50-76.

Riggins, R., Pimentel, R.A. & Walters, D.R. 1977. Morphometrics of *Lupinus nanus* (Leguminosae).I. Variation in natural populations. *Syst. B*ot. 2(4): 317-326.

Ritz, C.M., Zimmerman, N.F.A. & Hellwig, F.H. 2003. Phylogeny of subsect. Meleuphorbia (A. Berger) Pax & Hoffm. (*Euphorbia* L.) reflects the climatic regime in South Africa. *Plant Syst. Evol.* 241: 245-259.

Roessler, H. 1959. Revision der Arctotideae-Gorteriinae (Compositae). *Mitteilungen der Botanischen Staatssammlung München* Band III: 71-500

Rogers, A.R., Harpending, H. 1992. Population growth makes waves in the distribution of pairwise genetic distances. *Mol. Biol. Evol*. 9: 552–569.

Rohlf, F.J. 1990. Morphometrics. *Ann. Rev. Ecol. Syst*. 21: 299-316.

Rohlf, F.J. & Marcus, L.F. 1993. A revolution in morphometrics. *TREE.* 8(4): 129-132

Rutschmann, F. 2006. Molecular dating of phylogenetic trees: A brief review of current methods that estimate divergence times. *Divers. Distrib*. 12:35-48.

Ryder, O.A. 1986. Species conservation and systematics: the dilemma of subspecies. *TREE.* 1(1): 9-10.

Sang, T., Crawford, D.J., Stuessy, T.F. & Solva O.M. 1995. ITS sequences and the phylogeny of the genus *Robinsonia* (Asteraceae). *Systematic Botany*. 20(1): 55-64.

Sang, T., Crawford, D.J. & Stuessy, T.F. 1997. Chloroplast DNA phylogeny, reticulate evolution and biogeography of *Paeonia* (Paeoniaceae). *Am. J. Bot.* 84(8): 1120-1136.

Santiago-Valentin, E. & Olmstead, R.G. 2003. Phylogenetics of the Antillean Goetzeoideae (Solanaceae) and their relationships within the Solanaceae based on chloroplast and ITS DNA sequence data. *Syst. Bot.* 28(2): 452-460.

Schaal, B.A., Hayworth, D.A., Olsen, K.M., Rauscherm J.T. & Smith, W.A. 1998. Phylogeographic studies in plants: problems and prospects. *Mol. Ecol.* 7: 465-474.

Schilling, E.E. & Panero, J.L. 1996. Phylogenetic reticulation in subtribe Helianthinae. *Am. J. Bot.* 83(7): 939-948.

Schnitker, D. 1980. Global palaeoceonography and its deep water linkage to the Antarctic glaciation. *Earth Sci. Rev*. 16: 1-20.

Scotland, R.W., Olmstead, R.G. & Bennett, J.R. 2003. Phylogeny reconstruction: the role of morphology. *Syst. Biol.* 52(4): 539-548.

Seelanan, T., Schnable, A. & Wendel, J.F. 1997. Congruence and consensus in the cotton tribe (Malvaceae). *Syst. Bot*. 22(2): 259-290.

Shaw, J., Lickey, E.B., Beck, J.T., Farmer, S.B., Liu, W., Miller, J., Siripun, K.C., Winder, C.T., Schilling, E.E. & Small, R.L. 2005. The tortoise and the hare II: relative utility of 21 noncoding chloroplast DNA sequences for phylogenetic analysis. *Am. J. Bot.* 92(1): 142-166.

Shoemaker, D.D., Ahrens, M.E. & Ross, K.G. 2006. Molecular phylogeny of fire ants of the *Solenopsis saevissima* species-group based on mtDNA sequences. *Mol. Phylogenet. Evol*. 38: 200-215.

Siddall, M.E. 1997. Prior agreement: arbitration or arbitrary? *Syst. Biol.* 46(4): 765-769.

Simmons, M.P. & Ochoterena, H. 2000. Gaps as characters in sequence-based phylogenetic analyses. *Syst. Biol.* 49: 369-381.

Sites, J.W. & Marshall, J.C. 2003. Delimiting species: a renaissance issue in systematic biology. *TREE.* 18(9): 462-470.

Slatkin, M. & Hudson, R.R. 1991. Pairwise comparisons of mitochondrial DNA sequences in stable and exponentially growing populations. *Genetics*. 129:555-562.

Small, R.L. Lickey, E.B., Shaw, J. & Hauk, W.D. 2005. Amplification of noncoding chloroplast DNA for phylogenetic studies in lycophytes and monilophytes with a comparative example of relative phylogenetic utility from Ophioglossaceae. *Mol. Phylogenet. Evol.* 36:509-522.

Sole, C.L., Scholtz, C.H. & Batos, A.D.S. 2005. Phylogeography of the Namib Desert dung beetles *Scarabaeus* (*Pachysoma*) MacLeay (Coleoptera: Scarabaeidae). *J. Biogeogr*. 32:75-84.

Soliva, M., Kocyan, A. & Widmer, A. 2001. Molecular phylogenetics of the sexually deceptive orchid genus *Ophrys* (Orchidaceae) based on nuclear and chloroplast DNA sequences. *Mol. Phylogenet. Evol.* 20(1): 78-88.

Soltis, D.E. & Soltis, P.S. 1998. Choosing an approach and an appropriate gene for phylogeographic analysis. In: *Molecular systematics of plants II: DNA sequencing.* (Eds) D.E. Soltis, P.S. Soltis & J.J. Doyle. Kluwer academic publishers. pp 1-42.

Soltis, D.E., Soltis, P.S., Mort, M.E., Chase, M.W., Savolainen, V., Hoot, S.B. & Morton, C.M. 1998. Inferring complex phylogenies using parsimony: an empirical approach using three large DNA data sets for angiosperms. *Syst. Biol.* 47: 32-42.

Somers, K.M. 1986. Multivariate allometry and removal of size with principal components analysis. *Syst. Zool*. 35(3): 359-368.

Somers, K.M. 1989. Allometry, isometry and shape in principal components analysis. *Syst. Zool.* 38(2): 169-173.

Stevens, P.F. 1991. Character states, morphological variation, and phylogenetic analysis: a review. *Syst. Bot.* 16(3): 553-583.

Swofford, D.L. 2001. PAUP*: phylogenetic analysis using parsimony (*and other methods). Sinauer Associates, Sunderland, MA.

Taberlet, P., Gielly, L., Pautou, G. & Bouvet, J. 1991. Universal primers for amplification of three non-coding regions of chloroplast DNA. *Plant Mol. Biol.* 17: 1105-1109.

Tavaré, S. 1986. Some probabilistic and statistical problems in the analysis of DNA sequences. In: *Some mathematical questions in biology - DNA sequence analysis*. (Ed) R.M. Miura. Pp. 57-86. American Mathematics Society.

Tolley, K.A., Tilbury, C.R., Branch, W.R. & Matthee, C.A. 2004. Phylogenetics of the southern African dwarf chameleons, *Bradypodion* (Squamata: Chamaeleonidae). *Mol. Phylogenet. Evol*. 30: 354–365.

Touloumenidou, T., Bakker, F.T. & Albers, F. 2007. The phylogeny of *Monsonia* L. (Geraniaceae). *Plant. Syst. Evol*. 264:1-14.

Tribsch, A. & Schönswetter, P. 2003. Patterns of endemism and comparative phylogeography confirm palaeoenvironmental evidence for Pleistocene refugia in the Eastern Alps. *Taxon.* 52: 477-497.

van Zinderen Bakker, E.M. 1978. Quaternary vegetation change in southern Africa. In: *Biogeography and ecology of southern Africa*. (Ed) M.J.A. Werger. Dr. W. Junk.

Vargas, P., Baldwin, B.G. & Constance, L. 1998. Nuclear ribosomal DNA evidence for a western North American origin of Hawaiian and South American species of *Sanicula* (Apiaceae*). Proc. Natl. Acad. Sci. USA.* 95: 235-240.

Vrba, E.S. & Denton, G.H. 1995. *Palaeoclimate and evolution with emphasis on human origins*. Yale University Press, New Haven.

Vriesendorp, B. & Bakker, F.T. 2005. Reconstructing patterns of reticulate evolution in angiosperms: what can we do? *Taxon*. 54(3):593-604.

Wallis, G.P. & Trewick, S.A. 1998. Finding fault with vicariance: a critique of Heads. *Syst. Biol.* 50(4): 602-609.

Walsh, H.E., Kidd, M.G., Moum, T. & Friesen, V.L. Polytomies and the power of phylogenetic inference. *Evolution*. 53(3):932-937.

Wanntorp, L., Wanntorp, H.-E. 2003. The biogeography of *Gunnera* L.: vicariance and dispersal. *J. Biogeogr.*. 30(7): 979-987.

Wanntorp, L., Wanntorp, H.-E., Oxelman, B., Kallersjo, M. 2001. Phylogeny of *Gunnera*. *Plant Syst. Evol.* 226: 85-107.

Wendel, J.F. & Doyle, J.J. 1998. Phylogenetic incongruence: window into genome history and molecular evolution. In: *Molecular systematics of plants II: DNA sequencing.* (Eds) D.E. Soltis, P.S. Soltis & J.J. Doyle. Kluiwer Academic Publishers.

Wendel, J.F., Schnabel, A. & Seelanen, T. 1995. Bidirectional interlocus concerted evolution following allopolyploidy speciation in cotton (*Gossypium*). *Proc. Natl. Acad. Sci. USA.* 92: 280-284.

Wheeler, Q.D. & Platnick, N.I. 2000. The Phylogenetic Species Concept (*sensu* Wheeler & Platnick). In: *Species concepts and phylogenetic theory - a debate*. (Eds) Q.D. Wheeler & R. Meier. Columbia University Press, New York

White, F. 1998. The vegetative structure of African Ebenaceae and the evolution of rheophytes and ring species. In: *The biological monograph: the importance of field studies and functional syndromes for taxonomy and evolution of tropical plants*. (Eds) H.C. Fortune-Hopkins, C.R. Huxley, C.M. Pannell, G.T. Prance & F. White. Royal Botanical Gardens, Kew.

Whitten, W.M., Williams, N.H. & Chase, M.W. 2000. Subtribal and generic relationships of Maxillarieae (Orchidaceae) with emphasis on Stanhopeinae: combined molecular evidence. *Am. J. Bot.* 87(12): 1842-1856.

Wiens, J.J. & Penkrot, T.A. 2002. Delimiting species using DNA and morphological variation and discordant species limits in spiny lizards (*Sceloporus*). *Syst. Bot.* 51(1): 69-91.

Williams, D.M. 1994. Combining trees and combining data. *Taxon.* 43: 449-455

Willis, K.J. & Niklas, K.J. 2004. The role of Quaternary environmental change in plant macroevolution: the exception or the rule? *Phil. Trans. R. Soc. Lond. B.* 359: 159-172.

Yoder, A.D., Irwin, J.A. & Payseur, B.A. 2001. Failure of the ILD to determine data combinability for slow Loris phylogeny. *Syst. Biol*. 50(3): 408-424

Yuan, Y.M. Wohlhauser, S., Möller, M., Klackenberg, J., Callmander, M.W. & Küpfer, P. 2005. Phylogeny and biogeography of *Exacum* (Gentianaceae): a disjunctive distribution in the Indian Ocean basin resulted from long distance dispersal and extensive radiation. *Syst. Biol.* 54(1): 21-34.

Appendix 1: Summary of morphological characters from Roessler's species descriptions.

	caespitosa	ciliaris	heterochaeta	jurineifolia	krebsiana	leiopoda
Annual or perennial	perennial	perennial	perennial	perennial	perennial	perennial
Habit	subshrub	herbaceous	herbaceous	herbaceous	herbaceous	herbaceous
Stem developed/rosette	developed	rosette	rosette	rosette	rosette	rosette
Leaves:						
whole/pinnate/both	whole	both	both	pinnate	both	pinnate
leaf shape	linear	linear/linear-lanceolate	obovate		linear/linear-lanceolate	
margins revolute	yes	yes	somewhat	yes	yes	yes
width (whole leaf, mm)	1-1.5 mm	1 -4 mm	30-60 mm		(1-)2-6(-8) mm	
length (whole leaf, mm)	20 - 30 mm	40-80 (-150) mm	(5-)8-15(-25)mm	10-50(-70) mm	(30-)60-180(-250) mm	(30-)40-80 mm
Laciniae:						
number of pairs		1-4	1-3	2-5	1-4	(4-)5-7
opposite/alternate		opp/alt		opposite	opposite	opposite
width of lacinae		1-2 mm			1-3(-4) mm	2-3.5 mm
length of lacinae		2-10 mm		2-5(-8) mm	3-10(-15) mm	3-7(-10) mm
width of middle stem		1-2 mm		1-2(-3) mm	1-2 mm	1 mm
notes on laciniae			apex rounded			apex acute/obtuse
terminal : side lacinae (longer/shorter/same)						similar
apex in spinule excurrent	yes	yes	yes	yes	yes	yes
other notes	edges ciliate with 1mm long spinules	setae all the way up to 2-3 mm long ciliate				
Top surface:	smooth/glabrous	setose (rough)	densely setose	rough/densely setose	smooth/rough	hispid
Lower surface:	tomentose	tomentose	tomentose	tomentose	tomentose	tomentose

Appendix 1: Morphological characters for each of Roessler's species

Capitula:						
on peduncles/scapes	peduncles	scapes	scapes	scapes	scapes	scapes
peduncle/scape length	30-50 mm	40-100(-140)mm	30-80(-120) mm	5-40(-80) mm	(30)-50-120(-150) mm	(30-)60-100(-120) mm
with ligules expanded (mm)	30-40 mm	40-70 mm	(30-)40-70 mm	25-50 (-70) mm	30-60 mm	(50-)60-80 mm
glabrous/tomentose	glabrous	setose	glabrous	glabrous	glabrous	
Involucre:						
glabrous/tomentose/ciliate	glabrous	glabrous	glabrous/partially setose	glabrous	glabrous	setose
fused part shape	subcampanulate	subcylindrical	campanulate	campanulate	campanulate	broadly cupuliform
base shape	obtuse	truncate, pleated annulus	obtuse	obtuse	obtuse	obtuse
base intrusa/subintruse	intrusa	margin in annulus	subintrusa		subintrusa	
height	7-8 mm	8-10(-12) mm	8-10 mm	6-8(-10) mm	7-10 mm	10-15 mm
width	4 mm	7-9 mm	(5-)7-9 mm	4-7(-8) mm	(4-)5-8 mm	10-15 mm
scales seriate number	2-3	2-3	2-3	3	2-3	2-3
parietal scales	no	few	few	few	few	few
scales inserted where	margin of fused part	margin of fused part	margin of fused part	margin of fused part	margin of fused part	
Outer involucral scales:						
shape	linear-triangulate	linear/linear-triangulate	linear-lanceolate/ triangulate	linear/triangulate-lanceolate	linear	oblong-linear/triangulate
length	5 mm	6-10 mm	2-4 mm	1-3 mm		2-5 mm
width	1-2 mm	1 mm	1 mm	1 mm	1 mm	1-1.5 mm
tip shape	acute	acute	short setae excurrent		acute	acute
margin description	shortly denticulate	ciliate with setae 1mm long	with setulae excurrent	densely ciliate with 0.2mm spinules	shortly ciliate	most shortly ciliate

Inner involucral scale:						
shape	ovate-triangulate	narrowly triangulate	narrowly/ovate triangulate	ovate/narrow triangulate	narrowly/ovate triangulate	ovate/narrowly triangulate
length	7-8 mm	7-12(-20) mm	4-8 mm	(3-)4-6(-8) mm	See Note 1	4-7 mm
width	2-3 mm	2-3 mm	2-3 mm	1.5-2.5 (-3) mm	See Note 1	2-4 mm
tip shape	acuminate	acuminate			acuminate/acute/obtuse	obtuse/acute
margin description	membranous/entire	membranous, minutely ciliate	membranous, minutely ciliate/ entire	membranous, scarecly ciliate/entire	membranous/ entire	membranous, entire
Ligules:						
Colour	yellow	yellow	yellow/orange	white		orange
Eye spots		black/bicoloured	sometimes black/bicoloured			black/bicoloured
Other notes				disc florets sparsely hairy		

Ctd…

Appendix 1: Morphological characters for each of Roessler's species

	lichtensteinii	linearis linearis	linearis ovalis	maritima	othonnites	pectinata
Annual or perennial	annual/perennial	perennial	perennial	perennial	perennial	annual?
Habit	herbaceous	herbaceous	herbaceous	herbaceous	herbaceous	herbaceous
Stem developed/rosette	rosette/developed	rosette	rosette	developed	rosette	rosette
Leaves:						
whole/pinnate/both	entire	both	both	both	both	both
leaf shape	obovate	linear	linear	linear-lanceolate	linear/ linear-oblong	linear/linear-lanceolate
margins revolute	denticulate	yes	yes	yes	fleshy	yes
width (whole leaf, mm)	(3-)5-10 (-20) mm	1-5(-10) mm	1-25 mm		1-3 mm	1-3(-6) mm
length (whole leaf, mm)	(15-)20-40(-70) mm	(80-)100-300 mm	(80-)100-300 mm	20-60(-110)mm	20-50(-70) mm	(80-)100-250 mm
Laciniae:						
number of pairs		1-6	1-6	1-5	1-3	(1-)2-8
opposite/alternate		opposite	opposite	opposite	opposite	opposite
width of lacinae		1-4(-7) mm	1-10 mm	1-4 mm		1-2(-4) mm
length of lacinae		5-15(-25) mm	5-15(-25) mm	4-15(-20) mm	1-5 mm	5-15(-25) mm
width of middle stem		1-2 mm	1-2 mm			1-2 mm
notes on laciniae						apex acute
terminal : side lacinae (longer/shorter/same)				wider(6mm wide)		
apex in spinule excurrent	obtuse	yes	yes	yes	yes	yes
other notes	white ciliate spinules at edges			margin covered in tiny spinules		
Top surface:	tomentose (glabrous)	smooth/ciliate/ rough	smooth/ciliate/ rough	glabrous	glabrous, glaucous	smooth

Lower surface:	tomentose	tomentose	tomentose	tomentose	glabrous, glaucous	tomentose
Capitula:						
on peduncles/scapes	peduncles	scapes	scapes	peduncles	scapes	scapes
peduncle/scape length	(10-)20-60(-120) mm	100-350 mm	100-350 mm	20-100 mm	20-100(-130) mm	(80-)150-300 mm
with ligules expanded (mm)	20-40 mm	40-70 mm	40-70 mm	30-40 mm	20-35 mm	45-70(-90) mm
glabrous/tomentose	glabrous	glabrous/setose	glabrous/setose	tomentose/ glabrous	glabrous	glabrous/setose
Involucre:						
glabrous/tomentose/ciliate	glabrous	glabrous/setose	glabrous/setose	glabrous	glabrous	glabrous/setose
fused part shape	cylindrical	campanulate/ subcupuliform	campanulate/ subcupuliform	campanulate	turbinate	campanulate
base shape		obtuse	obtuse	obtuse		obtuse
base intrusa/subintruse	intrusa	subintrusa	subintrusa	subintrusa (slight)	intrusa	subintrusa
height	7-10 mm	8-12 mm	8-12 mm	8-10 mm	6-9 mm	8-11 mm
width	3-5 mm	6-12(15) mm	6-12(15) mm	5-8 mm	3-6 mm	6-10(-15) mm
scales seriate number	2	2-3	2-3	2	2-3	2-3
parietal scales	none	few	few	few	few	few
scales inserted where	margin of fused part	margin of fused part	margin of fused part	margin of fused part	margin of fused part	margin of fused part
Outer involucral scales:						
shape	linear/ triangulate	linear	linear			linear
length	1-2 mm				1.5-2 mm	7-10(-20) mm
width	1-1.5 mm				1.5-2 mm	1mm

tip shape						acute
margin description	minutely ciliate	ciliate setose	ciliate setose	with spinules ciliate		ciliate setose
Inner involucral scale:						
shape	ovate-triangulate					
length	4-7 mm	(8-)10-15(18) mm	(8-)10-15(18) mm		4-6 mm	8-15 mm
width	2-3 mm	1.5-2 mm	1.5-2 mm		1.5-3 mm	2 mm
tip shape		finely acuminate	finely acuminate			finely acuminate
margin description	membranous, entire	membranous, entire	membranous, entire	membranous, entire		membranous, entire
Ligules:						
Colour	yellow/orange	yellow/orange	yellow/orange	yellow/orange	yellow	yellow/orange
Eye spots	bicoloured	black/bicoloured	black/bicoloured			black/greybrown
Other notes	some green stripes					

Ctd…

Appendix 1: Morphological characters for each of Roessler's species

	rigens	rigida	schenckii	serrata	tenuifolia
Annual or perennial	perennial	perennial	perennial	perennial	annual
Habit	herbaceous	herbaceous	subshrub	herbaceous	herbaceous
Stem developed/rosette	developed	rosette	developed	rosette	rosette
Leaves:					
whole/pinnate/both	both	both	whole	both	both
leaf shape	lanceolate/ obovate-lanceolate	linear-lanceolate	obovate-spathulate	lanceolate	linear
margins revolute	somewhat	yes	dentate	yes	
width (whole leaf, mm)	(4-)5-10(-23) mm	2-5 mm	5-10(-15) mm	(3-)5-9 mm	1 mm
length (whole leaf, mm)	(30-)40-80(-110) mm	40-100(-150) mm	15-30(-35) mm	(40-)60-150 mm	(20-)30-60(-80) mm
Laciniae:					
number of pairs	1-2	1-2(-5)		(1-)2-4	1-5
opposite/alternate	opposite	opposite		opposite	opposite
width of lacinae		1-3 mm		2-5(-7) mm	1mm
length of lacinae		5-15(-20) mm		5-15 mm	2-8(-12) mm
width of middle stem		1 mm		1-2 mm	1 mm
notes on laciniae					
terminal : side lacinae (longer/shorter/same)	all same	same		2x wider/longer	
apex in spinule excurrent	no	yes	yes	yes	
other notes					
Top surface:	glabrous/tomentose	smooth/setose (rough)	tomentose	rough, setose	roughly setose
Lower surface:	tomentose	tomentose	tomentose	tomentose	tomentose
Capitula:					

on peduncles/scapes	peduncles	scapes	peduncles	scapes	peduncles
peduncle/scape length	40-100(-150) mm	40-150 mm	20-60 mm	50-150 mm	20-80(-140) mm
with ligules expanded (mm)	25-80 mm	40-60 mm	20-30(-35) mm	45-75 mm	10-15 mm
glabrous/tomentose	glabrous/tomentose	setose	tomentose	setose	glabrous/cobwebby
Involucre:					
glabrous/tomentose/ciliate	glabrous/tomentose	setose	tomentose	setose	
fused part shape	campanulate	campanulate	cylindrical	campanulate	cylindrical
base shape	obtuse	obtuse	obtuse	obtuse	truncate
base intrusa/subintruse	subintrusa	subintrusa	little intrusa	subintrusa	pleated annulus
height	8-10 mm	9-11 mm	6-9 mm	8-12 mm	4-5 mm
width	7-15 mm	(6-)8-12(-15) mm	3-5 mm	7 -10 mm	3-5 mm
scales seriate number	2-3	2-3	2	2-3	
parietal scales	few	few	few/no	few	many rows
scales inserted where	margin of fused part	margin of fused part	margin of fused part	margin of fused part	all over
Outer involucral scales:					
shape	triangulate-lanceolate	linear	same as inner, but smaller	linear	(parietal)subulate
length	4-7 mm	5-8 mm		5-12 mm	1-2 mm
width		1 mm		1 mm	
tip shape		acute		acute	acute
margin description	tomentose on outside	setose ciliate		setose	ciliate/entire

Inner involucral scale:					
shape	narrowly triangulate	triangulate	narrowly triangulate	narrowly triangulate	(terminal) triangulate-subulate
length	5-10 mm	4-6 mm	6-9 mm	8-10 mm	5-6 mm
width		2 mm	2-3 mm	2-2.5 mm	1(-1.5) mm
tip shape	acuminate	obtuse/acute		acuminate	
margin description	glabrous	membranous, entire	entire	membranous, entire	membranous, entire
Ligules:					
Colour	yellow	yellow/orange	yellow	yellow/orange	yellow/orange
Eye spots	sometimes black spots	often black/grown	rarely black spot	sometimes black/bicoloured	black/bicoloured
Other notes					disc florets sparsely hairy

Morphometric characters and abbreviations used in data table.

Character	**Abbrev**
Habit	Habit
Involucre setose	InvSet
Parietal scales	ParScl
Involucre base	InvBase
Adaxial leaf indumentum	LfIndu
Leaf margin	LfMarg
Leaf dissectedness	LfDiss
Outer involcral scale length	OIL
Outer involcral scale width	OIW
Inner involcral scale length	IIL
Inner involcral scale width	IIW
Involucre length	InvL
Involucre width	InvW
Leaf length	LfLgth
Leaf width	LfWdth
Stem length	StmLgth
Log(Outer involcral scale length)	LogOIL
Log(Outer involcral scale width)	LogOIW
Log(Inner involcral scale length)	LogIIL
Log(Inner involcral scale width)	LogIIW
Log(Involucre length)	LogInvL
Log(Involucre width)	LogInvW
Log(Leaf length)	LogLfLgth
Log(Leaf width)	LogLfWdth
Log(Stem length)	LogStmLgth
Log(Outer Involucral scale length/width)	LogOIRAT
Log(Inner Involucral scale length/width)	LogIIRAT
Log(Outer/Inner Involucral scale length)	LogOI/II
Log(Involucral length/width)	LogInvRAT
Log(Leaf length/width)	LogLFRAT

Appendix 2: Morphometric data set for Chapter 2.

	Cil1	Cil2	Cil3	Cil4	Cil5	Cil6	Cil7	Het1	Het2	Het3	Het4	Het5	Het6
Habit	1	1	1	1	1	1	1	1	1	1	1	1	1
InvSet	1	0	0	0	0	0	0	0	0	0	0	0	0
ParScl	1	1	1	1	1	1	1	0	0	0	0	0	0
InvBase	2	1	0	3	3	3	3	2	2	2	2	1	1
LfIndu	2	2	2	2	0	2	0	2	2	2	2	2	2
LfMarg	3	3	3	3	0	3	2	3	3	3	3	3	3
LfDiss	5	5	5	5	1	5	5	4	4	4	4	4	5
OIL	7.67	11.4	8.59	10.16	6.2	8.38	10.56	4.4	4.47	3.44	3.72	4.13	3.82
OIW	1.57	2.18	1.82	2.67	1.74	2.23	2.3	2.12	2.05	2.3	1.37	2.97	1.53
IIL	10.13	10.55	12.37	9.37	14.99	10.31	22.32	5.53	6.74	5.78	7.16	7.65	6.68
IIW	3.74	4.32	2.97	2.68	1.93	2.56	3.33	2.1	1.77	1.5	1.47	3.56	2.06
InvL	7.48	7.31	8.59	7.34	8.4	7.55	4.74	9.53	8.73	9.89	7.02	11.36	8.95
InvW	8.32	10.96	9.96	9.34	8.62	8.04	12.12	9.1	10.14	9.65	7.25	14.25	9.72
LfLgth	72.75	147.3	67.53	58.9	89.28	45.94	150.31	48.03	47.53	51.1	41.94	59.69	61.44
LfWdth	3.13	5.06	4.9	2.85	1.09	2.38	0.84	9.28	10.83	8.58	5.59	17.92	9.26
StmLgth	64.59	200	100.99	49.68	105	38.38	160	55.17	54.9	49.72	34.41	83.43	101.7
LogOIL	0.88480	1.05690	0.93399	1.00689	0.79239	0.92324	1.02366	0.64345	0.65031	0.53656	0.57054	0.61595	0.58206
LogOIW	0.19590	0.33846	0.26007	0.42651	0.24055	0.34830	0.36173	0.32634	0.31175	0.36173	0.13672	0.47276	0.18469
LogIIL	1.00561	1.02325	1.09237	0.97174	1.17580	1.01326	1.34869	0.74273	0.82866	0.76193	0.85491	0.88366	0.82478
LogIIW	0.57287	0.63548	0.47276	0.42813	0.28556	0.40824	0.52244	0.32222	0.24797	0.17609	0.16732	0.55145	0.31387
LogInvL	0.87390	0.86392	0.93399	0.86570	0.92428	0.87795	0.67578	0.97909	0.94101	0.99520	0.84634	1.05538	0.95182
LogInvW	0.92012	1.03981	0.99826	0.97035	0.93551	0.90526	1.08350	0.95904	1.00604	0.98453	0.86034	1.15381	0.98767
LogLfLgth	1.86183	2.16820	1.82950	1.77012	1.95075	1.66219	2.17699	1.68151	1.67697	1.70842	1.62263	1.77590	1.78845
LogLfWdth	0.49554	0.70415	0.69020	0.45484	0.03743	0.37658	-0.07572	0.96755	1.03463	0.93349	0.74741	1.25334	0.96661
LogStmLgth	1.81017	2.30103	2.00428	1.69618	2.02119	1.58410	2.20412	1.74170	1.73957	1.69653	1.53668	1.92132	2.00732
LogOIRAT	0.68890	0.71845	0.67392	0.58038	0.55184	0.57494	0.66194	0.31712	0.33855	0.17483	0.43382	0.14319	0.39737
LogIIRAT	0.43274	0.38777	0.61961	0.54360	0.89024	0.60502	0.82625	0.42051	0.58069	0.58584	0.68760	0.33221	0.51091
LogOI/II	-0.12081	0.03365	-0.15838	0.03515	-0.38341	-0.09001	-0.32503	-0.09927	-0.17835	-0.22537	-0.28437	-0.26771	-0.24271
LogInvRAT	-0.04622	-0.17589	-0.06427	-0.10465	-0.01123	-0.02731	-0.40772	0.02005	-0.06502	0.01067	-0.01400	-0.09844	-0.03584
LogLFRAT	1.36629	1.46405	1.13930	1.31527	1.91333	1.28561	2.25271	0.71396	0.64234	0.77493	0.87522	0.52256	0.82184

Appendix 2: Morphometric data set for Chapter 2.

	Het7	Het8	Het9	Jur1	Jur2	Jur3	Jur4	Jur5	Jur6	Jur7	Jur8	Jur9	KrbA1
Habit	1	1	1	1	1	1	1	1	1	1	1	1	1
InvSet	0	0	0	0	0	0	0	0	0	0	0	0	1
ParScl	0	0	1	1	1	1	1	0	0	0	0	0	0
InvBase	2	1	2	0	0	2	2	0	0	2	2	0	1
LfIndu	2	2	2	2	2	2	2	2	2	2	2	2	1
LfMarg	3	3	3	3	3	3	3	3	3	3	3	3	3
LfDiss	2	5	5	6	6	6	6	6	6	6	6	3	5
OIL	3.97	3.68	6.84	3.11	2.94	3.51	2.84	3.11	3.5	2.62	2.99	1.93	1.67
OIW	1.93	1.23	1.58	2	2.06	1.34	1.75	1.72	2.17	1.3	1.74	1.72	0.77
IIL	10.25	6.55	6.09	8.83	9.84	5.15	5.85	3.79	5.65	4.9	5.94	4.94	2.11
IIW	2.23	2.2	2.94	2	2.39	1.99	2.33	2.06	2.56	2.6	1.98	1.72	1.28
InvL	7.74	8.79	8.15	5.52	5.51	5.63	5.59	5.66	5.41	5.34	6.17	7.22	6.67
InvW	6.5	7.94	7.8	9.13	8.92	7.84	6.06	7.82	8.74	9.58	10.15	6.91	3.56
LfLgth	62.73	55.44	64.51	39.69	37.03	38.97	21.59	65.21	48.04	30.18	40.91	42.86	32.03
LfWdth	6.84	15.71	8.04	2.74	3.82	2.84	1.85	2.93	3.68	2.74	3.03	3.62	2.68
StmLgth	118.15	67.93	102.61	44.19	45.9	22.27	16.29	65.88	39.4	21.43	15	51.67	17.22
LogOIL	0.59879	0.56585	0.83506	0.49276	0.46835	0.54531	0.45332	0.49276	0.54407	0.41830	0.47567	0.28556	0.22272
LogOIW	0.28556	0.08991	0.19866	0.30103	0.31387	0.12710	0.24304	0.23553	0.33646	0.11394	0.24055	0.23553	-0.11351
LogIIL	1.01072	0.81624	0.78462	0.94596	0.99300	0.71181	0.76716	0.57864	0.75205	0.69020	0.77379	0.69373	0.32428
LogIIW	0.34830	0.34242	0.46835	0.30103	0.37840	0.29885	0.36736	0.31387	0.40824	0.41497	0.29667	0.23553	0.10721
LogInvL	0.88874	0.94399	0.91116	0.74194	0.74115	0.75051	0.74741	0.75282	0.73320	0.72754	0.79029	0.85854	0.82413
LogInvW	0.81291	0.89982	0.89209	0.96047	0.95036	0.89432	0.78247	0.89321	0.94151	0.98137	1.00647	0.83948	0.55145
LogLfLgth	1.79748	1.74382	1.80963	1.59868	1.56855	1.59073	1.33425	1.81431	1.68160	1.47972	1.61183	1.63205	1.50556
LogLfWdth	0.83506	1.19618	0.90526	0.43775	0.58206	0.45332	0.26717	0.46687	0.56585	0.43775	0.48144	0.55871	0.42813
LogStmLgth	2.07243	1.83206	2.01119	1.64532	1.66181	1.34772	1.21192	1.81875	1.59550	1.33102	1.17609	1.71324	1.23603
LogOIRAT	0.31323	0.47594	0.63640	0.19173	0.15448	0.41820	0.21028	0.25723	0.20761	0.30436	0.23512	0.05003	0.33623
LogIIRAT	0.66242	0.47382	0.31627	0.64493	0.61460	0.41295	0.39980	0.26477	0.34381	0.27522	0.47712	0.45820	0.21707
LogOI/II	-0.41193	-0.25039	0.05044	-0.45320	-0.52465	-0.16650	-0.31384	-0.08588	-0.20798	-0.27189	-0.29812	-0.40817	-0.10157
LogInvRAT	0.07583	0.04417	0.01906	-0.21853	-0.20921	-0.14381	-0.03506	-0.14039	-0.20831	-0.25382	-0.21618	0.01906	0.27268
LogLFRAT	0.96242	0.54765	0.90437	1.16093	0.98649	1.13741	1.06708	1.34745	1.11576	1.04197	1.13039	1.07334	1.07742

Appendix 2: Morphometric data set for Chapter 2.

	KrbA2	KrbA4	KrbA5	KrbA6	KrbA8	KrbA9	KrbA10	KrbA12	KrbK2	KrbK3	KrbK4	KrbK5	KrbK7
Habit	1	1	1	1	1	1	1	1	1	1	1	1	1
InvSet	0	0	0	0	0	0	0	1	0	0	0	0	0
ParScl	1	0	0	0	0	0	0	0	0	0	1	0	0
InvBase	2	1	1	8	1	2	2	0	1	2	2	2	2
LfIndu	0	0	0	0	0	0	3	3	2	1	2	0	0
LfMarg	3	3	0	0	3	3	3	3	3	3	3	3	3
LfDiss	5	5	5	1	1	5	5	5	5	1	4	1	1
OIL	4.44	7.79	2.14	2.31	2.5	2.52	3.4	3.4	4.48	3.5	5.62	4.94	7.43
OIW	1.26	2.32	0.87	1.91	0.82	0.93	2.05	1.9	1.8	1.83	1.34	1.3	1.33
IIL	5.47	6.82	4.1	3.07	4.28	2.53	3.85	5	6.3	3.84	4.33	5.53	6.9
IIW	2.64	2.89	1.37	1.75	2.01	1.65	2.7	2.3	1.91	1.86	1.67	1.5	2.2
InvL	8.84	10.98	7.74	6.42	5.68	5.53	7.62	8.66	7.71	7.04	8.33	5.68	7.81
InvW	9.31	10.96	3.19	4.81	4.17	5.05	7.07	5.44	6.33	5.82	7.59	6.56	7.56
LfLgth	137.14	165	62.14	48.75	91.95	33.28	139.45	49.66	77.71	48.15	100.23	52.53	75.08
LfWdth	3.46	14.76	1.91	2.49	6.05	2.3	4.31	2.68	3.45	5.16	7.47	5.29	3.54
StmLgth	113.71	82.7	58.66	33	83.65	17.21	141.22	47.54	103.96	35.75	107.71	13.03	77.58
LogOIL	0.64738	0.89154	0.33041	0.36361	0.39794	0.40140	0.53148	0.53148	0.65128	0.54407	0.74974	0.69373	0.87099
LogOIW	0.10037	0.36549	-0.06048	0.28103	-0.08619	-0.03152	0.31175	0.27875	0.25527	0.26245	0.12710	0.11394	0.12385
LogIIL	0.73799	0.83378	0.61278	0.48714	0.63144	0.40312	0.58546	0.69897	0.79934	0.58433	0.63649	0.74273	0.83885
LogIIW	0.42160	0.46090	0.13672	0.24304	0.30320	0.21748	0.43136	0.36173	0.28103	0.26951	0.22272	0.17609	0.34242
LogInvL	0.94645	1.04060	0.88874	0.80754	0.75435	0.74273	0.88195	0.93752	0.88705	0.84757	0.92065	0.75435	0.89265
LogInvW	0.96895	1.03981	0.50379	0.68215	0.62014	0.70329	0.84942	0.73560	0.80140	0.76492	0.88024	0.81690	0.87852
LogLfLgth	2.13716	2.21748	1.79337	1.68797	1.96355	1.52218	2.14442	1.69601	1.89048	1.68260	2.00100	1.72041	1.87552
LogLfWdth	0.53908	1.16909	0.28103	0.39620	0.78176	0.36173	0.63448	0.42813	0.53782	0.71265	0.87332	0.72346	0.54900
LogStmLgth	2.05580	1.91751	1.76834	1.51851	1.92247	1.23578	2.14990	1.67706	2.01687	1.55328	2.03226	1.11494	1.88975
LogOIRAT	0.54701	0.52605	0.39089	0.08258	0.48413	0.43292	0.21973	0.25273	0.39601	0.28162	0.62263	0.57978	0.74714
LogIIRAT	0.31638	0.37289	0.47606	0.24410	0.32825	0.18564	0.15410	0.33724	0.51831	0.31482	0.41377	0.56663	0.49643
LogOI/II	-0.09060	0.05775	-0.28237	-0.12353	-0.23350	-0.00172	-0.05398	-0.16749	-0.14806	-0.04026	0.11325	-0.04900	0.03214
LogInvRAT	-0.02250	0.00079	0.38495	0.12539	0.13421	0.03943	0.03254	0.20192	0.08565	0.08265	0.04040	-0.06256	0.01413
LogLFRAT	1.59809	1.04840	1.51234	1.29178	1.18180	1.16046	1.50994	1.26787	1.35266	0.96995	1.12768	0.99695	1.32652

Appendix 2: Morphometric data set for Chapter 2.

	KrbK8	KrbK9	KrbK10	KrbK11	KrbK12	KrbK13	KrbK14	KrbK16	KrbK17	KrbK18	KrbK19	KrbK20	KrbK22
Habit	1	1	1	1	1	1	1	1	1	1	1	1	1
InvSet	0	0	1	0	1	0	0	0	0	0	0	0	0
ParScl	1	1	1	0	0	0	0	0	0	0	0	1	1
InvBase	2	2	2	1	1	1	1	2	1	1	1	2	2
LfIndu	0	2	3	2	2	0	0	2	0	3	3	0	2
LfMarg	3	3	3	3	3	0	3	3	3	3	3	1	1
LfDiss	5	1	5	5	5	1	1	1	5	1	1	1	5
OIL	8.24	6.96	3.54	5.72	2.99	4.57	6.63	4.27	3.82	7.24	9.68	4.93	4.07
OIW	1.8	0.98	1.66	2.11	1.79	1.66	1.3	1.66	2.44	1.28	1.48	1.76	1.86
IIL	7.11	9.78	5.55	6.08	5.28	3.96	5.09	5.21	6.11	6.43	7.76	6.82	5.76
IIW	2.84	1.38	2.87	2.07	2.24	1.54	1.2	2.23	2.29	2.64	2.45	3.39	1.86
InvL	7.03	8.41	8.61	8.66	11.76	8.01	8.4	7.57	9.11	8.73	7.75	7.82	8.45
InvW	7.6	5.92	10.82	7.2	12.92	8.71	7.54	6.09	6.72	7.86	9.43	11.45	6.65
LfLgth	105.78	70.05	200	80.85	200	90.49	37.49	85.15	75.74	200	140.11	149.64	162
LfWdth	5.41	2.56	4.77	2.91	4.44	3.25	1.43	6.16	6.79	6.43	5.82	6	4.75
StmLgth	152.27	79.24	125.68	108.88	230	51.56	23.62	59.04	74.71	138.43	93.75	130.45	149
LogOIL	0.91593	0.84261	0.54900	0.75740	0.47567	0.65992	0.82151	0.63043	0.58206	0.85974	0.98588	0.69285	0.60959
LogOIW	0.25527	-0.00877	0.22011	0.32428	0.25285	0.22011	0.11394	0.22011	0.38739	0.10721	0.17026	0.24551	0.26951
LogIIL	0.85187	0.99034	0.74429	0.78390	0.72263	0.59770	0.70672	0.71684	0.78604	0.80821	0.88986	0.83378	0.76042
LogIIW	0.45332	0.13988	0.45788	0.31597	0.35025	0.18752	0.07918	0.34830	0.35984	0.42160	0.38917	0.53020	0.26951
LogInvL	0.84696	0.92480	0.93500	0.93752	1.07041	0.90363	0.92428	0.87910	0.95952	0.94101	0.88930	0.89321	0.92686
LogInvW	0.88081	0.77232	1.03423	0.85733	1.11126	0.94002	0.87737	0.78462	0.82737	0.89542	0.97451	1.05881	0.82282
LogLfLgth	2.02440	1.84541	2.30103	1.90768	2.30103	1.95660	1.57392	1.93018	1.87933	2.30103	2.14647	2.17505	2.20952
LogLfWdth	0.73320	0.40824	0.67852	0.46389	0.64738	0.51188	0.15534	0.78958	0.83187	0.80821	0.76492	0.77815	0.67669
LogStmLgth	2.18261	1.89894	2.09927	2.03695	2.36173	1.71231	1.37328	1.77115	1.87338	2.14123	1.97197	2.11544	2.17319
LogOIRAT	0.66065	0.85138	0.32890	0.43311	0.22282	0.43981	0.70757	0.41032	0.19467	0.75253	0.81561	0.44733	0.34008
LogIIRAT	0.39855	0.85046	0.28641	0.46793	0.37239	0.41017	0.62754	0.36853	0.42621	0.38661	0.50070	0.30358	0.49091
LogOI/II	0.06406	-0.14773	-0.19529	-0.02651	-0.24696	0.06222	0.11480	-0.08641	-0.20398	0.05153	0.09601	-0.14094	-0.15083
LogInvRAT	-0.03386	0.15247	-0.09922	0.08019	-0.04086	-0.03639	0.04691	0.09448	0.13215	0.04559	-0.08521	-0.16560	0.10404
LogLFRAT	1.29121	1.43717	1.62251	1.44379	1.65365	1.44472	1.41858	1.14060	1.04746	1.49282	1.38155	1.39690	1.53282

Appendix 2: Morphometric data set for Chapter 2.

	KrbK23	KrbK24	KrbK25	KrbK26	KrbK27	KrbK28	KrbS1	KrbS2	KrbS3	KrbS4	KrbS5	KrbS6	Leio1
Habit	1	1	1	1	1	1	1	1	1	1	1	1	1
InvSet	0	0	0	0	0	0	0	0	0	0	0	0	1
ParScl	1	1	1	0	0	0	1	0	1	0	0	1	0
InvBase	2	1	2	0	0	2	2	2	0	0	2	2	0
LfIndu	0	0	0	0	0	0	2	2	2	0	0	2	2
LfMarg	0	3	3	0	3	0	3	3	3	3	0	3	3
LfDiss	1	1	5	1	1	1	1	1	1	1	1	1	6
OIL	3.88	5.43	6.68	3.81	4.79	4.59	2.57	2.19	2.1	2.81	3.32	5.1	3.32
OIW	1.63	1.56	0.99	0.91	1.69	2.23	1.18	0.93	1.68	1.98	1.17	1.42	1.55
IIL	4.35	6.42	7.36	5.44	4.56	5.29	3.04	3.45	3.51	3.05	4.01	4.69	4.73
IIW	1.5	1.7	1.74	1.35	1.18	2.99	1.46	1.74	1.76	1.71	1.67	2.03	2.34
InvL	5.63	8.89	6.36	5.48	7.2	8.08	7.14	7.58	9.12	5.39	7.08	7.58	8.38
InvW	4.83	5.42	6.51	3.13	9.25	11.32	8.05	5.25	5.81	4.95	6.13	6.56	10.94
LfLgth	101.99	83.93	181	89.25	135	114.85	116.28	70.12	95.62	54.07	87.19	79.99	60.22
LfWdth	5.32	6.43	5.37	1.03	1.54	1.24	6.66	4.01	6.76	5.9	2.95	2.03	2.77
StmLgth	64.06	100.85	200	74.36	137	176	57.98	48.57	31.85	20.24	81.05	56.37	42.82
LogOIL	0.58883	0.73480	0.82478	0.58092	0.68034	0.66181	0.40993	0.34044	0.32222	0.44871	0.52114	0.70757	0.52114
LogOIW	0.21219	0.19312	-0.00436	-0.04096	0.22789	0.34830	0.07188	-0.03152	0.22531	0.29667	0.06819	0.15229	0.19033
LogIIL	0.63849	0.80754	0.86688	0.73560	0.65896	0.72346	0.48287	0.53782	0.54531	0.48430	0.60314	0.67117	0.67486
LogIIW	0.17609	0.23045	0.24055	0.13033	0.07188	0.47567	0.16435	0.24055	0.24551	0.23300	0.22272	0.30750	0.36922
LogInvL	0.75051	0.94890	0.80346	0.73878	0.85733	0.90741	0.85370	0.87967	0.95999	0.73159	0.85003	0.87967	0.92324
LogInvW	0.68395	0.73400	0.81358	0.49554	0.96614	1.05385	0.90580	0.72016	0.76418	0.69461	0.78746	0.81690	1.03902
LogLfLgth	2.00856	1.92392	2.25768	1.95061	2.13033	2.06013	2.06551	1.84584	1.98055	1.73296	1.94047	1.90304	1.77974
LogLfWdth	0.72591	0.80821	0.72997	0.01284	0.18752	0.09342	0.82347	0.60314	0.82995	0.77085	0.46982	0.30750	0.44248
LogStmLgth	1.80659	2.00368	2.30103	1.87134	2.13672	2.24551	1.76328	1.68637	1.50311	1.30621	1.90875	1.75105	1.63165
LogOIRAT	0.37664	0.54168	0.82914	0.62188	0.45245	0.31351	0.33805	0.37196	0.09691	0.15204	0.45295	0.55528	0.33081
LogIIRAT	0.46240	0.57709	0.62633	0.60527	0.58708	0.24778	0.31852	0.29727	0.29979	0.25130	0.38043	0.36368	0.30565
LogOI/II	-0.04966	-0.07274	-0.04210	-0.15467	0.02137	-0.06164	-0.07294	-0.19737	-0.22309	-0.03559	-0.08201	0.03640	-0.15372
LogInvRAT	0.06656	0.21490	-0.01012	0.24324	-0.10881	-0.14644	-0.05210	0.15951	0.19582	0.03698	0.06257	0.06277	-0.11577
LogLFRAT	1.28265	1.11571	1.52770	1.93777	1.94281	1.96671	1.24203	1.24270	1.15060	0.96210	1.47064	1.59554	1.33726

Appendix 2: Morphometric data set for Chapter 2.

	Leio2	Leio3	Leio4	Leio5	Leio6	Leio7	Leio8	Leio9	Leio10	Leio11	Lict1	Lict3	Lict4
Habit	1	1	1	1	1	1	1	1	1	1	0	0	0
InvSet	1	1	0	0	1	1	0	0	1	0	0	0	0
ParScl	0	0	0	0	1	1	0	1	1	1	0	0	0
InvBase	1	1	1	1	1	0	1	1	2	0	1	1	1
LfIndu	2	0	2	2	2	2	0	2	2	1	0	1	0
LfMarg	3	3	3	3	3	3	3	3	3	3	1	3	3
LfDiss	6	4	5	5	6	6	5	4	6	3	3	1	2
OIL	4.29	3.83	8.54	6.37	5.41	4.09	4.8	3.36	3.57	2.68	1.95	1.43	2.57
OIW	3.51	2.58	2.18	2.92	2.83	3.17	2.49	2.03	2.03	1.76	1.91	1.06	1.51
IIL	5.95	5.55	9.43	6.93	6.22	6.01	7.25	5.6	5.9	4.23	6.11	5.64	8.28
IIW	3.04	2.35	2.28	2.41	3.32	3.62	2.68	2.15	2.44	1.84	2.74	2.13	3.1
InvL	11.46	9.35	12.53	10.49	13.17	11.92	8.48	7.71	10.25	6.21	7.89	8.48	9.82
InvW	12.43	9.22	14.76	10.49	15.87	14.04	7.59	9.14	13.93	8.07	6.44	4.2	10.32
LfLgth	73.41	102.17	80.97	90.02	129.43	110.43	108.51	67.29	74.01	50.49	23.22	28.05	46.78
LfWdth	3.09	6.14	6.24	3.5	2.62	4	7.11	2.62	3.2	2.57	4.34	2.66	9.98
StmLgth	93.17	175	240	116.71	150.26	111.39	170	54.08	84.82	110	80.44	39.53	55.44
LogOIL	0.63246	0.58320	0.93146	0.80414	0.73320	0.61172	0.68124	0.52634	0.55267	0.42813	0.29003	0.15534	0.40993
LogOIW	0.54531	0.41162	0.33846	0.46538	0.45179	0.50106	0.39620	0.30750	0.30750	0.24551	0.28103	0.02531	0.17898
LogIIL	0.77452	0.74429	0.97451	0.84073	0.79379	0.77887	0.86034	0.74819	0.77085	0.62634	0.78604	0.75128	0.91803
LogIIW	0.48287	0.37107	0.35793	0.38202	0.52114	0.55871	0.42813	0.33244	0.38739	0.26482	0.43775	0.32838	0.49136
LogInvL	1.05918	0.97081	1.09795	1.02078	1.11959	1.07628	0.92840	0.88705	1.01072	0.79309	0.89708	0.92840	0.99211
LogInvW	1.09447	0.96473	1.16909	1.02078	1.20058	1.14737	0.88024	0.96095	1.14395	0.90687	0.80889	0.62325	1.01368
LogLfLgth	1.86576	2.00932	1.90832	1.95434	2.11203	2.04309	2.03547	1.82795	1.86929	1.70321	1.36586	1.44793	1.67006
LogLfWdth	0.48996	0.78817	0.79518	0.54407	0.41830	0.60206	0.85187	0.41830	0.50515	0.40993	0.63749	0.42488	0.99913
LogStmLgth	1.96928	2.24304	2.38021	2.06711	2.17684	2.04685	2.23045	1.73304	1.92850	2.04139	1.90547	1.59693	1.74382
LogOIRAT	0.08715	0.17158	0.59300	0.33876	0.28141	0.11066	0.28504	0.21884	0.24517	0.18262	0.00900	0.13003	0.23096
LogIIRAT	0.29164	0.37323	0.61658	0.45872	0.27265	0.22017	0.43220	0.41575	0.38346	0.36152	0.34829	0.42290	0.42667
LogOI/II	-0.14206	-0.16109	-0.04305	-0.03659	-0.06059	-0.16715	-0.17910	-0.22185	-0.21818	-0.19821	-0.49601	-0.59594	-0.50810
LogInvRAT	-0.03529	0.00608	-0.07114	0.00000	-0.08099	-0.07109	0.04815	-0.07389	-0.13323	-0.11378	0.08819	0.30515	-0.02157
LogLFRAT	1.37580	1.22116	1.11314	1.41027	1.69373	1.44103	1.18360	1.40965	1.36414	1.29327	0.72837	1.02305	0.67093

Appendix 2: Morphometric data set for Chapter 2.

	Lict5	Lict6	Lict8	Lict10	Lict11	Linlin1	Linlin2	Linlin3	Linlin4	Linlin5	Linlin6	Linlin9	Linlin10
Habit	0	0	0	0	0	1	1	1	1	1	1	1	1
InvSet	0	0	0	0	0	1	0	0	0	0	0	0	0
ParScl	0	0	0	0	0	1	0	1	1	1	1	1	1
InvBase	1	1	1	1	1	2	1	2	2	1	1	1	2
LfIndu	1	1	1	1	1	0	2	0	0	0	0	0	0
LfMarg	3	3	3	3	3	0	3	3	3	1	3	3	3
LfDiss	4	3	3	3	1	1	5	4	1	5	1	1	5
OIL	3.37	3.54	2.13	2.57	2.5	1.87	5.6	9.33	13.47	7.79	4.53	12.53	5.95
OIW	2.44	2.29	1.3	1.41	1.58	1.4	1.49	2.01	1.66	1.77	1.17	1.36	0.55
IIL	4.34	3.55	5.18	4.92	5.21	5.31	4.82	10.56	12.24	8.92	8.88	17.44	7.23
IIW	1.76	2.28	1.92	2.37	2.26	1.42	1.03	1.93	1.86	1.8	1.4	2.2	2.52
InvL	5.04	6.61	8.39	7.82	8	6.2	10.24	9.91	7.3	5.91	7.01	9.29	7.69
InvW	3.37	3.22	4.5	4.99	5.09	6.11	10.24	10.88	10.25	5.07	3.34	7.26	7.38
LfLgth	57.28	29.48	32.97	29.12	25.86	108.39	151.02	121.66	230	85.81	57.96	210	82.59
LfWdth	10.24	11.91	6.55	7.93	7.19	2.05	2.32	6.73	3.81	4.21	1.57	3.33	3.15
StmLgth	52.94	13.97	70.33	33.97	26.35	111.98	230	125.46	380	91.92	70.5	235	74.11
LogOIL	0.52763	0.54900	0.32838	0.40993	0.39794	0.27184	0.74819	0.96988	1.12937	0.89154	0.65610	1.09795	0.77452
LogOIW	0.38739	0.35984	0.11394	0.14922	0.19866	0.14613	0.17319	0.30320	0.22011	0.24797	0.06819	0.13354	-0.25964
LogIIL	0.63749	0.55023	0.71433	0.69197	0.71684	0.72509	0.68305	1.02366	1.08778	0.95036	0.94841	1.24155	0.85914
LogIIW	0.24551	0.35793	0.28330	0.37475	0.35411	0.15229	0.01284	0.28556	0.26951	0.25527	0.14613	0.34242	0.40140
LogInvL	0.70243	0.82020	0.92376	0.89321	0.90309	0.79239	1.01030	0.99607	0.86332	0.77159	0.84572	0.96802	0.88593
LogInvW	0.52763	0.50786	0.65321	0.69810	0.70672	0.78604	1.01030	1.03663	1.01072	0.70501	0.52375	0.86094	0.86806
LogLfLgth	1.75800	1.46953	1.51812	1.46419	1.41263	2.03499	2.17903	2.08515	2.36173	1.93354	1.76313	2.32222	1.91693
LogLfWdth	1.01030	1.07591	0.81624	0.89927	0.85673	0.31175	0.36549	0.82802	0.58092	0.62428	0.19590	0.52244	0.49831
LogStmLgth	1.72378	1.14520	1.84714	1.53110	1.42078	2.04914	2.36173	2.09851	2.57978	1.96341	1.84819	2.37107	1.86988
LogOIRAT	0.14024	0.18917	0.21444	0.26071	0.19928	0.12571	0.57500	0.66669	0.90926	0.64356	0.58791	0.96441	1.03415
LogIIRAT	0.39198	0.19229	0.43103	0.31722	0.36273	0.57281	0.67021	0.73811	0.81827	0.69509	0.80228	0.89912	0.45774
LogOI/II	-0.10986	-0.00123	-0.38595	-0.28203	-0.31890	-0.45325	0.06514	-0.05378	0.04159	-0.05883	-0.29231	-0.14360	-0.08462
LogInvRAT	0.17480	0.31235	0.27055	0.19511	0.19637	0.00635	0.00000	-0.04056	-0.14740	0.06658	0.32197	0.10708	0.01787
LogLFRAT	0.74770	0.39362	0.70188	0.56492	0.55590	1.72324	1.81355	1.25713	1.78080	1.30926	1.56723	1.79978	1.41862

Appendix 2: Morphometric data set for Chapter 2.

	Linlin12	Linlin13	Linlin15	Linlin21	Linlin23	Linlin24	Linlin25	Linlin26	Linlin27	Linlin28	Linlin29	LinO1	LinO2
Habit	1	1	1	1	1	1	1	1	1	1	1	1	1
InvSet	1	1	0	0	0	0	0	0	0	0	0	0	1
ParScl	1	1	1	0	1	0	0	0	1	0	0	1	1
InvBase	1	1	1	1	2	1	1	2	1	0	2	1	2
LfIndu	2	2	2	0	0	0	2	0	0	1	0	0	2
LfMarg	1	3	3	3	3	3	3	3	3	0	0	3	3
LfDiss	5	1	5	1	1	1	5	1	5	1	1	1	5
OIL	7.42	5.03	9.24	8.27	7.99	6.36	5.6	5.48	8.89	11.7	12.85	9.33	10.41
OIW	1.71	1.6	1.34	1.55	1.05	1.06	1.49	2.42	1.54	1.94	2.39	2.35	1.8
IIL	13.16	11.26	7.62	9.1	13.07	8.39	4.82	6.32	12.69	12.9	12.5	16.2	16.38
IIW	2.61	2.28	2.14	1.55	2.04	1.71	1.03	1.78	2.19	1.26	2.52	1.51	1.81
InvL	9.2	9.5	6.85	8.27	7.83	6.39	10.24	7.31	7.43	8.08	10.32	9.35	6.92
InvW	7.21	9.01	5.93	5.7	5	5.98	10.24	7.06	9.59	9.76	8.32	13.76	14.63
LfLgth	81.71	73.34	101.94	210	19.5	141.44	151.02	87.49	83.07	170	180	122.13	88.16
LfWdth	3.23	3.53	3.61	3.68	2.06	7.28	2.32	5.43	5.97	2.02	1.22	24.67	13.27
StmLgth	94.25	49.97	74.36	153.28	240	139.13	230	120	210	150	170	290	124.48
LogOIL	0.87040	0.70157	0.96567	0.91751	0.90255	0.80346	0.74819	0.73878	0.94890	1.06819	1.10890	0.96988	1.01745
LogOIW	0.23300	0.20412	0.12710	0.19033	0.02119	0.02531	0.17319	0.38382	0.18752	0.28780	0.37840	0.37107	0.25527
LogIIL	1.11926	1.05154	0.88195	0.95904	1.11628	0.92376	0.68305	0.80072	1.10346	1.11059	1.09691	1.20952	1.21431
LogIIW	0.41664	0.35793	0.33041	0.19033	0.30963	0.23300	0.01284	0.25042	0.34044	0.10037	0.40140	0.17898	0.25768
LogInvL	0.96379	0.97772	0.83569	0.91751	0.89376	0.80550	1.01030	0.86392	0.87099	0.90741	1.01368	0.97081	0.84011
LogInvW	0.85794	0.95472	0.77305	0.75587	0.69897	0.77670	1.01030	0.84880	0.98182	0.98945	0.92012	1.13862	1.16524
LogLfLgth	1.91228	1.86534	2.00834	2.32222	1.29003	2.15057	2.17903	1.94196	1.91944	2.23045	2.25527	2.08682	1.94527
LogLfWdth	0.50920	0.54777	0.55751	0.56585	0.31387	0.86213	0.36549	0.73480	0.77597	0.30535	0.08636	1.39217	1.12287
LogStmLgth	1.97428	1.69871	1.87134	2.18549	2.38021	2.14342	2.36173	2.07918	2.32222	2.17609	2.23045	2.46240	2.09510
LogOIRAT	0.63741	0.49745	0.83857	0.72717	0.88136	0.77815	0.57500	0.35497	0.76138	0.78038	0.73051	0.59881	0.76218
LogIIRAT	0.70262	0.69360	0.55154	0.76871	0.80665	0.69077	0.67021	0.55030	0.76302	1.01022	0.69551	1.03054	0.95664
LogOI/II	-0.24885	-0.34997	0.08372	-0.04154	-0.21373	-0.12030	0.06514	-0.06194	-0.15456	-0.04240	0.01199	-0.23963	-0.19686
LogInvRAT	0.10585	0.02300	0.06264	0.16163	0.19479	0.02880	0.00000	0.01511	-0.11083	-0.08204	0.09356	-0.16781	-0.32514
LogLFRAT	1.40307	1.31757	1.45084	1.75637	0.97617	1.28844	1.81355	1.20716	1.14347	1.92510	2.16891	0.69465	0.82240

Appendix 2: Morphometric data set for Chapter 2.

	LinO3	LinO4	LinO5	LinO6	LinO7	LinO8	LinO9	LinO10	Marit	Oth	Pct1	Pct2	Pct3
Habit	1	1	1	1	1	1	1	1	0	1	1	1	1
InvSet	0	0	0	0	0	0	0	0	0	1	0	1	1
ParScl	1	1	1	1	1	1	1	1	0	0	1	0	1
InvBase	2	2	2	0	2	2	2	0	2	2	1	1	1
LfIndu	0	0	0	0	0	0	0	0	0	1	0	2	0
LfMarg	0	0	2	2	2	2	2	2	0	3	0	3	3
LfDiss	1	1	5	5	1	5	1	1	5	5	6	5	5
OIL	4.89	6.22	7.02	10.53	8.34	9.55	11.25	7.63	2.95	3.34	7.26	4.68	3.94
OIW	1.45	2.08	2.52	2.1	2.15	1.77	1.43	1.68	1.06	1.27	1.88	1.78	1.21
IIL	11.83	10.83	12.91	20.09	16.54	22.76	20.06	15.1	3.9	5.11	4.03	3.53	5.77
IIW	2.69	1.18	1.94	2.07	1.74	2.88	1.92	1.95	1.18	0.85	2	1.34	0.9
InvL	8.57	8.27	8.98	11.34	12.55	12.21	11.53	10.68	6.86	6.67	10.42	7.58	10.32
InvW	10.16	11.48	12.07	14.16	10.71	14.05	10.46	12.08	3.9	5.76	7.2	7.58	12.15
LfLgth	76.55	120.13	93.97	110.44	212	155.09	155.47	81.02	50.17	48.05	68.73	99.45	69.25
LfWdth	10.65	14.81	15.17	11.04	25.28	22.1	19.98	17.32	2.18	2.91	1.21	1.52	7.56
StmLgth	142.86	150.56	114.56	124.57	103.93	153.93	220	130.4	52.4	63.46	75.02	70.91	73.67
LogOIL	0.68931	0.79379	0.84634	1.02243	0.92117	0.98000	1.05115	0.88252	0.46982	0.52375	0.86094	0.67025	0.59550
LogOIW	0.16137	0.31806	0.40140	0.32222	0.33244	0.24797	0.15534	0.22531	0.02531	0.10380	0.27416	0.25042	0.08279
LogIIL	1.07298	1.03463	1.11093	1.30298	1.21854	1.35717	1.30233	1.17898	0.59106	0.70842	0.60531	0.54777	0.76118
LogIIW	0.42975	0.07188	0.28780	0.31597	0.24055	0.45939	0.28330	0.29003	0.07188	-0.07058	0.30103	0.12710	-0.04576
LogInvL	0.93298	0.91751	0.95328	1.05461	1.09864	1.08672	1.06183	1.02857	0.83632	0.82413	1.01787	0.87967	1.01368
LogInvW	1.00689	1.05994	1.08171	1.15106	1.02979	1.14768	1.01953	1.08207	0.59106	0.76042	0.85733	0.87967	1.08458
LogLfLgth	1.88395	2.07965	1.97299	2.04313	2.32634	2.19058	2.19165	1.90859	1.70044	1.68169	1.83715	1.99760	1.84042
LogLfWdth	1.02735	1.17056	1.18099	1.04297	1.40278	1.34439	1.30060	1.23855	0.33846	0.46389	0.08279	0.18184	0.87852
LogStmLgth	2.15491	2.17771	2.05903	2.09541	2.01674	2.18732	2.34242	2.11528	1.71933	1.80250	1.87518	1.85071	1.86729
LogOIRAT	0.52794	0.47573	0.44494	0.70021	0.58873	0.73203	0.89582	0.65722	0.44452	0.41994	0.58678	0.41983	0.51271
LogIIRAT	0.64323	0.96275	0.82312	0.98701	0.97799	0.89778	1.01903	0.88894	0.51918	0.77900	0.30428	0.42067	0.80693
LogOI/II	-0.38368	-0.24084	-0.26459	-0.28055	-0.29737	-0.37717	-0.25118	-0.29645	-0.12124	-0.18467	0.25563	0.12247	-0.16568
LogInvRAT	-0.07391	-0.14244	-0.12843	-0.09645	0.06885	-0.06096	0.04230	-0.05350	0.24526	0.06370	0.16054	0.00000	-0.07090
LogLFRAT	0.85660	0.90910	0.79200	1.00016	0.92356	0.84619	0.89105	0.67004	1.36199	1.21780	1.75436	1.81576	0.96190

Appendix 2: Morphometric data set for Chapter 2.

	Pct4	Pct5	Pct6	Pct7	Pct8	Rigid1	Rigid3	Rigid4	Rigid5	Rigid6	Rigid7	Rigid8	Rigid9
Habit	1	1	1	1	1	1	1	1	1	1	1	1	1
InvSet	0	0	0	1	1	0	0	1	0	0	2	1	1
ParScl	1	1	1	1	1	1	0	1	1	1	1	0	0
InvBase	2	1	2	1	0	2	1	1	1	2	2	2	2
LfIndu	2	2	0	2	2	2	2	2	2	2	0	0	0
LfMarg	3	3	3	3	3	3	3	3	3	3	3	0	3
LfDiss	4	5	5	5	5	6	6	5	6	6	5	5	5
OIL	8.9	6.2	7.44	7.08	6.97	2.96	2.79	3.72	5.09	6.29	2.52	5.88	3.33
OIW	1.03	0.87	1.85	1.13	1.96	1.1	1.6	2.08	1.74	0.82	1.66	1.72	1.44
IIL	9.32	6.84	8.95	4.89	9.94	4.33	3.64	4.59	6.29	6.82	4.11	5.89	5.85
IIW	1.89	2.13	2.39	2.15	2.25	1.61	2.22	2.52	1.47	1.63	2.41	1.33	2
InvL	9.23	10.48	8.79	8.92	8.99	8.31	8.58	12.36	12.03	9.34	7.26	9.31	6.48
InvW	12.45	11.43	17.49	10.26	10.49	9.72	8.69	19.81	11.85	9.34	10.13	8.87	8.71
LfLgth	114.81	165	200	140	150	68.57	98.5	110	39.76	47.13	65.66	146.55	77.87
LfWdth	3.04	10.5	8.45	5.08	6.35	1.9	2.86	4.84	1.44	2.58	2.47	4.99	2.17
StmLgth	98.42	230	240	150	140	83.91	117.68	120	80.6	42.12	35.27	91.45	83.04
LogOIL	0.94939	0.79239	0.87157	0.85003	0.84323	0.47129	0.44560	0.57054	0.70672	0.79865	0.40140	0.76938	0.52244
LogOIW	0.01284	-0.06048	0.26717	0.05308	0.29226	0.04139	0.20412	0.31806	0.24055	-0.08619	0.22011	0.23553	0.15836
LogIIL	0.96942	0.83506	0.95182	0.68931	0.99739	0.63649	0.56110	0.66181	0.79865	0.83378	0.61384	0.77012	0.76716
LogIIW	0.27646	0.32838	0.37840	0.33244	0.35218	0.20683	0.34635	0.40140	0.16732	0.21219	0.38202	0.12385	0.30103
LogInvL	0.96520	1.02036	0.94399	0.95036	0.95376	0.91960	0.93349	1.09202	1.08027	0.97035	0.86094	0.96895	0.81158
LogInvW	1.09517	1.05805	1.24279	1.01115	1.02078	0.98767	0.93902	1.29688	1.07372	0.97035	1.00561	0.94792	0.94002
LogLfLgth	2.05998	2.21748	2.30103	2.14613	2.17609	1.83613	1.99344	2.04139	1.59945	1.67330	1.81730	2.16599	1.89137
LogLfWdth	0.48287	1.02119	0.92686	0.70586	0.80277	0.27875	0.45637	0.68485	0.15836	0.41162	0.39270	0.69810	0.33646
LogStmLgth	1.99308	2.36173	2.38021	2.17609	2.14613	1.92381	2.07070	2.07918	1.90634	1.62449	1.54741	1.96118	1.91929
LogOIRAT	0.93655	0.85287	0.60440	0.79695	0.55098	0.42990	0.24148	0.25248	0.46617	0.88484	0.18129	0.53385	0.36408
LogIIRAT	0.69295	0.50668	0.57343	0.35687	0.64520	0.42966	0.21475	0.26041	0.63133	0.62160	0.23182	0.64626	0.46613
LogOI/II	-0.02003	-0.04266	-0.08025	0.16072	-0.15415	-0.16520	-0.11550	-0.09127	-0.09193	-0.03513	-0.21244	-0.00074	-0.24471
LogInvRAT	-0.12997	-0.03768	-0.29880	-0.06078	-0.06702	-0.06807	-0.00553	-0.20487	0.00655	0.00000	-0.14467	0.02103	-0.12844
LogLFRAT	1.57711	1.19629	1.37417	1.44026	1.37332	1.55738	1.53707	1.35655	1.44108	1.26168	1.42460	1.46789	1.55491

Appendix 2: Morphometric data set for Chapter 2.

	Rigid12	Rigid13	Rigid14	Rigs2	Rigs3	Rigs4	Rigs5	Rigs6	Rigs7	Rigs9	Rigs10	Rigs11	Rigs16
Habit	1	1	1	0	0	0	0	0	0	0	0	0	0
InvSet	1	1	0	1	1	1	0	1	1	0	0	0	1
ParScl	1	0	0	1	1	1	1	1	1	1	1	1	0
InvBase	1	0	2	0	0	0	1	0	0	0	1	0	2
LfIndu	2	2	2	1	0	1	0	0	1	0	0	0	1
LfMarg	3	3	3	0	0	0	0	0	0	0	0	0	0
LfDiss	5	5	3	5	5	1	1	1	1	5	1	1	1
OIL	3.33	5.18	2.12	3.71	2.43	3.59	5.2	3.63	2.33	7.44	9.55	4.47	3.12
OIW	1.28	1.06	1.05	1.67	3.26	1.99	2.92	2.16	1.67	2.35	1.8	1.64	1.82
IIL	4.71	4.26	3.74	6.48	5.45	6.34	5.32	4.71	4.14	10.46	10.52	6.81	4.66
IIW	2.33	2.2	2.04	1.89	2.68	1.91	1.88	2.4	1.56	2.36	2.48	2.78	1.64
InvL	7.15	10.24	7.6	9.97	10.03	9.48	9.66	7.78	8.39	9.6	8.23	7.38	6.53
InvW	7.99	5	6.12	11.87	17.05	13.33	11.76	8.23	8.77	9.49	10.53	6.88	6.03
LfLgth	109.65	102.25	150.42	70.13	60.8	58.67	76.76	26.91	37.29	113.59	114.04	63.2	35.06
LfWdth	1.99	3.63	2.08	8.82	13.31	6.23	14.35	4.71	8.76	18.37	12.97	9.65	6.53
StmLgth	180	88.97	142	56.33	77.16	61.02	100	23.94	28.59	93.13	114.02	41.94	33.23
LogOIL	0.52244	0.71433	0.32634	0.56937	0.38561	0.55509	0.71600	0.55991	0.36736	0.87157	0.98000	0.65031	0.49415
LogOIW	0.10721	0.02531	0.02119	0.22272	0.51322	0.29885	0.46538	0.33445	0.22272	0.37107	0.25527	0.21484	0.26007
LogIIL	0.67302	0.62941	0.57287	0.81158	0.73640	0.80209	0.72591	0.67302	0.61700	1.01953	1.02202	0.83315	0.66839
LogIIW	0.36736	0.34242	0.30963	0.27646	0.42813	0.28103	0.27416	0.38021	0.19312	0.37291	0.39445	0.44404	0.21484
LogInvL	0.85431	1.01030	0.88081	0.99870	1.00130	0.97681	0.98498	0.89098	0.92376	0.98227	0.91540	0.86806	0.81491
LogInvW	0.90255	0.69897	0.78675	1.07445	1.23172	1.12483	1.07041	0.91540	0.94300	0.97727	1.02243	0.83759	0.78032
LogLfLgth	2.04001	2.00966	2.17731	1.84590	1.78390	1.76842	1.88513	1.42991	1.57159	2.05534	2.05706	1.80072	1.54481
LogLfWdth	0.29885	0.55991	0.31806	0.94547	1.12418	0.79449	1.15685	0.67302	0.94250	1.26411	1.11294	0.98453	0.81491
LogStmLgth	2.25527	1.94924	2.15229	1.75074	1.88739	1.78547	2.00000	1.37912	1.45621	1.96909	2.05698	1.62263	1.52153
LogOIRAT	0.41523	0.68902	0.30515	0.34666	-0.12761	0.25624	0.25062	0.22545	0.14464	0.50051	0.72473	0.43546	0.23408
LogIIRAT	0.30566	0.28699	0.26324	0.53511	0.30826	0.52106	0.45175	0.29281	0.42388	0.64662	0.62756	0.38910	0.45354
LogOI/II	-0.15058	0.08492	-0.24654	-0.24220	-0.35079	-0.24699	-0.00991	-0.11311	-0.24964	-0.14796	-0.04201	-0.18284	-0.17423
LogInvRAT	-0.04824	0.31133	0.09406	-0.07576	-0.23042	-0.14802	-0.08543	-0.02442	-0.01924	0.00501	-0.10703	0.03047	0.03460
LogLFRAT	1.74116	1.44976	1.85924	0.90044	0.65973	0.97393	0.72828	0.75689	0.62909	0.79123	0.94412	0.81619	0.72990

Appendix 2: Morphometric data set for Chapter 2.

	Rigs17	Rigs19	Rigs20	Rigs21	Rigs22	Rigs23	Serr1	Serr2	Serr3	Serr4	Serr6	Serr7	Serr8
Habit	0	0	0	0	0	0	1	1	1	1	1	1	1
InvSet	0	0	1	0	1	1	0	0	0	0	1	1	1
ParScl	1	1	1	1	1	0	1	1	1	0	0	0	1
InvBase	2	2	2	2	2	0	2	2	0	1	1	2	0
LfIndu	0	0	0	0	0	0	2	0	2	0	3	2	2
LfMarg	0	0	0	0	0	0	3	0	3	1	3	3	3
LfDiss	5	5	1	1	1	1	5	4	5	6	4	1	5
OIL	5.51	3.36	5.97	4.58	6.26	6.42	5.68	5.44	6.48	5.02	5	9.81	5.04
OIW	2.44	2.26	2.38	2.74	2.15	3.54	1.14	3.11	1.61	2.56	2.24	1.54	1.07
IIL	6.12	6.09	6.93	5.23	8.14	4.75	7.36	4.95	5.56	7.6	6.59	10.51	4.78
IIW	2.05	1.72	1.83	2.96	1.93	2.15	1.84	2.64	2.02	2.99	1.64	3.92	2.04
InvL	5.5	7.76	5.64	9.06	9.23	8.67	8.47	8.38	10.7	9.74	9.03	8	9.83
InvW	8.91	9.01	11.1	10.56	10.37	8.19	9.21	10.1	11.46	12.54	8.12	8.18	10.81
LfLgth	86.74	82.37	66.73	69.86	77.33	76.03	160	151.3	180	90.17	135.1	117.74	94.53
LfWdth	9.98	9.18	10.38	12.99	15.27	11.76	4.67	5.51	3.08	1.9	3.84	5.81	5.04
StmLgth	81.94	88.18	35.53	54.87	70.03	36.89	230	135.83	160	194	210	53.23	95.09
LogOIL	0.74115	0.52634	0.77597	0.66087	0.79657	0.80754	0.75435	0.73560	0.81158	0.70070	0.69897	0.99167	0.70243
LogOIW	0.38739	0.35411	0.37658	0.43775	0.33244	0.54900	0.05690	0.49276	0.20683	0.40824	0.35025	0.18752	0.02938
LogIIL	0.78675	0.78462	0.84073	0.71850	0.91062	0.67669	0.86688	0.69461	0.74507	0.88081	0.81889	1.02160	0.67943
LogIIW	0.31175	0.23553	0.26245	0.47129	0.28556	0.33244	0.26482	0.42160	0.30535	0.47567	0.21484	0.59329	0.30963
LogInvL	0.74036	0.88986	0.75128	0.95713	0.96520	0.93802	0.92788	0.92324	1.02938	0.98856	0.95569	0.90309	0.99255
LogInvW	0.94988	0.95472	1.04532	1.02366	1.01578	0.91328	0.96426	1.00432	1.05918	1.09830	0.90956	0.91275	1.03383
LogLfLgth	1.93822	1.91577	1.82432	1.84423	1.88835	1.88098	2.20412	2.17984	2.25527	1.95506	2.13066	2.07092	1.97557
LogLfWdth	0.99913	0.96284	1.01620	1.11361	1.18384	1.07041	0.66932	0.74115	0.48855	0.27875	0.58433	0.76418	0.70243
LogStmLgth	1.91350	1.94537	1.55060	1.73933	1.84528	1.56691	2.36173	2.13300	2.20412	2.28780	2.32222	1.72616	1.97813
LogOIRAT	0.35376	0.17223	0.39940	0.22311	0.46414	0.25853	0.69744	0.24284	0.60475	0.29246	0.34872	0.80415	0.67305
LogIIRAT	0.47500	0.54909	0.57828	0.24721	0.62507	0.34426	0.60206	0.27300	0.43972	0.40514	0.60404	0.42832	0.36980
LogOI/II	-0.04560	-0.25828	-0.06476	-0.05764	-0.11405	0.13084	-0.11253	0.04099	0.06650	-0.18011	-0.11992	-0.02993	0.02300
LogInvRAT	-0.20952	-0.06486	-0.29404	-0.06654	-0.05058	0.02474	-0.03638	-0.08108	-0.02980	-0.10974	0.04613	-0.00966	-0.04127
LogLFRAT	0.93909	0.95293	0.80812	0.73062	0.70451	0.81058	1.53480	1.43869	1.76672	1.67631	1.54632	1.30675	1.27314

Appendix 2: Morphometric data set for Chapter 2.

	Serr9	spnov1	spnov2	spnov3	Ten1	Ten2	Ten3	Ten4	Ten5	Ten6	Ten7	Ten8	Ten9	Ten10
Habit	1	1	1	1	1	1	1	1	1	1	1	1	1	1
InvSet	1	1	1	1	0	1	1	0	0	0	0	0	0	0
ParScl	1	0	0	0	2	2	2	2	2	2	2	2	2	2
InvBase	2	0	1	0	3	3	3	3	3	3	3	3	3	3
LfIndu	2	0	1	0	0	2	2	0	0	0	0	0	0	0
LfMarg	3	0	0	0	3	2	3	3	2	2	2	2	2	2
LfDiss	5	1	3	3	6	6	6	6	6	5	5	6	6	6
OIL	10.56	3.8	2.44	3.8	3.72	2.43	3.78	3.34	2.85	2.67	2.22	2.2	3.25	2.74
OIW	1.45	2.46	1.53	1.2	0.9	0.63	0.68	0.79	0.64	0.89	0.73	0.56	0.99	0.49
IIL	7.81	5.61	3.58	4.96	5.95	6.72	5.5	4.6	4.48	5.87	4.19	5.12	6.68	6.46
IIW	2.54	3.19	1.27	1.4	0.92	1.85	1.79	1.33	1.08	1.1	1.22	0.97	1.55	1.34
InvL	11.43	6.53	7.42	6.5	3.88	3.96	4.19	4.16	4.37	4.57	3.25	4.13	4.29	4.33
InvW	11.15	10.2	5.71	5.67	5.4	3.17	5.75	4.88	4.17	4.49	3.77	3.87	5.12	4.53
LfLgth	122.96	57.3	32.4	81.46	34.35	37.63	44.11	4.98	38.27	71.59	52.14	55.34	45.72	52.1
LfWdth	6.54	6.5	4.4	3.23	1.35	1.3	1.45	1.42	1.14	1.62	0.88	1.2	1.18	1.16
StmLgth	131.16	59.58	32.55	57.84	84.86	49.77	70.33	38.3	37.84	63.72	51.18	52.8	89.92	60.74
LogOIL	1.02366	0.57978	0.38739	0.57978	0.57054	0.38561	0.57749	0.52375	0.45484	0.42651	0.34635	0.34242	0.51188	0.43775
LogOIW	0.16137	0.39094	0.18469	0.07918	-0.04576	-0.20066	-0.16749	-0.10237	-0.19382	-0.05061	-0.13668	-0.25181	-0.00436	-0.30980
LogIIL	0.89265	0.74896	0.55388	0.69548	0.77452	0.82737	0.74036	0.66276	0.65128	0.76864	0.62221	0.70927	0.82478	0.81023
LogIIW	0.40483	0.50379	0.10380	0.14613	-0.03621	0.26717	0.25285	0.12385	0.03342	0.04139	0.08636	-0.01323	0.19033	0.12710
LogInvL	1.05805	0.81491	0.87040	0.81291	0.58883	0.59770	0.62221	0.61909	0.64048	0.65992	0.51188	0.61595	0.63246	0.63649
LogInvW	1.04727	1.00860	0.75664	0.75358	0.73239	0.50106	0.75967	0.68842	0.62014	0.65225	0.57634	0.58771	0.70927	0.65610
LogLfLgth	2.08976	1.75815	1.51055	1.91094	1.53593	1.57553	1.64454	0.69723	1.58286	1.85485	1.71717	1.74304	1.66011	1.71684
LogLfWdth	0.81558	0.81291	0.64345	0.50920	0.13033	0.11394	0.16137	0.15229	0.05690	0.20952	-0.05552	0.07918	0.07188	0.06446
LogStmLgth	2.11780	1.77510	1.51255	1.76223	1.92870	1.69697	1.84714	1.58320	1.57795	1.80428	1.70910	1.72263	1.95386	1.78347
LogOIRAT	0.86230	0.18885	0.20270	0.50060	0.61630	0.58627	0.74498	0.62612	0.64866	0.47712	0.48303	0.59423	0.51625	0.74755
LogIIRAT	0.48782	0.24517	0.45008	0.54935	0.81073	0.56020	0.48751	0.53891	0.61785	0.72725	0.53585	0.72250	0.63444	0.68313
LogOI/II	0.13101	-0.16918	-0.16649	-0.11570	-0.20397	-0.44176	-0.16287	-0.13901	-0.19643	-0.34213	-0.27586	-0.36685	-0.31289	-0.37248
LogInvRAT	0.01077	-0.19369	0.11377	0.05933	-0.14356	0.09664	-0.13745	-0.06933	0.02035	0.00767	-0.06446	0.02824	-0.07681	-0.01961
LogLFRAT	1.27419	0.94524	0.86709	1.40174	1.40559	1.46159	1.48317	0.54494	1.52595	1.64534	1.77269	1.66386	1.58822	1.65238

cpDNA primer screening and selection for Chapter 3

For the six cpDNA regions initial screened, nine samples were selected to determine if any inter- and intraspecific variability could be distinguished in each region (see Table A3.1 for sample details). Table A3.2 lists the primers details for the regions not detailed in Chapter 3, Table 3.2.3.

Table A3.1: Nine samples used for primer screening (full details in Table 3.2.1).

Species	subspp	Sample
leiopoda		M240901
linearis	linearis	RM1010
	ovalis	RM854
rigida		M280902
tenuifolia		CAM1601
jurineifolia	scabra	CAM1604
lichtensteinii		CAM1916
rigens	leucolaena	RM952_1
krebsiana	serrulata	RM965

Table A3.2: Rejected cpDNA regions primer names, uses, authors, sequences, PCR annealing temperature and number of cycles.

Name	Use	Reference	Sequence	**Anneal Temp**	**No. Cycles**
***trn*C-*psb*M**					
*trn*CF	Amplif/Seq	Shaw et al., 2005	CCA GTT CRA ATC YGG GTG	52°C	30
*psb*MR	Amplif/Seq	Shaw et al., 2005	ATG GAA GTA AAT ATT CTY GCA TTT ATT GC		
***trn*S-*trnf*M**					
*trn*S	Amplif/Seq	Demesure et al., 1995	GAG AGA GAG GGA TTC GAA CC	52°C	30
*trnf*M	Amplif/Seq	Demesure et al., 1995	CAT AAC CTT GAG GTC ACG GG		
***trn*T-*trn*L**					
Tab a	Amplif/Seq	Taberlet et al., 1991	CAT TAC AAA TGC GAT GCT CT	53-55°C	30-35
tab b	Amplif/Seq	Taberlet et al., 1991	TCT ACC GAT TTC GCC ATA TC		

Table A3.3 presents a list of comparative information of each region's length, variability, informativeness and data signal strength. Initial investigations into relative variability and information content indicated that although the *trn*C-*psb*M and *trn*T-*trn*L regions proved to be the most variable and informative of all the cpDNA regions, there were significant amplification and sequencing problems with both. In the *trn*C-*psb*M region, one sample (even when PCR amplification produced a clean clear band on an agarose gel) could not be successfully sequenced in either direction, and another sample could not be successfully sequenced with the reverse primer. Table A3.4 lists the indel information for each region. In the *trn*T-*trn*L region, the presence of multiple poly-A/T strings (up to

17 bp in length) in almost all samples made amplification and bidirectional sequencing problematic. The *psbA-trnH* region can be seen to be highly prone to multibase repeat insertions, while the *trnS-fM* region is prone to single base pair repeat strings.

Table A3.3: Characteristics of each cpDNA region, including number of samples, total number of characters, number and percentage of variable and parsimony informative characters, as well as data signal statistic.

			Variable Characters		Parsimony Inform. Ch.		
	No. samp.	Tot. chars	Number	%	Number	%	g_1
*trn*S-*trnf*M	9	1021	14	1.4	0	0	
*trn*L-F	9	858	23	2.7	0	0	
*trn*C-*psb*M	8	541	20	3.7	5	0.9	-0.77
*psb*A-*trn*H	9	533	34	6.4	1	0.2	-2.823
*rp*S16	9	827	15	1.8	2	0.3	-0.588
*trn*T-*trn*L	9	545	22	4	3	0.6	-0.491

The *psb*A-*trn*H and *rp*S16 regions were thus the next most profitable cpDNA regions to pursue for potential phylogenetic signal content. The *trn*L-F regions (jointly amplified by the "tab c" and "tab f" primers) had the next highest number of variable characters, and this region was tentatively pursued in the hopes that a greater sample size would render more phylogenetically informative sites.

Table A3.4: Indel information for each cpDNA region.

Region	**Indels**	**Poly-N repeat strings**	**Other**
*rp*S16	2 x 1 bp 1 x 9 bp	poly-G (6-8 bp)	1 x 5 bp repeat insertion
		poly-A (9-13 bp)	
*trn*L-F	1 x 1 bp		
*trn*S-fM	1 x 2 bp	poly-A (3-4 bp)	
		poly-T (9-13 bp)	
		poly-C (3-4 bp)	
		poly-T (7-8 bp)	
*trn*T-L	1 x 1 bp 1 x 5 bp	poly-T (11-17 bp)	1 x 4 bp repeat insertion
		poly-A string (8-10 bp, some with T inserts)	
*psb*A-*trn*H	4 x 1 bp 1 x 6 bp 1 x 11 bp 1 x 19 bp 1 x 269 bp	poly-A (7-9 bp)	1 x 5 bp repeat insertion
			2 x 6 bp repeat insertion
			1 x 5 bp repeat insertion (imperfect)
			1x (3xTTAAA) repeat insertion (3rd repeat imperfect)
			1 x 4 bp repeat insertion (imperfect)
			1 x (2x5 bp) repeat insertion
			1 x 11bp inversion (inside larger matchpaired region)
*trn*C-*psb*M	1 x 1bp 1 x 5bp	poly-A (7-13 bp)	
		poly-T (8-9 bp)	
		poly-T (5-6 bp)	

Appendix 4: nrDNA sequence data for Chapter 3.

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[                                      10        20        30        40        50        60        70        80        90       100       110]

Berkheya                       TCGAACCCTGCATAGCAGAACGACCCGTGAACACGTAACCACAACCGGGTGCTAAGGGGGACAGGTTTATAGCCGGCGACCCTTGGTGCCCTGCCTACTTGCGTGCATGT
Gorteria                       TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACCCACAACCGGGTGTCAAGGGGGACAGGCTC-TAGCCGGCGACCCTTGGTGCCCCGCCAACGTGCGTGCATGT
Hirpicium                      TCGAACCATGCATAGCAGAACGACCCGCGAACACGTAACCACAACCGGGTGTCAAGGGGGACAGGCTC-TAGCCGGCGACCCTTGGTGCCTTGCCTATGTGCGTGCATGT
caespitosa_RC448               TCGAACCCTGCAAAGCAGAACGACCYGCGAACACGTACATACAACCGGGTGTCAMGGGGGACAGGCAC-TAGCCRGCGACCCTTGATGCCCTGCCTACCTRCGTGCATGT
caespitosa_RVC307              TCGAACCCTGCAAAGCAGAACGACCYGCGAACACGTACATACAACCGGGTGTCAMGGGGGACAGGCAC-TAGCCRGCGAYCCTTGATGCCCTGCCTACCTRCGTGCATGT
ciliaris_RM1230                TCGAACCCTGCAAAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACAGGCAC-TAGCCGGCGACTCTTGATGCCCTGCCTACCTGCGTACATGT
ciliaris_RM1382                TCGAACCCTGCAAAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACAGGCGC-TAGCCGGCGACTCTTGATGCCCTGCCTACCTGCGTACATGT
heterochaeta_RM1429_1          TCGAACCCTGCATAGCAGAACGACCCGCGAACATGTACATACAMCCGGGTGTAAAGGGG--CAGGCTC-TAGCCGGCGACCCTTGACGCCCTGCCTTCCTGCGTGCATGT
heterochaeta_RM1451            TCGAACCCTGCATAGCAGAACGACCCGCGAACATGTACATACAACCGGGTGTAAAGGGG--CAGGCTC-TAGCCGGCGACCCTTGACGCCCTGCCTTCCTGCGTGCATGT
jurineifolia_jur_SR682         TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAATCGGGTGTTAAGGGGGACAGGCTA-TAGCCGGCGACCCTTGACGCCCTGCCTACCTGCGTGCATGT
jurineifolia_jur_RM1518        TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAATCGGGTGTTAAGGGGGACAGGCTA-TAGCCGGCGACCCTTGACGCCCTGCCTACCTGCGTGCATGT
jurineifolia_scab_CAM1604      TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAATCGGGTGTTAAGGGGGACAGGCTA-TAGCCGGCGACCCTTGACGCCCTGCCTACCTGCGTGCATGT
jurineifolia_scab_CAM2652      TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAATCGGGTGTTAAGGGGGACAGGCTA-TAGCCGGCGACCCTTGACGCCCTGCCTACCTGCGTGCATGT
krebsiana_arctotoides_RM868    TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
krebsiana_arctotoides_RM876    TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
krebsiana_krebsiana_RM1114     TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
krebsiana_krebisiana_RM1136    TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTTCATGT
krebsiana_serrulata_RM863      TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
krebsiana_serrulata_RM965      TCGAACCCTGCATAGCAGAACGACCCGTGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
leiopoda_M240901               TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAACCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
leiopoda_RM1309                TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCGGCGACCCTTGATGCCCTGCCAACCTGCGTGCATGT
lichtensteinii_CAM1916         TCGAACCCTGCATAGCRGAACGACCCGCGAACACGTACATACAACCGGGTGTAAAGGGGGGCAGGCTC-TAGCCGGCGACCCTTGACGCCCTGCCTTCCTGCGTACATGT
lichtensteinii_RM1249          TCGAACCCTGCATAGCAGAACGACCYGCGAACACGTACATACAACCGGGTGTAAAGGGGGGCAGGCTC-TAGCCGGCGACCCTTGACGCCCTGCCTTCCTGCGTACATGT
linearis_linearis_RM1010       ???????????????????ACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
linearis_linearis_SH113        TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGYCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
linearis_ovalis_NDsn           TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCGGCGACCCTTGATGCCCTGCCRACCTGCGTGCATGT
linearis_ovalis_RM854          TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
maritima_RM1038                TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
maritima_M290606_6             TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCGGCGACCCTTGATGCCCTGCCTACCWGCGTGCATGT
othonnites_RM1306              TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCAGCGACCCTTGATGCCCTGCCTACCTGCGTTCATGT
pectinata_M120903              TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCGGTGACCCATGATGCCCTGCCTACCTGCGTACATGT
pectinata_RM1044               TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGATTGGCTC-TWGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
rigida_M280902                 ???????????????CAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAACCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
rigida_RM840                   TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
rigens_leucolaena_RM773        TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
rigens_leucolaena_RM952_1      TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
rigens_rigens_RM763            TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
rigens_rigens_SR463            TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
rigens_uniflora_JC201205       TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
rigens_uniflora_RM920          TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
schenckii                      ??????????????????????????????????GTACATACAACCGGGTGTTAAGGGGGGCAGGCTC-TAGCCGGCGACCCTTGACGCCTTGCCTTCCTGCGTACATGC
serrata_M250904_15             TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAACCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
serrata_RM898                  TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TARCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
tenuifolia_CAM1601             ?????????????????????????????????????????????????????ATGGGGGACAGGCTC-TAGCCSGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
tenuifolia_M2730               TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTAAAGGGGGACAGGCTC-TAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
spnov_M040906_33               TCGAACCCTGCATAGCAGAACGACCCGCGAACRCGTACATACAACCGGGTGTCAAGGGGGACTGGCTC-TAGCCAGCGACCCTTGATGCCCTGCCTACCTGCGTTCATGT
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[                                       120       130       140       150       160       170       180       190       200       210       220]

Berkheya                       TGCCTCGTTYGGGGCTCATGAAC--GTCACWTAGGCATCAAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAATATAAGAAGGGATCGTWC-GTGTCGTCCCGT
Gorteria                       TGCCTCTATAGGG-CTCATGAAC--GTCATGTCGGCATCAAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAAGAAGGGCTCGTATCGTGTCGTCCCGT
Hirpicium                      TGCCCCGTTTGGGGCTCGTGAAC--GTCATGTTGGCATYAAAACAAAACCCGGCACGGCATGTGCCAAGGAAAACAAAACAATAGAAGGGCTCGTATCTTGTCGTCCCGT
caespitosa_RC448               AGCCCTTTTTGGGGCTSGTGAAC--GTAGTGTTGGCATCAAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACMAAACATAAGAAGGGCTCGYATCTTGTCGTCCCGT
caespitosa_RVC307              AGCCCTTTTTGGGGCTSGTGAAC--GTAGNGTTGGCATCAAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACMAAACATAAGAAGGGCTCGCATCTTGTCGTCCCGT
ciliaris_RM1230                TGCCCTTTTTGGGGCTCGTGAAC--GTAGTGTTGGCATCAAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAAGAAGGGCTCGCATCTTGTCGTCCCGT
ciliaris_RM1382                GGCCCTTTTTGGRGCTCGTGAAC--GTAGTGTTGGCATCAAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAAGAAGGGCTCGCATCTTGTCGTCCCGT
heterochaeta_RM1429_1          AGCC-TTTCYGGG-CTCGTGAAC--GTAGTGTCGGCATCCAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACAAAAGAAGGGCTCGTATCGTGTCGTCCCGT
heterochaeta_RM1451            AGCC-TTTCTGGG-CTCGTGAAC--GTAGTGTTGGCATCAAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACAAAAGAAGGGCTCGTATCGTGGCGTCCCGT
jurineifolia_jur_SR682         AGCCCTGTTTGGGGCTCTTGAAC--GTTATGTAGGCACCAAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAAGAAGGGCTCGTACCGTGTCGTCCCGT
jurineifolia_jur_RM1518        AGCCCTGTTTTGGGCTCTTGAAC--GTTATGTAGGCACCAAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAAGAAGGGCTCGTACCATGTCGTCCCGT
jurineifolia_scab_CAM1604      AGCCCTGTTTGGGGCTCTTGAAC-GTTA-TGTAGGCACCAAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAAGAAGGGCTCGTACCGTGTCGTCCCGT
jurineifolia_scab_CAM2652      AGCCCTGTTTGGGGCTCTTGAAC--GTTATGTAGGCACCAAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAAGAAGGGCTCGTACCRTGTCGTCCCGT
krebsiana_arctotoides_RM868    AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGTCGTCCCGT
krebsiana_arctotoides_RM876    AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGKCGTCCCGT
krebsiana_krebsiana_RM1114     AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCGT
krebsiana_krebisiana_RM1136    AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCGT
krebsiana_serrulata_RM863      AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCGT
krebsiana_serrulata_RM965      AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCGT
leiopoda_M240901               AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCGT
leiopoda_RM1309                AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATATGAAGGGCTCGTACCGTGGCGTCCCGT
lichtensteinii_CAM1916         GGCCCTTTCTGGG-CTCGTGAACGTGTAGTGTTGGCATCAAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAAGAAGGGCTCGTATCGTGTCGTCCCGT
lichtensteinii_RM1249          GGCCCTTTCTGGG-CTCGTGAACGTGTAGTGTTGGCATCAAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAAGAAGGGCTCGTATCGTGTCGTCCCGT
linearis_linearis_RM1010       AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCGT
linearis_linearis_SH113        AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCGT
linearis_ovalis_NDsn           AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCGT
linearis_ovalis_RM854          AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCGT
maritima_RM1038                AGCCCTTTTTGGGGCTCGTGAAC--TCAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCGT
maritima_M290606_6             AGCCCTTTTTGGGGCTCRTGAAC--TCAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCGT
othonnites_RM1306              AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCGT
pectinata_M120903              AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCGCGTACCATGGCGTCCCGT
pectinata_RM1044               AGCCCTTTTTGGGGCTCGTGAAC--TYAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACAGTGGCGTCCCGT
rigida_M280902                 AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCGT
rigida_RM840                   AGCCCTTTTTGGGGCTCGTGAAC--TCAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCGT
rigens_leucolaena_RM773        AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCGT
rigens_leucolaena_RM952_1      AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCGT
rigens_rigens_RM763            AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCGT
rigens_rigens_SR463            AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCGT
rigens_uniflora_JC201205       AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCGT
rigens_uniflora_RM920          AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCGT
schenckii                      AGCCCTTTCTGGG-CTCGTGAACGTGGAGTGTTGGCATCAAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAATCATAAGAAGGGCTCGTATAGTGTCGTCCCGT
serrata_M250904_15             AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCGT
serrata_RM898                  AGCCCTTTTTGGGGCTCGTGAAC--TCAGTGTTGGCATCTWAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCGT
tenuifolia_CAM1601             AGCCCCTTTTGGG-CTCGTGAAC--GTAGTGTTTGCATCAAAACAAACCCCGGCACGGCATGTGCCAAGGAAAGAAAACATAAGAAGGGCTCGTATCGTGTCGTCCCGT
tenuifolia_M2730               AGCCCCTTTTGGG-CTCGTGAAC--GTAGTGTTGGCATCAAAACAAACCCCGGCACGGCATGTGCCAAGGAAAGAAAACATAAGAAGGGCTCGTATCGTGTCGTCCCGT
spnov_M040906_33               AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAACCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCGT
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[                                       230       240       250       260       270       280       290       300       310       320       330]

Berkheya                       TCGCGGTGTGCGCAYGTTCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
Gorteria                       TCGCGGTGTGCGCATGTTCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
Hirpicium                      TCGCGGTGTGCGCATGGAC--GTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
caespitosa_RC448               TCGCGGTGTGCGCATGTGCTTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
caespitosa_RVC307              TCGCGGTGTGCGCATGTGCTTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
ciliaris_RM1230                TCGCGGTGTGCGCATGTGCTTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAGAATGCGATACTTGGTGT
ciliaris_RM1382                TCGCGGTGTGCGCATGTGCTTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
heterochaeta_RM1429_1          GTGCGGTGTGCGCATGTGCGTGTCTCTTTTATAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
heterochaeta_RM1451            TTGCGGTGTACGCATGTGCGTGTCTCTTTTATAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
jurineifolia_jur_SR682         TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTARTCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
jurineifolia_jur_RM1518        TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
jurineifolia_scab_CAM1604      TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
jurineifolia_scab_CAM2652      TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
krebsiana_arctotoides_RM868    TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
krebsiana_arctotoides_RM876    TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
krebsiana_krebsiana_RM1114     TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
krebsiana_krebisiana_RM1136    TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
krebsiana_serrulata_RM863      TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
krebsiana_serrulata_RM965      TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
leiopoda_M240901               TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
leiopoda_RM1309                TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
lichtensteinii_CAM1916         TTGCGGTGTACGCATGTGCKTGTCTCTTTTATAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
lichtensteinii_RM1249          TTGCGGTGTACGCATGTGCGTGTCTCTTTTATAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
linearis_linearis_RM1010       TCGCGGTGTGCGAATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
linearis_linearis_SH113        TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
linearis_ovalis_NDsn           TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
linearis_ovalis_RM854          TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
maritima_RM1038                TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
maritima_M290606_6             TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
othonnites_RM1306              TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
pectinata_M120903              TCGCGGTGTGCGCATGTGCGTGTCCCTTTATTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
pectinata_RM1044               TCGCGGTGTATGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
rigida_M280902                 TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
rigida_RM840                   TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
rigens_leucolaena_RM773        TTGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
rigens_leucolaena_RM952_1      TTGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
rigens_rigens_RM763            TTGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
rigens_rigens_SR463            TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
rigens_uniflora_JC201205       TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAA-TGCGATACTTGGTGT
rigens_uniflora_RM920          TTGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTASCAAAATGSGATACTTGGTGT
schenckii                      TTGCGGTGTACGCATGTGC--GTCTCTTTTATAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
serrata_M250904_15             TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
serrata_RM898                  TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
tenuifolia_CAM1601             TTGCGGTGTACGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGAT-AAGAACGTAGCAAAATGCGATACTTGGTGT
tenuifolia_M2730               TTGCGGTGTACGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
spnov_M040906_33               TCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTGT
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[                                       340       350       360       370       380       390       400       410       420       430       440]

Berkheya                       GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCC-CACA
Gorteria                       GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCCCACA
Hirpicium                      GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCC-CACA
caespitosa_RC448               GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
caespitosa_RVC307              GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
ciliaris_RM1230                GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
ciliaris_RM1382                GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
heterochaeta_RM1429_1          GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACT
heterochaeta_RM1451            GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACT
jurineifolia_jur_SR682         GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
jurineifolia_jur_RM1518        GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
jurineifolia_scab_CAM1604      GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
jurineifolia_scab_CAM2652      GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
krebsiana_arctotoides_RM868    GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
krebsiana_arctotoides_RM876    GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
krebsiana_krebsiana_RM1114     GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
krebsiana_krebisiana_RM1136    GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
krebsiana_serrulata_RM863      GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
krebsiana_serrulata_RM965      GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
leiopoda_M240901               GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
leiopoda_RM1309                GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
lichtensteinii_CAM1916         GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
lichtensteinii_RM1249          GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
linearis_linearis_RM1010       GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
linearis_linearis_SH113        GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
linearis_ovalis_NDsn           GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
linearis_ovalis_RM854          GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
maritima_RM1038                GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
maritima_M290606_6             GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
othonnites_RM1306              GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
pectinata_M120903              GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
pectinata_RM1044               GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
rigida_M280902                 GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
rigida_RM840                   GAATTGCAGAATCCCGYGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
rigens_leucolaena_RM773        GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
rigens_leucolaena_RM952_1      GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
rigens_rigens_RM763            GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
rigens_rigens_SR463            GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
rigens_uniflora_JC201205       GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
rigens_uniflora_RM920          GAATTGCAGAATCCCGTGAACCATTGAGTTTTTGAACRCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
schenckii                      GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
serrata_M250904_15             GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
serrata_RM898                  GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
tenuifolia_CAM1601             GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
tenuifolia_M2730               GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
spnov_M040906_33               GAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCACA
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[                                       450       460       470       480       490       500       510       520       530       540       550]

Berkheya                       ACACGTCCCTAACKGGTACGYGTTGCCTT-GGGGGCGGATATTGGTCTCCCGTGCCTTAGGGTGTGGTTGGCCTAAACTAGAGTCCCCTCGGTGGACGCACGGCTAGTGG
Gorteria                       ACTCCTCCCTATTAGGTACGTGTTGTGTC--GGGGCGGAAATTGGTCTCCCGTGCCTTT-GGTGTGGTTGGCCTAAACCAGAGTCCCCTCGGTGGACGCACGGCTAGTGG
Hirpicium                      ACTCCTCCTTATTAGGTACGTGTTGTGTT--GGGGCGGATATTGGTCTCCCGTGCCTTT-GGTGTGGTTGGCCTAAACCAGAGTCCCCTCGGTGGACGCACGGCTAGTGG
caespitosa_RC448               ACTCCTCCCTTTTGGGAGCACGTTGTGTC-GGGGGCGGATATTGGTCTCCCGTGCCTTT-GGTGTGGTTGGCCTAAATCAGAGTCCYCTYGGCGGACGCACGGCTAGTGG
caespitosa_RVC307              ACTCCTCCCTTTTGKGAGCACGTTGTGTC-GGGGGCGGATATTGGTCTCCCGTGCCTTT-GGTGTGGTTGGCCTAAAWCAGAGTCCYCTYGGCGGACGCACGGCTAGTGG
ciliaris_RM1230                ACTCCTCCCTTTTGGGAGAACGTTGTGT--GGGGGCGTATATTGGTCTCCCGTGCCTTT-GGTGTGGTTGGCCTAAATCAGAGTCCCCTTGGCGGACGCATGGCTAGTGG
ciliaris_RM1382                ACTSCTCCCTTTTGGGAGAACGTTGTGT--GGGGGCGTATATTGGTCTCCCGTGCCTTT-GGTGTGGTTGGCCTAAATCAGAGTCCCCTTGGCGGACGCATGGCTAGTGG
heterochaeta_RM1429_1          AC-CCTTCCTGTTGGGAACACGTTGTGTGAGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCAGAGTCCCCTTGGTGGACGCACGGCTAGTGG
heterochaeta_RM1451            AC-CCTTCCTGTTGGGAACACGTTGTGTGAGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCAGAGTCCCCTTGGTGGACGCACGGCTAGTGG
jurineifolia_jur_SR682         ACTCCTCCCTGTTGGGATCACGTTGGGTT-GGGGGCGGATATTGGCCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCAGAGTCCCCTCGGTGGACGCACGGCTAGTGG
jurineifolia_jur_RM1518        ACTCCTCCCTGTTGGGATCACGTTGGGTT-GGGGGCGGATRTTGGCCTCCCGTGCCTTT-GGTGTGGTTGGCCTAAATCAGAGTCCCCTCGGTGGACGCACGGCTAGTGG
jurineifolia_scab_CAM1604      ACTCCTCCCTGTTGGGATCACGTTGGGTT-GGGGGCGGATATTGGCCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCAGAGTCCCCTCGGTGGACGCACGGCTAGTGG
jurineifolia_scab_CAM2652      ACTCCTCCCTGTTGGGATCACGTTGGGTT-GGGGGCGGATATTGGCCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCAGAGTCCCCTCGGTGGACGCACGGCTAGTGG
krebsiana_arctotoides_RM868    ACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
krebsiana_arctotoides_RM876    ACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
krebsiana_krebsiana_RM1114     ACTCCTCCCTATTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
krebsiana_krebisiana_RM1136    ACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
krebsiana_serrulata_RM863      ACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
krebsiana_serrulata_RM965      ACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
leiopoda_M240901               ACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
leiopoda_RM1309                ACTCCTCCCTGTTGGGAAAAMGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGCTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
lichtensteinii_CAM1916         AC-CCTCCYTGTTGGGAACACGTTGTGTCAGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCAGAGTCCCCTCGGTGGACGCACGGCTAGTGG
lichtensteinii_RM1249          AC-CCTCCTTGTTGGGAACACGTTGTGTCAGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCAGAGTCCCCTCGGTGGACGCACGGCTAGTGG
linearis_linearis_RM1010       ACTCCTCCCTGTTGGGAAARCGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
linearis_linearis_SH113        ACTCCTCCCTGTTGGGAAAACRTTGTGTCGGGGGGCGGATATTGGTCTCCCAWGCCTTT-GGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
linearis_ovalis_NDsn           ACTCCTCCCTRTTGGGAAAACRTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
linearis_ovalis_RM854          ACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
maritima_RM1038                ACTCCTCCCTGTTGGGAAAACGTTGTGTTGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGCTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
maritima_M290606_6             ACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGCTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
othonnites_RM1306              ACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
pectinata_M120903              ACTCCTCCCTGTTGGGAAAACGTTGTGTC-GGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGATGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
pectinata_RM1044               ACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGCTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
rigida_M280902                 ACTCCTCCCTGTTGGGAAAATGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
rigida_RM840                   ACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGCTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
rigens_leucolaena_RM773        ACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
rigens_leucolaena_RM952_1      ACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
rigens_rigens_RM763            ACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
rigens_rigens_SR463            ACTCCTCCCTATTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
rigens_uniflora_JC201205       ACTCCTCCCTATTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
rigens_uniflora_RM920          ACTCCTCCCTGKTGGRAAAACGTTGTGTCGGGGGGMGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGC-TAAATCTGAGTCCCCTMGGTGGACGCACGGYTAGTGG
schenckii                      GC-CCTCCCTGTTGGGAACACGTTGTGTCAGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCAGAGTCCCCTCGGTGGACGCACGGCTAGTGG
serrata_M250904_15             ACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATTTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
serrata_RM898                  ACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGCTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
tenuifolia_CAM1601             ACTCCTCCCTGTTGGGAACACGTTGTGTCA-GGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCAGAGTCCCCTCGGTGGACGCACGGCTAGTGG
tenuifolia_M2730               ACTCCTCCCTGTTGGGAACACGTTGTGTCA-GGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCAGAGTCCCCTCGGTGGACGCACGGCTAGTGG
spnov_M040906_33               ACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTT-GGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
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[                                      560       570       580       590       600       610       620       630       640       650       660]

Berkheya                       TGGTTGATAAGACCCTCGTCTGTTGTCGTGCTAAGCTGTTTGGGAAGTACTCGTAAAAAGACCCCAACGCATTGTCTTGTGACCATGCTTCGACCGCGACCCCAGGTCAG
Gorteria                       TGGTTGACAAGACCCTCGTCTGGTGTCGTGCTAAGCTATTTGGGAAGTACTCAAGAAAAGACCCCAACGCATTGTCTTGYGATGATGCTTCGACCGCGACCCCAGGTCAG
Hirpicium                      TGGTTGACAAGACCCTCGTCTGGTGTCGTGCTAAGCTGTACGGGAAGTACTCATGAAACGACCCCAACGCATTGTCTTCTGACAATGCTTCGACCGCGACCCCAGGTCAG
caespitosa_RC448               TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAGCTRTAAGGGAAGTACTCTTGAAAAGACCCCAACGCATTGTCTTGTGACGATGCTTCGACCGCGACCCCAGGTCAG
caespitosa_RVC307              TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAGCTRTAAGGGAAGTACTCTTGAAAAGACCCCAACGCATTGTCTTGTGACGATGCTTCGACCGCGACCCCAGGTCAG
ciliaris_RM1230                TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAGCTGYAAGGGAAGTACTCTTAAAAAGATCCCAACGCATTGTCTTGTGACGATGCTTCGACCGCGACCCCAGGTCAG
ciliaris_RM1382                TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAGCTGTAAGGGAAGYACTCTTAAAAAGATCCCAACGCATTGTCTTGTGACGATGCTTCGACAGCGACCCCAGGTCAG
heterochaeta_RM1429_1          TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAGCTGTAAGGAAAGTACTCATTAAATGACCCCAACGCATTGTCTTGTGACGATGCTTCGACCGCGACCCCAGGTCAG
heterochaeta_RM1451            TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAGCTGTAAGGAAAGTACTCATTAAATGACCCCAATGCATTGTCTTGTGACGATGCTTCGACCGCGACCCCAGGTCAG
jurineifolia_jur_SR682         TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAGCTGTAAGGGAAGTACTCATGAAAAGACCCCAATGCATTGTCTCGYGACRATG???????????????????????
jurineifolia_jur_RM1518        TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAGCTGTAAGGGAAGTACTCATGAAAAGACCCCAATGCATTGTCTCGCGACGATGTTTCGACCGCGACCCCAGGTCAG
jurineifolia_scab_CAM1604      TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAGCTGTAAGGGAAGTACTCATGAAAAGACCCCAATGCATTGTCTCGCGACAATGTTTCGACCGCGACCCCAGGTCAG
jurineifolia_scab_CAM2652      TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAGCTGTAAGGGAAGTACTCATGAAAAGACCCCAAYGCATTGTCTCGYGACRATGTTTCGACCGCGACCCCAGGTCAG
krebsiana_arctotoides_RM868    TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAG-TCAG
krebsiana_arctotoides_RM876    TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_krebsiana_RM1114     TGGT-GACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATTAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_krebisiana_RM1136    TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_serrulata_RM863      TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_serrulata_RM965      TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGCAATGGAAGTGCTCATGAAAAGAACCAAACGCGT???????????????????????????????????????
leiopoda_M240901               TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
leiopoda_RM1309                TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
lichtensteinii_CAM1916         TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAGCTGTAAGGGAAGTACTCATTAAAAGACCCCAATGCATTGTCTTGTGACGATRCTTCGACCGCGACCCCAGGTCAG
lichtensteinii_RM1249          TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAGCTGTAAGGGAAGTACTCATTAAAAGACCCCAATGCATTGTCTTGTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearis_RM1010       TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearis_SH113        TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_ovalis_NDsn           TGGTTGACAAGACCCTCTTCTGGTGTCRTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_ovalis_RM854          TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
maritima_RM1038                TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
maritima_M290606_6             TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
othonnites_RM1306              TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
pectinata_M120903              TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCGGACGATGCTTCGACCGCGACCCCAGGTCAG
pectinata_RM1044               TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
rigida_M280902                 TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
rigida_RM840                   TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
rigens_leucolaena_RM773        TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
rigens_leucolaena_RM952_1      TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
rigens_rigens_RM763            TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
rigens_rigens_SR463            TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
rigens_uniflora_JC201205       TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTYGACCGCGACCCCAGGTCAG
rigens_uniflora_RM920          TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTC-AC????????????????
schenckii                      TGGTTGACAAGACCCTCTTCCGGTGTCGTGCTAAGCTGTAAGGGAAGTACTCATTAAAAGACCCCAACGCATTGTCTTGTGACGATGCTTCGACCGCGACCCCAGGTCAG
serrata_M250904_15             TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
serrata_RM898                  TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
tenuifolia_CAM1601             TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAGCTGTAAGGGAAGTACTCATTAAAAGACCCTGACGCATTGTCTCGTGACGACGCTTCGACCGCGACCCCAGGTCAG
tenuifolia_M2730               TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAGCTGTAAGGGAAGTACTCATTAAAAGACCCTGATGCATTGTCTCGTGACGACGCTTCGACCGCGACCCCAGGTCAG
spnov_M040906_33               TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
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                                          ITS <  > ETS
[                                       670    || 680       690       700       710       720       730       740       750       760       770]

Berkheya                       GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGATACAACCCGTCCTGCATGGACATGCCAACRCACGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACGAG
Gorteria                       GCGGGACTACCCGCTGAG??TAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACGAGCCAACGCACGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACGAG
Hirpicium                      GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGATGCAACCCACCACGCATGGACATGCCAACACATGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACGAG
caespitosa_RC448               GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGATGCAACCCGCCATGCATGGACTGGCCATCGCACGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTRAACGAG
caespitosa_RVC307              GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGATGCAACCCGCCATGCATGGACTGGCCAACGCACGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACGAG
ciliaris_RM1230                GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGATGCAACCCGACATGCACGGACTTGCCAACGCACGACGAGTG-ATCGTTTTAGAGAAGCGAGAAYGCYAAACGAG
ciliaris_RM1382                GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCAGCATGCACGGACTTGCCAACGCACGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACGAG
heterochaeta_RM1429_1          ??????????????????GGTAGCATTCCTCTTCGACGCAACCCGTCACACATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACACTAAACGAG
heterochaeta_RM1451            GCG???????????????GGTAGCATTCCTCTTCGACGCAACCCGTCACACATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACACTAAACGAG
jurineifolia_jur_SR682         ??????????????????GGTAGCATTCCTCTTCGATGCAACCCGCCATGCATGGACTTGCCAACACACGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACGAG
jurineifolia_jur_RM1518        G?????????????????GGTAGCATTCCTCTTCGATGCAACCCGCCATGCATGGACTTGCCAACACACGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACGAG
jurineifolia_scab_CAM1604      GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGATGCAACCCGCCATGCATGGACTTGCCAACACACGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACGAG
jurineifolia_scab_CAM2652      GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGATGCAACCCGCCATGCATGGACTTGCCAACACACGACGAGGTGATCGTTTTAGAGAAGCGAGAACGCTAAACGAG
krebsiana_arctotoides_RM868    GCGGGACTACCCGCTGAG??TAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
krebsiana_arctotoides_RM876    GCGGGACTACCCGCTGAG?GTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGSCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
krebsiana_krebsiana_RM1114     GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCaACCCGCCACGCATGGACTAGCCaACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
krebsiana_krebisiana_RM1136    GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
krebsiana_serrulata_RM863      GCTGGACTACC????????GTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
krebsiana_serrulata_RM965      ??????????????????GGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
leiopoda_M240901               GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
leiopoda_RM1309                GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAGG
lichtensteinii_CAM1916         GCGGGACTA?????????GGTAGCATTCCTCTTCGACGCAACCCGCCACACATGGACTAGCCAACACACGACGAGTG-ATCGTTTTAGAGAAGCGAGAACACTAAACGAG
lichtensteinii_RM1249          GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACACATGGACTAGCCAACACACGACGAGTG-ATCGTTTTAGAGAAGCGAGAACACTAAACGAG
linearis_linearis_RM1010       GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
linearis_linearis_SH113        GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
linearis_ovalis_NDsn           GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
linearis_ovalis_RM854          GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
maritima_RM1038                GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
maritima_M290606_6             GCGG??????????????GGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
othonnites_RM1306              GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
pectinata_M120903              GCGGGACTACCCGCTGAG?GTAGCATTCCTCTTCGACGCAACCCGTCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
pectinata_RM1044               GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
rigida_M280902                 GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
rigida_RM840                   GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCAYGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
rigens_leucolaena_RM773        GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAATCAAG
rigens_leucolaena_RM952_1      GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAATCAAG
rigens_rigens_RM763            GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAATCAAG
rigens_rigens_SR463            GCGGGACTACCCGCTGAG?GTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
rigens_uniflora_JC201205       GCGGGACTACCCGCTGAG?GTAGCATTCCTCTTCGACGCAACCCGCCACCCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
rigens_uniflora_RM920          ??????????????????GGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAATCAAG
schenckii                      GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACACATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACACTAAACGAG
serrata_M250904_15             GCGGGACTACCCGCTGAG??????ATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
serrata_RM898                  GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
tenuifolia_CAM1601             GCGGGACTACCCGCTGAG?????????????????????????????????????????????????????????TG-ATCGTTTTAGAGAAGTGAGAACACTAAACGAG
tenuifolia_M2730               GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCACGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGTGAGAACACTAAACGAG
spnov_M040906_33               GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAGTG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAAG
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[                                       780       790       800       810       820       830       840       850       860       870       880]

Berkheya                       GGCAAAAAAGGATCGTGT-AAGACCCCATGCCCACATCAGGTTCAATATCCAAGAGACCAAGCANAACTCAGCAAGCCACATCGTCAAT--G-TTTTTACAACGACGAG-
Gorteria                       GGCAAAAAAGGATTGATT-AGGATCCCATGCCCACATCAGGTTCAGTATCCAAGAGACCAAGCAGAACTCAGCAAGCCACATCGTCGAA--G-TGATAACAAC-ACGAGA
Hirpicium                      GGCAAAAAAGGATCATGT-AAGACCCCATGCCCACATTAGGTTCAATATCCAAGAATCCAAGTGAAACTCAGCAAGCCACATCATCAAA--G-TGTTTACAATGACGAGA
caespitosa_RC448               GACATAAAAGGATCATTT-AAGACCCCATGCCCACATCAGGTTCCGTATCCAAGACACCAAGCGAAWCTCATCAAGCCACATCGTCGAA--G-TGTTTACAACGACAAGA
caespitosa_RVC307              GACATAAAAGGATCATTT-AAGACCCCATGCCCACATCAGGTTCCGTATCCAAGACACCAAGCTAATCTCAGCAAGCCACATCGTCGAA--G-TGATTACAACGACAAGA
ciliaris_RM1230                GACRTAAAAGGATCATTTTRAGACCCCATGCCCACATCAGGTTCCGTATCCAAGACAACAAGCGAAACTCAGCAAGCCACATCGTCGAAGTGCTTTACACAACGAYAAGA
ciliaris_RM1382                GACGTAAAAGGATCATTTTGAGACCCCATGCCCACATCAGGTTCCGTATCCAAGACAACAAGCGAAACTCAGCAAGCCACATCGTCGAAGTC-TTTACACAACGATAAGA
heterochaeta_RM1429_1          GACATAAAAAGATCATCT-AAGACCCCATGCCCACATCAGGTTCCGTATCCAAGACACCAAGCAAAACTCAGCAAGCCACATCAACGAA--G-TGTTTACAACGACAAGA
heterochaeta_RM1451            GACATAAAAAGATCATCT-AAGACCCCATGCCCACATCAGGTTCCGTATCCAAGACACCAAGCAAAACTCAGCAAGCCACATCAACGAA--G-TGTTTACAACGACAAGA
jurineifolia_jur_SR682         GGCATAAAAGGATCATGT-AAGACCCTATGCCCACATCAGGTTCCGTATCCAAGACACCAAGCGAAACTCAGCAAGCCATATCGTCGTA--G-TGTTTACAACRACAAGA
jurineifolia_jur_RM1518        GGCATAAAAGGATCATGT-AAGACCCCATGCCCACATCAGGTTCCGTATCCAAGACACCAAGCGAAACTCAGCAAGCCATATCGTCGTA--G-TGTTTACAACGACAAGA
jurineifolia_scab_CAM1604      GGCATAAAAGGATCATGT-AAGACCCTATGCCCACATCAGGTTCCGTATCCAAGACACCAAGCGAAACTCAGCAAGCCATATCGTCGTA--G-TGTTTACAACAACAAGA
jurineifolia_scab_CAM2652      GGCATAAAAGGATCATGT-AAGACCCYATGCCCACATCAGGTTCCGTATCCAAGACACCAAGCGAAACTCAGCAAGCCATATCGTCGTA--G-TGTTTACAACRACAAGA
krebsiana_arctotoides_RM868    GACATAAAAAGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
krebsiana_arctotoides_RM876    GACATAAAAAGATCATYT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
krebsiana_krebsiana_RM1114     GACATAAAAAGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
krebsiana_krebisiana_RM1136    GACATAAAAAGATCATYT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
krebsiana_serrulata_RM863      GACATAAAAAGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
krebsiana_serrulata_RM965      GACATAAAAAGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTYAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
leiopoda_M240901               GACATAAAAAGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
leiopoda_RM1309                GACATAAAAAGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
lichtensteinii_CAM1916         GACATAAAAAGATCATCT-AAGACCCCATGCCCACATCAGGTTCCGTATCCAAGACACCAAGCGAAACTCAACAAGCCACATCGACGAA--G-TGTTTACAACGACRAAA
lichtensteinii_RM1249          GACATAAAAAGATCATCT-AAGACCCCATGCCCACATCAGGTTCTGTATCCAAGACACCAAGCGAAACTCAACAAGCCACATCGACGAA--G-TGTTTACAACGACAAAA
linearis_linearis_RM1010       GACATAAAAAGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
linearis_linearis_SH113        GACATAAAAAGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
linearis_ovalis_NDsn           GACATAAAAAGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
linearis_ovalis_RM854          GACATAAAAAGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
maritima_RM1038                GACATAAAAAGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
maritima_M290606_6             GACATAAAAAGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
othonnites_RM1306              GACATAAAAAGATCATCT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
pectinata_M120903              GACATAAAAAGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCAAT--G-TGTACACAACGACAAGA
pectinata_RM1044               GACATAAAAAGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
rigida_M280902                 GACATAAAAAGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
rigida_RM840                   GACATAAAAAGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
rigens_leucolaena_RM773        GACATAAAAAGATCATGT-AAGACCC-ATGACCAAATTAGGTTCAATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAA-TG-TATACACAACAACAAGA
rigens_leucolaena_RM952_1      GACATAAAAAGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
rigens_rigens_RM763            GACATAAAAAGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
rigens_rigens_SR463            GACATAAAAGGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
rigens_uniflora_JC201205       GACATAAAAAGATCATCT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGACGAT--G-TGTACACAACGACAAGA
rigens_uniflora_RM920          GACATAAAAAGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
schenckii                      GACATTAAAGGATCATCT-AAGACCACATGCCCACATCAGGTTCCGTATCCAAGACACCAAGCGAAACTCAACAAGCCACATCGACGAA--G-TGTTTACAACGACGAAA
serrata_M250904_15             GACATAAAAAGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
serrata_RM898                  GACATAAAAAGATCATTT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
tenuifolia_CAM1601             GACATAAAAGGATCATTT-AAGACCCCATGCCCACATCAGGTTCCATATCCRAGACACCAAGCGAAACTCAGCAAGCCACATTGCCGAA--G-TGTTTACAAGGACGAGA
tenuifolia_M2730               GACATAAAAGGATCATTT-AAGACCCCATGCCCACATCAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATTGCCGAA--G-TGTTTACAACGACAAGA
spnov_M040906_33               GACATAAAAAGATCATCT-AAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT--G-TGTACACAACGACAAGA
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[                                        890       900       910       920       930       940       950       960       970       980       990]

Berkheya                       TGGATTACAGAGACCACTTCCTGGTTCGTCACACACCACAAGTGTGATGCACGACGAAACTGGCTTCGATCGGTCCAYGCAATGCCTTCGATTAGGTATGCAACACAGGA
Gorteria                       TGGATTACAAAGACCACTTCCTAGTCCGTCACACACCACAATTGTGATGCATGGCGAAAACGGCTTCGATCGGTCCAAACAATGCCTTCGATTAGGTACGCAACACAGGA
Hirpicium                      TGGATTACAGAGAACTCTTTCTGGTCCGTCACACACCACAAGTGCGATGCATGACGAAAACAGCTTATATCGATCCATACAATGCCTTTGTTTAGGTACGCAACACAGGA
caespitosa_RC448               TGGATTACAGAGAACGCTTACTGGTCCGTCATGCACCACATGTGCGATGCGTGACGGAAACAGATTCAATCGGTCCATACAATGCCTTCGATTASGTACGCAACACAGGA
caespitosa_RVC307              TGGATTACAGAGACCGCTTACTGGTCCGTCATGCACCACATGTGCGATGCGTGACGGATACAGATTCAATCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGGA
ciliaris_RM1230                TGGATTACAGAGAACGCTTACTGGTCCGTCATGCACCACATGTGCGATGCGTGACTGAAACAGATTCAATCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGGA
ciliaris_RM1382                TGGATTACAGAGAACGCTTACTGGTCCGTCATGCACCAAATGTGCGATGCGTGAAGGAAACAGATTCAATCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGGA
heterochaeta_RM1429_1          TGGCTTACAGAGACCACTTACTGGTCCGTCATGCACCACA-GTGCGATGCGTGACAAAAACAGATTCAATCGGTCCATACAATGCCTTTGATTAGGAACGCAACACAGGA
heterochaeta_RM1451            TGGCTTACAGAGACCACTTACTGGTCCGTCATGCACCACA-GTGCGATGCGTGACAAAAACAGATTCAATCGGTCCATACAATGCCTTTGATTAGGAACGCAACACAGGA
jurineifolia_jur_SR682         TGGATTACAGAGACCACTAGCTGGTCCGTCATGCACCACAAGTGCGATGCGTGACGGAAACAGATTCAATCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGAA
jurineifolia_jur_RM1518        TGGATTACAGAGACCACTTGCTGGTCCGTCATGCACCACAAGTGCGATGCGTGACGGAAACAGATTCAATCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGAA
jurineifolia_scab_CAM1604      TGGATTACAGAGACCACTTGCTGGTCCGTCATGCACCACAAGTGCGATGCGTGACGGAAACARATTCARTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGAA
jurineifolia_scab_CAM2652      TGGATTACAGAGACCACTTGCTGGTCCGTCATGCACCACAAGTGCGATGCGTGACGGAAACAGATTCAATCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGAA
krebsiana_arctotoides_RM868    TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsiana_arctotoides_RM876    TGGATTACTAAGACCACTTACCGGKCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsiana_krebsiana_RM1114     TGGATTACTAAGAACACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsiana_krebisiana_RM1136    TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsiana_serrulata_RM863      TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsiana_serrulata_RM965      TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGYGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
leiopoda_M240901               TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
leiopoda_RM1309                TGGATTACTGAgACCACTTACCGGTCCATCATGCAGCACATGTGCGATGCATGACGGAAACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGYA
lichtensteinii_CAM1916         TGGCTTACAGAGACCACTTACTGGTCCGTCATGCACCACAAGTGCGATGCGTGACGGAAACAGATTCAATCGGTCCATACAATGCCTTTGATTAGGTACGCAACACAGGA
lichtensteinii_RM1249          TGGCTTACAGAGACCACTTACTGGTCCGTCATGCACCACAAGTGCGATGCGTGACGGAAACAGATTCAATCGGTCCATACAATGCCTTTGATTAGGTACGCAACACAGGA
linearis_linearis_RM1010       TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
linearis_linearis_SH113        TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
linearis_ovalis_NDsn           TGGATTACTAAGACCACTTACCGGKCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
linearis_ovalis_RM854          TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
maritima_RM1038                TGGATTACTGAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
maritima_M290606_6             TGGATTACTGAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
othonnites_RM1306              TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
pectinata_M120903              TGGATTACAGAGACCACTTACCGGTCCWGCATGCACCACKTGTGCGATGAATGACGGATACACATTCAGTCGGTCCATACAATGCCTTCAATTAGGTACTCAACACAGTA
pectinata_RM1044               TGGATTACTGAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigida_M280902                 TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigida_RM840                   TGGATTACTGAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigens_leucolaena_RM773        TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigens_leucolaena_RM952_1      TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigens_rigens_RM763            TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigens_rigens_SR463            TGGATTACTAAGARCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCRTTCGGTCCATRCAATGCCTTCGATTAGGTACACAACACAGTA
rigens_uniflora_JC201205       TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigens_uniflora_RM920          TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
schenckii                      TGGCTTACAGAGACCACTTACTGGTCCGTCATGCACCACAAGTGCGATGCGTGACGGAAACAGATTCAATCGGTCCATACAATGCCTTTGATTAGGTACGCAACACAGGA
serrata_M250904_15             TGGATTACTAAGACCACTTACTGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
serrata_RM898                  TGGATTACTGAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCRATTAGGTACGCAACACAGTA
tenuifolia_CAM1601             TGGATTACGGAGACCACTTACTGGTCCGTCTTGCACCACAAGTGCGATGCGTGACGGAAAAAGATTCAATCAGT-CATACAATGCCCTTGATTAGGTACGCAACACAGGA
tenuifolia_M2730               TGGATTACGGAGACCACTTACTGGTCCGTCATGCACCACAAGTGCGATGCGTGACGGAAAAAGATTCAATCTGT-CATACAATGCCCTCGATTAGGTACGCAACACAGGA
spnov_M040906_33               TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
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[                                       1000      1010      1020      1030      1040      1050      1060      1070      1080      1090      1100]

Berkheya                       AACCCGCAATACGAGCAAGAC-AAAACAAGCCTTGCTACATAAATGAAGAGGTAAGTACGCGTAGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
Gorteria                       AACCCCCAATACGAGCAAGAC-AAAACAAGTCTTGCCACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
Hirpicium                      AACCCACAATATGAGCAAGAC--AAACAAGCCTTGCTGCATAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
caespitosa_RC448               AACCCACAATACGAGCAAGTCTAAAACAAGACTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
caespitosa_RVC307              AACCCACAATACGAGCAAGTCTAAAACAAGACTTGCTACGTAAATGAAGAGGTAAGCACGCGTGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
ciliaris_RM1230                AACCCACAATACgAGCAAGTCTAAAAGAAGACTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
ciliaris_RM1382                AACCCACAATACGAGCAAGTCTAAAAGAAGACTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
heterochaeta_RM1429_1          AACCCACAAAACGAGCAAGTCTACAACAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
heterochaeta_RM1451            AACCCACAAAACGAGCAAGTCTACAACAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
jurineifolia_jur_SR682         AACCCACAATACGAGCAAGTCTAAAACAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
jurineifolia_jur_RM1518        AACCCACAATACGAGCAAGTCTAAAACAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
jurineifolia_scab_CAM1604      AACCCACAATACGAGCAAGTCTAAAACAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
jurineifolia_scab_CAM2652      AACCCACAATACGAGCAAGTCTAAAACAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_arctotoides_RM868    AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_arctotoides_RM876    AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_krebsiana_RM1114     AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_krebisiana_RM1136    AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_serrulata_RM863      AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_serrulata_RM965      AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
leiopoda_M240901               AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
leiopoda_RM1309                AACCCGCAATACGAGCAACACTAAAATAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
lichtensteinii_CAM1916         AACCCACAATACGAGCAAGTCTACAACAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
lichtensteinii_RM1249          AACCCACAATACGAGCAAGTCTACAACAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_linearis_RM1010       AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_linearis_SH113        AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGAC?????????????????????????
linearis_ovalis_NDsn           AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_ovalis_RM854          AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
maritima_RM1038                AACCCATAATACGAGCAACACTAAAATAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
maritima_M290606_6             AACCCACAATACGAGCAACACTAAAATAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
othonnites_RM1306              AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
pectinata_M120903              AACCCTCAATACGAGCATCACTAAATCAAGCCTTGCTACGTGAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
pectinata_RM1044               AACCCACAATACGAGCAACACTAAAATAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigida_M280902                 AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigida_RM840                   AACCCACAATACGAGCAACACTAAAATAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCACTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigens_leucolaena_RM773        AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigens_leucolaena_RM952_1      AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigens_rigens_RM763            AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigens_rigens_SR463            AACCCACAATACGAGCAAGACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigens_uniflora_JC201205       AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigens_uniflora_RM920          AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
schenckii                      AACCCACAATACGAGCAAGTCTACAACAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAAYAAACCAAA
serrata_M250904_15             AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
serrata_RM898                  AACCCACAATACGAGCAACACTAAAATAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
tenuifolia_CAM1601             AACCCACAATACGAGCAAGTCTATAACAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCAAGAAGACATCCAACCACCCGTAACAAACCAAA
tenuifolia_M2730               AACCCACAATACGAGCAAGTCTATAACAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCAAGAAGACATCCAACCACCCGTAACAAACCAAA
spnov_M040906_33               AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
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[                                       1110      1120      1130      1140      1150      1160      1170      1180      1190      1200      1210]

Berkheya                       CACCACTCATGCACCTTTACGGAAAACACTTCCCGAAACCACCCGACTAGTAGCCACCCGCCTAGCACAAACGG-CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAGAA
Gorteria                       CACCACTCATGCACCTTTACGGTAAACACTCCCCGAAACCACCCGACTAGTAGCCACCCGCATGGTACAA-TGACCAAGCAAGCAACCAAAAGCCAAGGCAATCCCAAAA
Hirpicium                      CACCACTCATGCACCTTTACGGTAAACATTTCCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAAAG-CCAAGCAAGCAACCAAAAGCCAAAGTAATCCCAAAA
caespitosa_RC448               CACCACTCATGCACCTTTACGGTAAACATTTCCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAAGG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
caespitosa_RVC307              CACCACTCATGCACCTTTACGGTAAACATTTCCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAAGG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
ciliaris_RM1230                CACCACTCATGCACCTTTACGGTAgACATTTCCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAAGG--CAAGCAAGCAACCaAAAGCCAAAGCAATCCCAAAA
ciliaris_RM1382                CACCACTCATGCACCTTTACGGTAAACATTTCCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
heterochaeta_RM1429_1          CACCACTCATGCACCTTTACGGTAAACATTCCCCGAAACCACCCGACTAGTAGCCACCCACTTAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
heterochaeta_RM1451            CACCACTCATGCACCTTTACGGTAAACATTCCCCGAAACCACCCGACTAGTAGCCACCCACTTAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
jurineifolia_jur_SR682         CACCACTCATGCACCTTTACGGTAAACATTTCCCGAAACCACCCGACTAGTAGCCACCCACRTAGCACAAAAGGCCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
jurineifolia_jur_RM1518        CACCACTCATGCACCTTTACGGTAAACATTTCCCAAAACCACCCGACTAGTAGCCACCCACATAGCACAAAAGGCCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
jurineifolia_scab_CAM1604      CACCACTCATGCACCTTTACGGTAAACATTTCCCGAAACCACCCGACTAGTAGCCACCCACGTAGCACAAAAGGCCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
jurineifolia_scab_CAM2652      CACCACTCATGCACCTTTACGGTAAACATTTCCCGAAACCACCCGACTAGTAGCCACCCACRTAGCACAAAAGGCCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_arctotoides_RM868    CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_arctotoides_RM876    CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_krebsiana_RM1114     CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAaCCAAAAGCCAAAGCAATCCCAAAA
krebsiana_krebisiana_RM1136    CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_serrulata_RM863      CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_serrulata_RM965      CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
leiopoda_M240901               CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
leiopoda_RM1309                CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAaTCCCAAAA
lichtensteinii_CAM1916         CACCACTCATGCACCTTTACGGTAAACATTCCCCGAAACCACCCGACTAGTAGCCACCCACTTRRCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
lichtensteinii_RM1249          CACCACTCATGCACCTTTACGGTAAACATTCCCCGAAACCACCCGACTAGTAGCCACCCACTTAACACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearis_RM1010       CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearis_SH113        ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
linearis_ovalis_NDsn           CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_ovalis_RM854          CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
maritima_RM1038                CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
maritima_M290606_6             CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
othonnites_RM1306              CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
pectinata_M120903              CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACGAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
pectinata_RM1044               CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigida_M280902                 CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigida_RM840                   CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGC????????????????
rigens_leucolaena_RM773        CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCAAAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigens_leucolaena_RM952_1      CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCAAAAATG--CAAGCAAGCAACCAAAA??????????????????
rigens_rigens_RM763            CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCAAAAATG--CAAGCAAGCAACCA?????????????????????
rigens_rigens_SR463            CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCTATCCCAAAA
rigens_uniflora_JC201205       CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigens_uniflora_RM920          CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCAAAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
schenckii                      CACCACTCATGCACCTTTACGGTAAACATTCCCCGAAACCACCCGACTAGTAGCCACCCACTTAACACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
serrata_M250904_15             CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--cAAGCAAGCAACCAAA???????????????????
serrata_RM898                  CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
tenuifolia_CAM1601             CACCACTCATGCACCTTTACGGTAAACATTTCCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAGAGCGATCCCAAAA
tenuifolia_M2730               CACCACTCATGCACCTTTACGGTAAACATTTCCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAGAGCAATCCCAAAA
spnov_M040906_33               CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAATG--CAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
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[                                       1220      1230      1240      1250      1260      1270      1280      1290      1300      1310      1320]

Berkheya                       ATGCACCGAACGATGCGAGAAACAAT-AAGCTACGAAACCAA-CATG-ATTGCCTCATCAAGACGCTCGTTTCATTATTTTCT-TCACACAACGCATCGCTAGCC-AGGC
Gorteria                       ATGAACCGCACGATGCGAGAAACACAAAAGCTACCGAACCAA-CATGATTTGCTCATAAAAAACGCTCGCTTCATGATATTCT-ATGCACAACGCATCGCTAGCC-GGGC
Hirpicium                      ATGCACCGAACGATGCGAGAAACAATTAAGCTACGAAACCGA-CA---ATTGCTTCGTCAAAACGCTCGCATTATGGTTTTCT-ACGCACAACGCATCGCTAGCC-GGGC
caespitosa_RC448               ATGCACCGAACGATGCGAGAAAGAGTAAAGCTACGAAACCAA-CATG-ATCGCCTCATCAAAACGCTCGCTTCATGATTTCTA-ACA???????????????????????
caespitosa_RVC307              ATGCACCGAACGATGCGAGAAAYAATAAAGCTACGAAACCGA-CATG-ATCGCCTCATCAAAACGCTCGCTTGATGATTTTCT-AGACACGACGCATCGCTAGCC-AGGC
ciliaris_RM1230                ATGCACCGAACGATGCGAGAAACCATAAAGCTACGAAACCGTTCGCGAATCGCCTCATCAAAACGCTCGCTTCATGATTTTCTTAGACACCACGCATCGCTAGCC-GAGC
ciliaris_RM1382                ATGCACCGAACGATGCGAGAAACAATAAAGCTACGAAACCRTTCACGAATCGCCTCATCAAAACGCTCGCTTCATGATTTTCTTAGACACCACGCATCGCTAGCC-GAGC
heterochaeta_RM1429_1          ATGCACCGAACGACGCGAGAAACAATTAAGCTACGAAACCGA-CACG-ATCGCCTCATCAAAACGCTCGCTTCATGATTTTCT-ACACACAACGCATCGCTAGACTRGGC
heterochaeta_RM1451            ATGCACCGAACGACGCGAGAAACAATTAAGCTACGAAACCGA-CACG-ATCGCCTCATCAAAACGCTCGCTTCATGATTTTCT-ACACACAACGCATCGCTAGACTAGGC
jurineifolia_jur_SR682         ATGCACCGAACGATGCGAGAAACAATAAAGCTACGAAACCAA-CATG-ATCGCCTCATTAAAACGCTCGCTTCATGATTTTCT-ACGCACAACGTATCGCTAGCC-GGGC
jurineifolia_jur_RM1518        ATGCACCGAACGATGCGAGAAACAATAAAGCAACGAAACCAA-CATG-ATCGCCTCATTAAAACGCTCGCTTCATGATTTTCT-ACGCACAACGTAACGCTAGCC-GGGC
jurineifolia_scab_CAM1604      ATGCACCGAACGATGCGAGAAACAATAAAGCTACGAAACCAA-CATG-ATCGCCTCATTAAAACGCTCGCTTCATGATTTTCT-ACGCACAACGTATCGCTAGCC-GGGC
jurineifolia_scab_CAM2652      ATGCACCGAACGATGCGAGAAACAATAAAGCTACGAAACCAA-CATG-ATCGCCTCATTAAAACGCTCGCTTCATGATTTTCT-ACGCACAACGTATCGCTAGCC-GGGC
krebsiana_arctotoides_RM868    ATGTACCGAGCGATGCGAGAAACAGTAAAGCTACGAAACCAA-CAGG-ATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-ACACACAACGCATCGCTAGCA-AGGC
krebsiana_arctotoides_RM876    ATGTACCGARCGATGCGAGAAACAGTAAAGCTACGAAACCAA-CAGG-ATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-ACACACAACGCATCGCTAGCA-AGGC
krebsiana_krebsiana_RM1114     ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAA-CACG-ATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-ACGCACAACGCATCGCTAGCA-AGGC
krebsiana_krebisiana_RM1136    ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAA-CAGG-ATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-ACACACAACGCATCGCTAGCA-AGGC
krebsiana_serrulata_RM863      ATGTACCGAGCGATGCGAGAAACAGTAAAGCTACGAAACCAA-CAGG-ATCGCCTCATACAAAYGCTCGCTTCATTATTTCCA-ACACACAACGCATCGCTAGCA-AGGC
krebsiana_serrulata_RM965      ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAA-CAGG-ATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-ACACACAACGCATCGCTAGCA-AGGC
leiopoda_M240901               ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAA-CAGG-ATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-ACACACAACGCATCGCTAGCA-AGGC
leiopoda_RM1309                aTGCACCGAACGATGCGAGAAACAGTAaCGCTACGAAacCAA-CACG-ATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A?????????????????????????
lichtensteinii_CAM1916         ATGAACCGAACGATGCGAGAAACAATAAAGCTACGAAACCGA-CACG-ATCGCCTCATCAAAACGCTCGCTTCATGCTTTTCT-ACACACAACGCATCGCAAGACTAGGC
lichtensteinii_RM1249          ATGAACCGAACGATGCGAGAAACAATAAAGCTACGAAACCGA-CACG-ATCGCCTCATCAAAACGCTCGCTTCATGCTTTTCT-ACACACAACGCATCGCAAGACTAGGC
linearis_linearis_RM1010       ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAA-CACG-ATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-ACACACAACGCATCGCTAGCA-AGGC
linearis_linearis_SH113        ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
linearis_ovalis_NDsn           ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAA-CACG-ATCGCCTCATACTAACGCTCGCTTCATTATTTCCA-ACACACAACGCATCGCTAGCA-AGGC
linearis_ovalis_RM854          ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAA-CAGG-ATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-ACACACAACGCATCGCTAGCA-AGGC
maritima_RM1038                ATGCACCGAACGATGCGAGAAACAGAAAAGCTACGAAACCAA-CACG-ATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-ACACACAACGCATCGCTAGCA-AGGC
maritima_M290606_6             ATGCACCGAACGATGCGAGAAACAGAAAAGCTACGAAACCAA-CACG-ATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-ACACACAACGCATCGCTAGCA-AGGC
othonnites_RM1306              ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAA-CAGG-ATCGCCTCATACAAACACTCGCTTCATTATTTCCA-ACACACAACGCATCGCTAGCA-AGGC
pectinata_M120903              ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAA-CACG-ATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-ACACACAACGCATCGCTAGCA-AGGC
pectinata_RM1044               ATGCACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAA-CACG-ATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-ACACACAACGCATCGCTAGCA-AGGC
rigida_M280902                 ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAA-CCGG-ATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-ACACACAACGCATC????????????
rigida_RM840                   ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
rigens_leucolaena_RM773        ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAA-CAGG-ATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-ACACACAACGCATCGCTAGCA-AGGC
rigens_leucolaena_RM952_1      ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
rigens_rigens_RM763            ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
rigens_rigens_SR463            ATGTACCGAACGATGCGAGAAACAGTAAGGCTACGAAACCAA-CACG-ATCGCCTCATACAAACGCTCGCTTCATGATTTCCA-ACACACAACGCATCGCTAGCA-AGGC
rigens_uniflora_JC201205       ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAA-CAGG-ATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-ACACACAACGCATCGCTAGCA-AGGC
rigens_uniflora_RM920          ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAA-CAGG-ATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-ACACACAACGCATCGCTAGCA-AGGC
schenckii                      ATGAACCGAACGATGCGAGAAACAATAAAGCTACGAAACCGA-CACG-ATCGCCTCATCAAAACGCTCGCTTCATGATTTTCT-ACACACAACGCATCGCAAGACAAGGC
serrata_M250904_15             ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
serrata_RM898                  ATGCACCGAACGATGCGAGAAACAGAAAAGCTACGAAACCAA-CACG-ATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-ACACACAACGCATCGCTAGCA-AGGC
tenuifolia_CAM1601             ATGCACCGAACGATGCGAGAAACAATTAAGCTACG???????????????????????????????????????????????????????????????????????????
tenuifolia_M2730               ATGCACCGAACGATGCGAGAAACAACTAAGCTACGAAACCGA-CACG-ATCGCCTCATCAAAACGCTCGCTTCATGGTTTTCC-ACACACAACGCATCACAAGCC-AGGC
spnov_M040906_33               ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAA-CAGG-ATCGCCTCATACAAACACTCGCTTCATTATTTCCA-ACACACAACGCATCGCTAGCA-AGGC
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[                                    1330      1340      1350      1360      1370      1380      1390      1400      1410      1420      1430]

Berkheya                       TTGTGCCAACACGTCGTGTTTAGAAAAAAA-TCAACTTGCCACCCTCCGTGGTGTTGCGAAGCGACAATACCACATCCTCGA????????????????????????????
Gorteria                       TTGTGCCAACACGTCATGCATCGAAATCAAATCAGCTTGCCACCCTCCGTGGTGTTGCGAAGCAACATCACCACATCCTCGAGTATGCACCGTTCACAAAAT-GCCT???
Hirpicium                      TTGTGCCAACACGTCATGGTTCAAAAACAAATCAGCTTGCTACCCTCCRTGGAAATGCGAAGCTACATTWCCACATCCTCGGATACACACCGTTGACGACAA--CCTTGC
caespitosa_RC448               ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
caespitosa_RVC307              TAGTGCCAACACGTCATGCTTCGAAAACAAATCAGCTTGCCACCCTCCATGGTGTTGCGAAGCGACATCACCAGATCCTCGG????????????????????????????
ciliaris_RM1230                TTGTGCGAACACGTCATGCTTCGAAAACAAATCAGCTTGCCACCCTCCATGGTGTTGCGAAGCGACATCACCAGATCCTCGGGTACGCACCGTTCACTACGTCGCCTTGT
ciliaris_RM1382                TTGKGCGAACACGTCATGCTTCGAAAACAAATCAGCTTGCCACCCTCCATGGTGTTGCGAAGCGACATCACCAGATCCTCGGGTACGCACCGTTCACTACGTCGCCTTGT
heterochaeta_RM1429_1          T--TGCAAACACGTCATGCATCGAAAACAAATCAGCTTGCCACCCTCCATGGTGTTGCGAAGCGACAACACCACATCATTGG---CACACCGTTAACTACGTCGCCTTGA
heterochaeta_RM1451            T--TGCAAACACGTCATGCATCGAAAACAAATCAGCTTGCCACCCTCCATGGTGTTGCGAAGCGACAACACCACATCATTGG---CACACCGTTAACTACGTCGCCTTGT
jurineifolia_jur_SR682         TAGTGCCAACACGTCATGCGTCGAAAACTAATCAGCTTGCCACCCTCAATGGTGTTGCGAAGCGACATCACCACATCCTCGGGTACGCACCGTTCACTACGTCGCCTTG?
jurineifolia_jur_RM1518        TAGTGCCAACACGTCATGCTTCGAAAAATAATCAGCTTGCCACCCTCAATGGTGTTGCGAAGCGACATCACCACATCCTCGGGTACGCACCGTTCACTAC??????????
jurineifolia_scab_CAM1604      TAGTGCCAACACGTCATGCGTCGAAAACTAATCAGCTTGCCACCCTCAATGGTGTTGCGAAGCGACATCACCACATCCTCGGGTACGCACCGTTCACTACGTCGCCTTGT
jurineifolia_scab_CAM2652      TAGTGCCAACACGTCATGCGTCGAAAACTAATCAGCTTGCCACCCTCAATGGTGTTGCGAAGCGACATCACCACATCCTCGG-TACGCAC????????????????????
krebsiana_arctotoides_RM868    TAGTGCCAACACGTCGTGGTTTGAAAACAAATCAGCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTTGT
krebsiana_arctotoides_RM876    TAGTGCCAACACGTCGTGGTTTGAAAACAAATCAGCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTTGT
krebsiana_krebsiana_RM1114     TAGTGCCAACACGTCGTGGTTTGAAAACAAATCAGCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTTGT
krebsiana_krebisiana_RM1136    TAGTGCCAACACGTCGTGGTTTGAAAAC??????????????????????????????????????????????????????????????????????????????????
krebsiana_serrulata_RM863      TAGTGCCAACAYGTCGTGGTTTGAAAACAAATCAGCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTTGT
krebsiana_serrulata_RM965      TAGTGCCAACACGTCRTGGTTTGAAAACAAATCAGCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTTGT
leiopoda_M240901               TAGTGCCAACACGTCGTGGTTTGAAAACAAATCAGCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTTGT
leiopoda_RM1309                ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
lichtensteinii_CAM1916         T--TGCGAACACGTCATGCATCGAAAAGTAATCAGCTTGCCATCCTCCATGGTGTTGCGAAGCGACAACACCACATCATCGG????????????????????????????
lichtensteinii_RM1249          T--TGCGAACACGTCATGCATCGAAAAGTAATCAGCTTGCCATCCTCCATGGTGTTGCGAAGCGACAACACCACATCATCG---TAAAACCGTTAACTA???????????
linearis_linearis_RM1010       TAGTGCCAACACGTCGTGCTTTGAAAACAAATCAGCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTTGT
linearis_linearis_SH113        ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
linearis_ovalis_NDsn           TAGTGCCAACACGTCGTGGTTTGAAAACAAATCAGCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTTGT
linearis_ovalis_RM854          TAGTGCCAACACGTCGTGGTTTGAAAACAAATCAGCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTTGT
maritima_RM1038                TAGTGCCAACACGTCGTGCTTTGAAAACAAATCAGCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTTGT
maritima_M290606_6             TAGTGCCAACACGTCGTGCTTTGAAAACAAATCAGCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTTGT
othonnites_RM1306              TAGTGCCAACACGTCGTGGTTTGAAAACAAATCAGCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCAG----TCACCGTTCACTACGTCGCCTTGT
pectinata_M120903              TAGTGCCAACACGTCGTGGTTTGAAAACAAATCAGCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT??
pectinata_RM1044               TAGTGGCAACACGTCGTGCTTTAAAAACAAATCAGCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTTGT
rigida_M280902                 ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
rigida_RM840                   ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
rigens_leucolaena_RM773        TAGTGCCAACACGTCGTGCTTTGAAAACAAATCAGCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTTGT
rigens_leucolaena_RM952_1      ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
rigens_rigens_RM763            ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
rigens_rigens_SR463            TAGTGCCACCACGTCGTGG???????????????????????????????????????????????????????????????????????????????????????????
rigens_uniflora_JC201205       TAGTGCCAACACGTCGTGGTTTGAAAACAAATCAGCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT??
rigens_uniflora_RM920          TAGTGCCAACACGTCGTGCTTTGAAAACAAATCAGCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTTGT
schenckii                      T--TGCGAACACGTCATGCATCGAAAACCAATCAGCTTGCCACCCTCCATGGTGTTGCGAAGCGACAACACCACATCATCGGGTACAAACCGWTAACTACGTCGCCTTGT
serrata_M250904_15             ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
serrata_RM898                  TAGTGCCAACACGTCGTGCTTTGAAAAC??????????????????????????????????????????????????????????????????????????????????
tenuifolia_CAM1601             ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
tenuifolia_M2730               TTGTGCCAACACGTCATGCATCGAAAACAAATCAGCTTGCCACCCTCCATGGTGATGCGAAGCGACATCACCACATCATCGGGTACGCACCGTTCACTACGTCGCCTCGT
spnov_M040906_33               TAGTGCCAACACGTCGTGGTTTGAAAACAAATCAGCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCAG----TCACCGTTCACTACGTCGCCTTGT
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[                                       1440]

Berkheya                       ???????????
Gorteria                       ???????????
Hirpicium                      CCATCAGCTGG
caespitosa_RC448               ???????????
caespitosa_RVC307              ???????????
ciliaris_RM1230                CCATCAGCTGG
ciliaris_RM1382                CCATCAGCTGG
heterochaeta_RM1429_1          CCATCAGCTGG
heterochaeta_RM1451            CCATCAGCTGG
jurineifolia_jur_SR682         ???????????
jurineifolia_jur_RM1518        ???????????
jurineifolia_scab_CAM1604      CCATCAGCTGG
jurineifolia_scab_CAM2652      ???????????
krebsiana_arctotoides_RM868    CCATCAGCTGG
krebsiana_arctotoides_RM876    CCATCAGCTGG
krebsiana_krebsiana_RM1114     CCATCAGCTGG
krebsiana_krebisiana_RM1136    ???????????
krebsiana_serrulata_RM863      CCATCAGCTGG
krebsiana_serrulata_RM965      CCATCAGCTGG
leiopoda_M240901               CCATCAGCTGG
leiopoda_RM1309                ???????????
lichtensteinii_CAM1916         ???????????
lichtensteinii_RM1249          ???????????
linearis_linearis_RM1010       CCATCAGCTGG
linearis_linearis_SH113        ???????????
linearis_ovalis_NDsn           CCATCAGCTGG
linearis_ovalis_RM854          CCATCAGCTGG
maritima_RM1038                CC?????????
maritima_M290606_6             CCATCAGCTGG
othonnites_RM1306              CCATCAGCTG?
pectinata_M120903              ???????????
pectinata_RM1044               CCATCAGCTGG
rigida_M280902                 ???????????
rigida_RM840                   ???????????
rigens_leucolaena_RM773        CCATCAGCTGG
rigens_leucolaena_RM952_1      ???????????
rigens_rigens_RM763            ???????????
rigens_rigens_SR463            ???????????
rigens_uniflora_JC201205       ???????????
rigens_uniflora_RM920          CCATCAGCTGG
schenckii                      AAATCAGCTGT
serrata_M250904_15             ???????????
serrata_RM898                  ???????????
tenuifolia_CAM1601             ???????????
tenuifolia_M2730               CCATCAGCTGG
spnov_M040906_33               CCATCAGCTGG
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[                                     10        20        30        40        50        60        70        80        90        100       110]

Berkheya                        ATTCTTACATCCACCATTTTATATAGGAATGAAGGTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCCT-CTTTTTT-ATTAGGTTGTAATGT-----A
Gorteria                        ATTCTTAGATCCACCATTTTATATAGGAATGAAGGTGCT-CTTAGCTCGACGTCGTTTGTTCTATTCTACTAGAAGCCTT-CTTTTTTTATTGGGTTGTAATGT-----A
Hirpicium                       ATTCTTACATCCACCATTTTATATAGGAATGAAGGTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-TTTTTTT-ATTGGGTTGTAATGT-----A
caespitosa_RVC448               ????????ATCCACCATTTTATATAGGAATGAAGGTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-CTTTTTTTATTGGGTTGTAATGTAATGTA
caespitosa_RVC307               ATTCTTACATCCACCATTTTATATAGGAATGAAGGTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTTATTTTTTTTATTGGGTTGTAATGTAATGTA
ciliaris_RM1230                 ATTCTTACATCCACCATTTTATATAGGAATGAAGGTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-CTTTTTTTATTGGGTTGTAATGT-----A
ciliaris_RM1382                 ATTCTTACATCCACCATTTTATATAGGAATGAAGGTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-CTTTTTTTATTGGGTTGTAATGTAATGTA
heterochaeta_RM1429             ATTCTTACATCCACCATTTTATATAGGAATGAAGGTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-CTTTTTTTATTGGGTTGTAATGT-----A
heterochaeta_RM1451             ATTCTTACATCCACCATTTTATATAGGAATGAAGGTGCT-CTTGGCTCGACATCGTTTGTTCTATTCTACTAGAACCCTTCTTTTTTT-ATTGGGTTGTAATGT-----A
jurineifolia_jur_SR682          ???????????????ATTTTATATAGGAATGAAGGTGCTCCTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-CTTTTTT-ATTGGGTTGTAATGT-----A
jurineifoliajur_RM1518          ???????????????ATTTTATATAGGAATGAAGGTGCTCCTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-CTTTTTTTATTGGGTTGTAATGT-----A
jurineifolia_scab_CAM1604       ATTCTTACATCCACCATTTTATATAGGAATGAAGGTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-CTTTTTTTATTGGGTTGTAATGT-----A
jurineifolia_scab_CAM2652       ATTCTTACATCCACCATTTTATATAGGAATGAAGGTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-CTTTTTTTATTGGGTTGTAATGT-----A
krebsiana_arctotoides_RM868     ??????????????CATTTTATATAGGAATGAAGCTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-TTTTTTT-ATTGGGTTGTAATGT-----A
krebsiana_arctotoides_RM876     ??????????????CATTTTATATAGGAATGAAGCTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
krebsiana_krebisiana_RM1114     ATTCTTACATCCACCATTTTATATAGGAATGAAGCTGCT-CTTGGCTCGACGTCATTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
krebsiana_krebsiana_RM1136      ATTCTTACATCCACCATTTTATATAGGAATGAAGCTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
krebsiana_serrulata_RM863       ATTCTTACATCCACCATTTTATATAGGAATGAAGCTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
krebsiana_serrulata_RM965       ATTCTTACATCCACCATTTTATATAGGAATGAAGCTGCT-CCTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
leiopoda_M240901                ATTCTTACATCCACCATTTTATATAGGAATGAAGGTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
leiopoda_RM1309                 ATTCTTACATCCACCATTTTATATAGGAATGAAGCTGCT-CTTGGCTCGACGTCATTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
lichtenstenii_CAM1916           ATTCTTACATCCACCATTTTATATAGGAATGAAGGTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-CTTTTTTTATTGGGTTGTAATGT-----A
lichtensteinii_RM1249           ATTCTTACATCCACCATTTTATATAGGAATGAAGGTGCT-CCTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-CTTTTTTTATTGGGTTGTAATGT-----A
linearis_linearis_RM1010        ATTCTTACATCCACCATTTTATATAGGAATGAAGCTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
linearis_linearis_SH113         ATTCTTACATCCACCATTTTATATAGGAATGAAGCTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
linearis_ovalis_NDsn            ATTCTTACATCCACCATTTTATATAGGAATGAAGCTGCT-CCTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
linearis_ovalis_RM854           ??????????????CATTTTATATAGGAATGAAGCTGCC-CTTGGCTCGACGNCGTTTGTTCTATTCTACTAGAACCCTT-TTTCTTTTATTGGGTTGTAATGT-----A
maritima_RM1038                 ATTCTTACATCCACCATTTTATATAGGAATGAAGCTGCT-CTTGGCTCGACGTCATTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
maritima_M290606_6              ATTCTTACATCCACCATTTTATATAGGAATGAAGGTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
othonnites_RM1306               ??????????CCACCATTTTATATAGGAATGAAGCTGCT-CTTGGCTCGACGTCATTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
pectinata_M120903               ?????????TCCACCATTTTATATAGGAATGAAGCTGCT-CTTGGCTCGACGTCATTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
pectinata_RM1044                ATTCTTACATCCACCATTTTATATAGGAATGAAGCTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
rigida_M280902                  ???CTTACATCCACCATTTTATATAGGAATGAAGCTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
rigida_RM840                    ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
rigens_leucolaena_RM773         ??????????????????????????????????????????????TCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
rigens_leucolaena_RM952_1       ATTCTTACATCCACCATTTTATATAGGAATGAAGCTGCT-CTTGGCTCGACGTCATTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
rigens_rigens_RM763             ??????????????????????????????????????????????????????????????????????????????TT-TTTTTTTTATTGGGTTGTAATGT-----A
rigens_rigens_SR463             ??????TTCTCCACCATTTTATATAGGAATGAAGCTGCA-CATGGCTCGACGTCATTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
rigens_uniflora_JC201205        ATTCTTACATCCACCATTTTATATAGGAATGAAGCTGCT-CTTGCCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
rigens_uniflora_RM920           ????????CTCCACCATTTTATATAGGAATGAAGCTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
schenckii                       ATTCTTACATCCACCATTTTATATAGGAATGAAGGTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-CTTTTTTTATTGGGTTGTAATGT-----A
serrata_M250904_15              ATTCTTACATCCACCATTTTATATAGGAATGGAAGTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-TTTCTTTTATTGGGTTGTAATGT-----A
serrata_RM898                   ATTCTTACATCCACCATTTTATATAGGAATGAAGCTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-TTTTTTT-ATTGGGTTGTAATGT-----A
tenuifolia_CAM1601              ATTCTTACATCCACCATTTTATATAGGAATGAAGGTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-CTTTTTTTATTGGGTTGTAATGT-----A
tenuifolia_M2730                ATTCTTACATCCACCATTTTATATAGGAATGAAGGTGCT-CTTGGCTCGACGTCGTTTGTTCTATTCTACTAGAACCCTT-CTTTTTTTATTGGGTTGTAATGT-----A
spnov_M040906_33                ATTCTTACATCCACCATTTTATATAGGAATGAAGCTGCT-CTTGGCTCGACGTCATTTGTTCTATTCTACTAGAACCCTT-TTTTTTTTATTGGGTTGTAATGT-----A
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[                                      120       130       140       150       160       170       180       190       200       210       220]

Berkheya                       AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
Gorteria                       AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
Hirpicium                      AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
caespitosa_RVC448              AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
caespitosa_RVC307              AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
ciliaris_RM1230                AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
ciliaris_RM1382                AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
heterochaeta_RM1429            AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
heterochaeta_RM1451            AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
jurineifolia_jur_SR682         AATAGTTCATGGTGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
jurineifoliajur_RM1518         AATAGTTCATGGTGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
jurineifolia_scab_CAM1604      AATAGTTCATGGTGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAATGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
jurineifolia_scab_CAM2652      AATAGTTCATGGTGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
krebsiana_arctotoides_RM868    AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
krebsiana_arctotoides_RM876    AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
krebsiana_krebisiana_RM1114    AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
krebsiana_krebsiana_RM1136     AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
krebsiana_serrulata_RM863      AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
krebsiana_serrulata_RM965      AATAGTTCAKGAKGGAGCYCGAGTAGAAAGTATTGATTAATTTCYCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
leiopoda_M240901               AATAGTTCATGANGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
leiopoda_RM1309                AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
lichtenstenii_CAM1916          AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
lichtensteinii_RM1249          AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
linearis_linearis_RM1010       AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
linearis_linearis_SH113        AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
linearis_ovalis_NDsn           AATAGTTCATGAKGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
linearis_ovalis_RM854          AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
maritima_RM1038                AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
maritima_M290606_6             AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
othonnites_RM1306              AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
pectinata_M120903              AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
pectinata_RM1044               AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
rigida_M280902                 AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
rigida_RM840                   ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
rigens_leucolaena_RM773        AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
rigens_leucolaena_RM952_1      AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
rigens_rigens_RM763            AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
rigens_rigens_SR463            AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
rigens_uniflora_JC201205       AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
rigens_uniflora_RM920          AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
schenckii                      AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
serrata_M250904_15             AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
serrata_RM898                  AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
tenuifolia_CAM1601             AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
tenuifolia_M2730               AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
spnov_M040906_33               AATAGTTCATGATGGAGCTCGAGTAGAAAGTATTGATTAATTTCTCAGGGGCAACGATCTAGGGTTAATGCCAATCAATAAATTGGAACAACTTCGTAAGTATATCTTCG
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[                                      230       240       250       260       270       280       290       300       310       320       330]

Berkheya                       ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTAAACTCAAAATAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
Gorteria                       ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCGAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
Hirpicium                      ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
caespitosa_RVC448              ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
caespitosa_RVC307              ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
ciliaris_RM1230                ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
ciliaris_RM1382                ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
heterochaeta_RM1429            ATATAGAAA-----AGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
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jurineifolia_jur_SR682         ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCCCGTATGAATTAACCGTCG
jurineifoliajur_RM1518         ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCCCGTATGAATTAACCGTCG
jurineifolia_scab_CAM1604      ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCCCGTATGAATTAACCGTCG
jurineifolia_scab_CAM2652      ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCCCGTATGAATTAACCGTCG
krebsiana_arctotoides_RM868    ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
krebsiana_arctotoides_RM876    ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
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leiopoda_M240901               ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
leiopoda_RM1309                ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
lichtenstenii_CAM1916          ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
lichtensteinii_RM1249          ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
linearis_linearis_RM1010       ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
linearis_linearis_SH113        ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
linearis_ovalis_NDsn           ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
linearis_ovalis_RM854          ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
maritima_RM1038                ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
maritima_M290606_6             ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
othonnites_RM1306              ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
pectinata_M120903              ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
pectinata_RM1044               ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
rigida_M280902                 ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
rigida_RM840                   ??????????????????????????????????????AACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
rigens_leucolaena_RM773        ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
rigens_leucolaena_RM952_1      ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
rigens_rigens_RM763            ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
rigens_rigens_SR463            AAATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
rigens_uniflora_JC201205       ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
rigens_uniflora_RM920          ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
schenckii                      ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
serrata_M250904_15             ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
serrata_RM898                  ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
tenuifolia_CAM1601             ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTGCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
tenuifolia_M2730               ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTGCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
spnov_M040906_33               ATATAGAAATCGAAAGGATCCGATTCGAGCAAATTTTCAACTCAAAAAAATTTGTTGGAACCGCTAAAACTTTTTCGATCCACAGTGTATCGCGTATGAATCAACCGTCG
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[                                       340       350       360       370       380       390       400       410       420       430       440]

Berkheya                       GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAAGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
Gorteria                       GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
Hirpicium                      GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAAAATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
caespitosa_RVC448              GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
caespitosa_RVC307              GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
ciliaris_RM1230                GTATGATTCTTTGATAGAAATAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
ciliaris_RM1382                GTATGATTCTTTGATAGAAATAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
heterochaeta_RM1429            GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
heterochaeta_RM1451            GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
jurineifolia_jur_SR682         GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
jurineifoliajur_RM1518         GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
jurineifolia_scab_CAM1604      GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
jurineifolia_scab_CAM2652      GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
krebsiana_arctotoides_RM868    GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
krebsiana_arctotoides_RM876    GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
krebsiana_krebisiana_RM1114    GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
krebsiana_krebsiana_RM1136     GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
krebsiana_serrulata_RM863      GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
krebsiana_serrulata_RM965      GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
leiopoda_M240901               GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
leiopoda_RM1309                GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
lichtenstenii_CAM1916          GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
lichtensteinii_RM1249          GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
linearis_linearis_RM1010       GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
linearis_linearis_SH113        GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
linearis_ovalis_NDsn           GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
linearis_ovalis_RM854          GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
maritima_RM1038                GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
maritima_M290606_6             GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
othonnites_RM1306              GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
pectinata_M120903              GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
pectinata_RM1044               GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
rigida_M280902                 GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
rigida_RM840                   GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
rigens_leucolaena_RM773        GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
rigens_leucolaena_RM952_1      GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
rigens_rigens_RM763            GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
rigens_rigens_SR463            GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCCCCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
rigens_uniflora_JC201205       GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
rigens_uniflora_RM920          GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
schenckii                      GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
serrata_M250904_15             GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCCCCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
serrata_RM898                  GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
tenuifolia_CAM1601             GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
tenuifolia_M2730               GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
spnov_M040906_33               GTATGATTCTTTGATAGAAAGAAATCACAAAAGGGGTATGTTGCTACCATTTTGAAAGGATTAAGAAGCACCGAAGTAATGTCTAAACCCAATGATTTAAAACAAAGATA
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[                                         450       460       470       480       490       500       510       520       530       540       550]

Berkheya                       AAGGATCCCAGAACAAGGAAACACCACTTCAATTGTCTCACGGATCTGAATAAAGAATCCAAATAGATTTTAAACGAGACAAAAAGGGGAGGGGTTAAAGACCACTCAAT
Gorteria                       AAGGATCCCAGAACAAGGAAACACCACTTCAATTGTCTCACAGATCTGAATAAAGAATCCAAATAGATTTTAAACGAGACAAAAGGGGGGG---TTAAAGACCACTCAAT
Hirpicium                      AAGGATCCCAGAACAAGGAAACACCACTTCGATTGTCTCACGGATCTGAATAAAGAATCCAAATAGATTTTAAACGAGACAAAAAGGGGGG---TTAAAGACCACTCAAT
caespitosa_RVC448              AAGGATCCCAGAACAAGGAAACACCACTTCAATTGTCTCACGGATCTGAATAAAGAATCCAAATAGATTTTAAACGAGACAAAAGGGGG-----TTAAAGACCACTCAAA
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heterochaeta_RM1429            AAGGATCCCAGAACAAGGAAACACCACTTCAATTGTCTCACGGATCTGAATAAAGAATCCAAATAGATTTTAAACGAGACAAAAGGGGGGG---TTAAAGACCACTCAAA
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jurineifoliajur_RM1518         AAGGATCCCAGAACAAGGAAACACCACTTCAATTGTCTCACGGATCTGAATAAAGAATCCAAATAGATTTTAAACGAGACAAAAGGGGGGGG--TTAAAGACCACTCAAA
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leiopoda_RM1309                AAGGATCCCAGAACAAGGAAACACCACTTCAATTGTCTCACGGATCTGAATAAAGAATCCAAATAGATTTTAAACGAGACAAAAGGGGGGGG--TTAAAGACCACTCAAA
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rigens_leucolaena_RM952_1      AAGGATCCCAGAACAAGGAAACACCACTTCAATTGTCTCACGGATCTGAATAAAGAATCCAAATAGATTTTAAACGAGACAAAAGGGGGGGGGGTTAAAGACCACTCAAA
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tenuifolia_M2730               AAGGATCCCAGAACAAGGAAACACCACTTCAATTGTCTCACGGATCTGAATAAAGAATCCAAATAGATTTTAAACGAGACAAAAGGGGGGG---TTAAAGACCACTCAAA
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[                                       560       570       580       590       600       610       620       630       640       650       660]

Berkheya                       AAAAAAA------------------GATTTTTCTTTAATATTATTTTAAGAATTATTGAACTTGAGTTATGAGTACAAATGATTTTTTCTTTTTCAGGAAGGAAGCTAAA
Gorteria                       AAAAAAA---------TATCTTAAAGATTT--CTTTAATAT--AATTGAGAATTATTGAACATGAGTTATGAGTACAAATGATTTTTTCTTTTTCAGGAAGGAAGCTAAA
Hirpicium                      AAAAAAAAA---------TCTTAAAGGTTTTTCTTTAATAT--AATTGAGAATTATTGAACTTGAGTTATGAGTACAAATGATTTTTTCTTTTTCAGGAAGGAAGCTAAA
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linearis_ovalis_NDsn           AAAAAAAA--TAAAAATATCTTAAAGATTTTTCTTTAATAT--AATTGAGAATTATTGAACTTGAGTTATGAGTACAAATGATTTTTTCTTTTTCAGGAAGGAAGCTAAA
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maritima_M290606_6             AAAAAAAA--TAAAAATATCTTAAAGATTTTTCTTTAATAT--AATTGAGAATTATTGAACTTGAGTTATGAGTACAAATGATTTTTTCTTTTTCAGGAAGGAAGCTAAA
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rigida_M280902                 AAAAAAA---TAAAAATATCTTAAAGATTTTTCTTTAATAT--AATTGAGAATTAT??????????????????????????????????????????????????????
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rigens_leucolaena_RM773        AAAAAAAA--TAAAAATATCTTAAAGATTTTTCTTTAATAT--AATTGAGAATTATTGAACTTGAGTTATGAGTACAAATGATTTTTTCTTTTTCAGGAAGGAAGCTAAA
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rigens_rigens_SR463            AAAAAAAA--TAAAAATATCTTAAAGATTTTTCTTTAATAT--AATTGAGAATTATTGAACTTGAGTTATGAGTACAAATGATTTTTTCTTTTTCAGGAAGGAAGCTAAA
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rigens_uniflora_RM920          AAAAAAA---TAAAAATATCTTAAAGATTTTTCTTTAATAT--AATTGAGAATTATTGAACTTGAGTTATGAGTACAAATGATTTTTTCTTTTTCAGGAAGGAAGCTAAA
schenckii                      AAAAAAA---TAAAAATATCTTAAAGATTTTTCTTTAATAT--AATTGAGAATTATTGAACTTGAGTTATGAGTACAAATGATTTTTTCTTTTTCAGGAAGGAAGCTAAA
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tenuifolia_CAM1601             AAAAAA----TAAAAATATCTTAAAGATTTTTCTTTAATAT--AATTGAGAATTATTGAACTTGAGTTATGAGTACAAATGATTTTTTCTTTTTCAGGAAGGAAGCTAAA
tenuifolia_M2730               AAAAAA----TAAAAATATCTTAAAGATTTTTCTTTAATAT--AATTGAGAATTATTGAACTTGAGTTATGAGTACAAATGATTTTTTCTTTTTCAGGAAGGAAGCTAAA
spnov_M040906_33               AAAAAA----TAAAAATATCTTAAAGATTTTTCTTTAATAT--AATTGAGAATTATTGAACTTGAGTTATGAGTACAAATGATTTTTTCTTTTTCAGGAAGGAAGCTAAA
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[                                       670       680       690       700       710       720       730       740       750       760       770]

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Gorteria                       TAAAAATGATTATGAGTTAAATT-------ATAGGCTAATTTCTTTT-------ACGGATTCCTTTACTATTTAATTTATTATAATTTTATCCATA--------------
Hirpicium                      TAAAAA---------GTTAAATT-------ATAGGCTAATTTCTTTT-------ACGGATTCCTTTACTATTTATTAGAA-----TTTACTCCATA--------------
caespitosa_RVC448              AAAAAATGACTATGAGTTAAATT-------ATAGGCTAATTTCTTTTTTATTTTACGGATTCCTTTACTATTTATTAGAA-----TTTTATCCATA--------------
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linearis_ovalis_NDsn           TAAAAATGACTATGAGTTAAATT-------ATAGGCTAATTTCTTTTTTATTTTACGGATTCCTTTACTATTTATTAGAA-----TTTTATCCATA--------------
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maritima_M290606_6             TAAAAATGACTATGAGTTAAATT-------ATAGGCTAATTTCTTTTTTATTTTACGGATTCCTTTACTATTTATTAGAA-----TTTTATCCATA--------------
othonnites_RM1306              TAAAAATGACTATGAGTTAAATT-------ATAGGCTAATTTCTTTTTTATTTTACGGATTCCTTTACTATTTATTAGAA-----TTTTATCCATA--------------
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rigida_RM840                   TAAAAATGACTATGAGTTAAATT-------ATAGGCTAATTTCTTTTTTATTTTACGGATTCCTTTACTATTTATTAGAA-----TTTTATCCATA--------------
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schenckii                      TAAAAA---------GTTAAATT-------ATAGGCTAATTTCTTTTTTATTTTACGGATTCCTTTACTATTTATTAGAA-----TTTTATCCATA--------------
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serrata_RM898                  TAAAAATGACTATGAGTTAAATT-------ATAGGCTAATTTCTTTTTTATTTTACGGATTCCTTTACTATTTATTAGAA-----TTTTATCCATA--------------
tenuifolia_CAM1601             TAAAAATGACTATGAGTTAAATT-------ATAGGCTAATTTCTTTTTTATTTTACGGATTCCTTTACTATTTATTAGAA-----TTTTATCCATA--------------
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[                                       780       790       800       810       820       830       840       850       860   ||  870       880]

Berkheya                       TCCATAGACAAAACTTCAAATCATTTTTTCTCGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGGG-TTCTTTTTCATCTACATCTACAAATCCACTGCC
Gorteria                       ------GACAAAACTTCAAATCATTTTTTCTCGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCT??????????????
Hirpicium                      ------GACAAAACTTCAAATCATTTTTTCTCGAGCCGTACGAGGAGAAAACTTCCT-TACGGTTCTAGGGGGGGGGTTCTT??????????????ACAAATCCACTGCC
caespitosa_RVC448              ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGGG-TTCTTTTTCATCTACATCTACAAATCCACTGCC
caespitosa_RVC307              ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGGG-TTCTTTTTCATCTACATCTACAAATCCACTGCC
ciliaris_RM1230                ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGGG-TTCTTTTTCATCTACATCTACAAATCCACTGCC
ciliaris_RM1382                ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTC????????????????ACAAATCCACTGCC
heterochaeta_RM1429            ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
heterochaeta_RM1451            ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCT??????????????
jurineifolia_jur_SR682         ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
jurineifoliajur_RM1518         ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
jurineifolia_scab_CAM1604      ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
jurineifolia_scab_CAM2652      ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
krebsiana_arctotoides_RM868    ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG??????????????????????????TCCACTGCC
krebsiana_arctotoides_RM876    ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTA????????????????????????????ACAAATCCACTGCC
krebsiana_krebisiana_RM1114    ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
krebsiana_krebsiana_RM1136     ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG?????????????????????ACAAATCCACTGCC
krebsiana_serrulata_RM863      ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
krebsiana_serrulata_RM965      ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCT?CAAATCCACTGCC
leiopoda_M240901               ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
leiopoda_RM1309                ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
lichtenstenii_CAM1916          ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCT??????????????
lichtensteinii_RM1249          ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCC????????????????????????????????????????ACAAATCCACTGCC
linearis_linearis_RM1010       ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
linearis_linearis_SH113        ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
linearis_ovalis_NDsn           ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
linearis_ovalis_RM854          ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
maritima_RM1038                ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTAC????ACAAATCCACTGCC
maritima_M290606_6             ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
othonnites_RM1306              ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTAC????????????????????????????????????????????????????????????????CTGCC
pectinata_M120903              ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
pectinata_RM1044               ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTA????????-???????????????????ACAAATCCACTGCC
rigida_M280902                 ????????????????????????????????????????????????????????????????????????????????????????????????ACAAATCCACTGCC
rigida_RM840                   ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
rigens_leucolaena_RM773        ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
rigens_leucolaena_RM952_1      ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
rigens_rigens_RM763            ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
rigens_rigens_SR463            ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
rigens_uniflora_JC201205       ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTA?????ACAAATCCACTGCC
rigens_uniflora_RM920          ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
schenckii                      ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCTACAAATCCACTGCC
serrata_M250904_15             ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGGG-TTCTTTTTCATCTACATCTACAAATCCACTGCC
serrata_RM898                  ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCT?CAAATCCACTGCC
tenuifolia_CAM1601             ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCT???AATCCACTGCC
tenuifolia_M2730               ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTTTCATCTACATCT????????????CC
spnov_M040906_33               ------GACAAAACTTCAAATCATTTTTTCTTGAGCCGTACGAGGAGAAAACTTCCTATACGGTTCTAGGGGGGG--TTCTTTT-CATCTACATCTACAAATCCACTGCC
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[                                       890       900       910       920       930       940       950       960       970       980       990]

Berkheya                       TTGATCCACTGGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAGCTAGTATTACTATATTT-------------------TTCCATTAACATGAAA
Gorteria                       ?TGATCCACTTGGCTACATCCGCCCCTTTACTATTAT-----------CTAGTATTATCTAGTATTACTATATTT-----GTAATACTATATTTTTCCATTAACAAGAAA
Hirpicium                      TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTATCTAGTATTACTATATTT-------------------TTCCATTAACATGAAA
caespitosa_RVC448              TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-------------------------------------------------------------------------
caespitosa_RVC307              TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-------------------------------------------------------------------------
ciliaris_RM1230                TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-------------------------------------------------------------------------
ciliaris_RM1382                TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-------------------------------------------------------------------------
heterochaeta_RM1429            TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
heterochaeta_RM1451            ?????????TTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
jurineifolia_jur_SR682         TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
jurineifoliajur_RM1518         TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
jurineifolia_scab_CAM1604      TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTCTTAA-TAGTATTACTATATTTTTACA------------------------------
jurineifolia_scab_CAM2652      TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATT-CTATATTTTTACA------------------------------
krebsiana_arctotoides_RM868    TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
krebsiana_arctotoides_RM876    TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
krebsiana_krebisiana_RM1114    TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
krebsiana_krebsiana_RM1136     TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
krebsiana_serrulata_RM863      TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
krebsiana_serrulata_RM965      TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
leiopoda_M240901               TTGATCCACTTGGCTACATCCGCCCCTCTACTATTATTCTACTATTATCTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
leiopoda_RM1309                TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
lichtenstenii_CAM1916          ??????????????????????????????CTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
lichtensteinii_RM1249          TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
linearis_linearis_RM1010       TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
linearis_linearis_SH113        TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
linearis_ovalis_NDsn           TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
linearis_ovalis_RM854          TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
maritima_RM1038                TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
maritima_M290606_6             TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
othonnites_RM1306              TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTGA-TAGTATTACTATATTTTTACA------------------------------
pectinata_M120903              TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
pectinata_RM1044               TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
rigida_M280902                 TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
rigida_RM840                   TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
rigens_leucolaena_RM773        TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
rigens_leucolaena_RM952_1      TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
rigens_rigens_RM763            TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
rigens_rigens_SR463            TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
rigens_uniflora_JC201205       TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
rigens_uniflora_RM920          TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
schenckii                      TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
serrata_M250904_15             TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAG---TAA-TAGTATTACTATATTTTTACA------------------------------
serrata_RM898                  TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
tenuifolia_CAM1601             TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------ATAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
tenuifolia_M2730               TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------ATAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
spnov_M040906_33               TTGATCCACTTGGCTACATCCGCCCCTCTACTATTAT-----------CTAGTATTAA-TAGTATTACTATATTTTTACA------------------------------
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[                                       1000      1010      1020      1030      1040      1050      1060      1070      1080      1090      1100]

Berkheya                       AAAAA----GATTCTATTTTTCTTTCTTTTTTCTGAAATTAAAGTAATAA------ATAAGCAAAATTATCATTTCAATCTAAAATAGATTGAAATTGAATTGTAAATAA
Gorteria                       AAAAAAAAAGATCATATTTTTCTTTCTTATTTCTGAAATAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
Hirpicium                      AAA------TATTCTATTTTTCTTTCTTATTTCTGAAATTAAAGTAATAATAATAAATAAGCAAAATTATCATTTCAATCTATTTTAGATTGAAATTGAATTATAAATAA
caespitosa_RVC448              --------------------------------------------------------------------------------------------------------------
caespitosa_RVC307              --------------------------------------------------------------------------------------------------------------
ciliaris_RM1230                --------------------------------------------------------------------------------------------------------------
ciliaris_RM1382                --------------------------------------------------------------------------------------------------------------
heterochaeta_RM1429            ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATCTTAGATTGAAATTGAATTGGAAATAA
heterochaeta_RM1451            ------------------------------------TTAAAAAGTAATAA------ATAAGAAAAATTATCATTTTTATCTATCTTAGATTGAAATTGAATTGGAAATAA
jurineifolia_jur_SR682         --------------------TTAAATTAAAATTAAATTAAAAATTAATTA------ATAAGCAAAATTCTCATTTTTATCCATTTTAGATTGAAATTGAATTGGAAATAA
jurineifoliajur_RM1518         --------------------TTAAATTAAAATTAAATTAAAAATTAATAA------ATAAGCAAAATTCTCATTTTTATCCATTTTAGATTGAAATTGAATTGGAAATAA
jurineifolia_scab_CAM1604      --------------------TTAAATTAAAATAAAATTAAAAATTAATTA------ATAAGCAAAATTCTCATTTTTATCCATTTTAGATTGAAATTGAATTGGAAATAA
jurineifolia_scab_CAM2652      -------------------------TTAAATTAAAATTAAAAATTAATTA------ATAAGCAAAATTCTCATTTTTATCCATTTTAGATTGAAATTGAATTGGAAATAA
krebsiana_arctotoides_RM868    ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
krebsiana_arctotoides_RM876    ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTCTAATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
krebsiana_krebisiana_RM1114    ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
krebsiana_krebsiana_RM1136     ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATAATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
krebsiana_serrulata_RM863      ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
krebsiana_serrulata_RM965      ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATAATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
leiopoda_M240901               -----------------TAGTATTACTATATTTTTATTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
leiopoda_RM1309                ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
lichtenstenii_CAM1916          ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
lichtensteinii_RM1249          ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
linearis_linearis_RM1010       ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
linearis_linearis_SH113        ------------------------------TTTTAATTAAAAAGTAATAA------ATAAGCAAAATTATAATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
linearis_ovalis_NDsn           ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGACATTGAATTGGAAATAA
linearis_ovalis_RM854          ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
maritima_RM1038                ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
maritima_M290606_6             ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
othonnites_RM1306              ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
pectinata_M120903              ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
pectinata_RM1044               ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
rigida_M280902                 ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATAATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
rigida_RM840                   ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
rigens_leucolaena_RM773        ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
rigens_leucolaena_RM952_1      ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
rigens_rigens_RM763            ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
rigens_rigens_SR463            ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
rigens_uniflora_JC201205       ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATAATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
rigens_uniflora_RM920          ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATAATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
schenckii                      ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
serrata_M250904_15             ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
serrata_RM898                  ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
tenuifolia_CAM1601             --------------------------------TTAAATAAATAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
tenuifolia_M2730               --------------------------------TTAAATAAATAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
spnov_M040906_33               ------------------------------------TTAAAAAGTAATAA------ATAAGCAAAATTATCATTTTTATCTATTTTAGATTGAAATTGAATTGGAAATAA
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[                                       1110      1120      1130      1140      1150      1160      1170      1180      1190      1200      1210]

Berkheya                       AACTTCATAAAAGATTGGGAAAAGGATATATAAA---------------------CCT-ATAA------TATTCTAATTAGAATATCAAT------TAATACAAAGATAA
Gorteria                       AACTTCATAAAAGATTGGGAAAAGGATATATAAA---------------------CCTTATAA------TATTCTAA---------------------------------
Hirpicium                      AACTTCATAAAAGATTGGGAAAAGGATATATAAA---------------------CCT-ATAA------TATTCTAATTAGAATATCAAT------TAATACAAAGATAA
caespitosa_RVC448              --------------------------------------------------------------------------------------------------------------
caespitosa_RVC307              --------------------------------------------------------------------------------------------------------------
ciliaris_RM1230                --------------------------------------------------------------------------------------------------------------
ciliaris_RM1382                --------------------------------------------------------------------------------------------------------------
heterochaeta_RM1429            AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
heterochaeta_RM1451            AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
jurineifolia_jur_SR682         AACTTCATAAAAGATTGGGAAAAGG-TATATAAATATAAA---------------CCT-ATAATAA---TATTCTAATTAGAATATCAAT------TAATACAAAGAGAA
jurineifoliajur_RM1518         AACTTCATAAAAGATTGGGAAAAGG-TATATAAATATAAA---------------CCT-ATAATAATAATATTCTAATTAGAATATCAAT------TAATACAAAGAGAA
jurineifolia_scab_CAM1604      AACTTCATAAAAGATTGGGAAAAGG-TATATAAATATAAA---------------CCT-ATAATAATAATATTCTAATTAGAATATCAAT------TAATACAAAGAGAA
jurineifolia_scab_CAM2652      AACTTCATAAAAGATTGGGAAAAGG-TATATAAATATAAA---------------CCT-ATAATAATAATATTCTAATTAGAATATCAAT------TAATACAAAGAGAA
krebsiana_arctotoides_RM868    AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
krebsiana_arctotoides_RM876    AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------TATAAACCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
krebsiana_krebisiana_RM1114    AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
krebsiana_krebsiana_RM1136     AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------TATAAACCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
krebsiana_serrulata_RM863      AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
krebsiana_serrulata_RM965      AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------TATAAACCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
leiopoda_M240901               AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
leiopoda_RM1309                AACTTCATAAAAGATTGGGAAAAGGATATATAAATATA-------TAAATATAAACCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
lichtenstenii_CAM1916          AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
lichtensteinii_RM1249          AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
linearis_linearis_RM1010       AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAATAATATTCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
linearis_linearis_SH113        AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------TATAAACCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
linearis_ovalis_NDsn           AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------TATAAACCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
linearis_ovalis_RM854          AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------TATAAACCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
maritima_RM1038                AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
maritima_M290606_6             AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
othonnites_RM1306              AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
pectinata_M120903              AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
pectinata_RM1044               AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAATAAATATAAATATAAACCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
rigida_M280902                 AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------TATAAACCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
rigida_RM840                   AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
rigens_leucolaena_RM773        AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
rigens_leucolaena_RM952_1      AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
rigens_rigens_RM763            AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
rigens_rigens_SR463            AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
rigens_uniflora_JC201205       AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------TATAAACCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
rigens_uniflora_RM920          AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------TATAAACCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
schenckii                      AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
serrata_M250904_15             AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
serrata_RM898                  AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
tenuifolia_CAM1601             AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAT--------ATATAAACCT-ATAATAT-AATATTCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
tenuifolia_M2730               AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAT--------ATATAAACCT-ATAATAT-AATATTCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
spnov_M040906_33               AACTTCATAAAAGATTGGGAAAAGGATATATAAATATAAA---------------CCT-ATAATAT------TCTAATTAGAATATCAATATCAATTAATACAAAGAGAA
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[                                       1220      1230      1240      1250      1260      1270      1280      1290      1300      1310      1320]

Berkheya                       ACCACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAAGCAAATA------------GTACTAAATAAAAAAAA-GGAGC
Gorteria                       ---------ATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGTCAAATA------------GTACTAAATAAAAAAAA-GGAGC
Hirpicium                      AACACGCTAATTGAACCAAA--------CTATAAAAAGCCCTTCTTATTTTTAAAGAAACTATGTAAGGAAAAGA------------GTACTAAATAAAAAAAA-GGAGC
caespitosa_RVC448              ----------------------------------AAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
caespitosa_RVC307              ----------------------------------AAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
ciliaris_RM1230                ----------------------------------AAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
ciliaris_RM1382                ----------------------------------AAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGA??
heterochaeta_RM1429            AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA----------------AAAAAAA--GGAGC
heterochaeta_RM1451            AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
jurineifolia_jur_SR682         AACACGCTAATCGAACCAAA--------CTATAAAGAGCCCTTGCTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAAAGGAGC
jurineifoliajur_RM1518         AACACGCTAATCGAACCAAA--------CTATAAAGAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAAAGGAGC
jurineifolia_scab_CAM1604      AACACGCTAATCGAACCAAA--------CTATAAAGAGCCCTTGCTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAAAGGAGC
jurineifolia_scab_CAM2652      AACACGCTAATCGAACCAAA--------CTATAAAGAGCCCTTGCTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAAAGGAGC
krebsiana_arctotoides_RM868    AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
krebsiana_arctotoides_RM876    AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAA--GGAGC
krebsiana_krebisiana_RM1114    AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
krebsiana_krebsiana_RM1136     AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAA--GGAGC
krebsiana_serrulata_RM863      AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
krebsiana_serrulata_RM965      AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAA--GGAGC
leiopoda_M240901               AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAAAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
leiopoda_RM1309                AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
lichtenstenii_CAM1916          AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
lichtensteinii_RM1249          AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
linearis_linearis_RM1010       AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
linearis_linearis_SH113        AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAA--GGAGC
linearis_ovalis_NDsn           AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
linearis_ovalis_RM854          AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAATAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
maritima_RM1038                AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
maritima_M290606_6             AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
othonnites_RM1306              AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
pectinata_M120903              AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
pectinata_RM1044               AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
rigida_M280902                 AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAA--GGAGC
rigida_RM840                   AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
rigens_leucolaena_RM773        AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
rigens_leucolaena_RM952_1      AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
rigens_rigens_RM763            AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATATAGTATAGTACTAAATAAAAAAAA-GGAGC
rigens_rigens_SR463            AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
rigens_uniflora_JC201205       AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAA--GGAGC
rigens_uniflora_RM920          AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAA--GGAGC
schenckii                      AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
serrata_M250904_15             AACACGCTAATCGAACCAAACTATAAAACTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
serrata_RM898                  AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
tenuifolia_CAM1601             AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAA--GGAGC
tenuifolia_M2730               AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAA--GGAGC
spnov_M040906_33               AACACGCTAATCGAACCAAA--------CTATAAAAAGCCCTTGTTATTTTTAAAGAAACTATGTAAGGCAAATAGTATA-------GTACTAAATAAAAAAAA-GGAGC
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[                                       1330      1340      1350      1360      1370      1380      1390      1400      1410      1420      1430]

Berkheya                       AATAGCTTCCCTCTTGTTTTATC------AAGAGGG-CGTTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
Gorteria                       AATA-ACGCCCTCTTG-----ATAAAAC-AAGATGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATG????
Hirpicium                      AATA-ACGCCCTCTTG-----ATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
caespitosa_RVC448              AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
caespitosa_RVC307              AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
ciliaris_RM1230                AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
ciliaris_RM1382                ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
heterochaeta_RM1429            AATA-ACGCCCTCTTGATATAATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
heterochaeta_RM1451            AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
jurineifolia_jur_SR682         AATAGCTTCCCTCTTGTTTTATCATATC-AAGAGGG-CGTTATTGCTCCTTTTTTAGTTCAAGAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
jurineifoliajur_RM1518         AATAGCTCCCCTCTTGTTTTATCATATC-AAGAGGG-CGTTATTGCTCCTTTTTTAGTTCAAGAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
jurineifolia_scab_CAM1604      AATAGCTTCCCTCTTGTTTTATCATATC-AAGAGGG-CGTTATTGCTCCTTTTTTAGTTCAAGAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
jurineifolia_scab_CAM2652      AATAGCTTCCCTCTTGTTTTATCATATC-AAGAGGG-CGTTATTGCTCCTTTTTTAGTTCAAGAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
krebsiana_arctotoides_RM868    AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATGCAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
krebsiana_arctotoides_RM876    AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
krebsiana_krebisiana_RM1114    AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
krebsiana_krebsiana_RM1136     AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
krebsiana_serrulata_RM863      AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
krebsiana_serrulata_RM965      AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
leiopoda_M240901               AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
leiopoda_RM1309                AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
lichtenstenii_CAM1916          AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
lichtensteinii_RM1249          AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
linearis_linearis_RM1010       AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
linearis_linearis_SH113        AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
linearis_ovalis_NDsn           AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
linearis_ovalis_RM854          AATA-ACGCCCTCTTGATATGATAAAACCAAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
maritima_RM1038                AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
maritima_M290606_6             AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
othonnites_RM1306              AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
pectinata_M120903              AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
pectinata_RM1044               AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
rigida_M280902                 AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
rigida_RM840                   AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
rigens_leucolaena_RM773        AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
rigens_leucolaena_RM952_1      AATA-ACGCCCTCTTGATATGATAAACC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
rigens_rigens_RM763            AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
rigens_rigens_SR463            AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
rigens_uniflora_JC201205       AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
rigens_uniflora_RM920          AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
schenckii                      AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
serrata_M250904_15             AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
serrata_RM898                  AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
tenuifolia_CAM1601             AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
tenuifolia_M2730               AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGMGC
spnov_M040906_33               AATA-ACGCCCTCTTGATATGATAAAAC-AAGAGGGAAGCTATTGCTCCTTTTTTAGTTCAAAAACTCGTATACAATCAGACCAAAGTCTTATCCATTTGTAGATGGAGC
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                                                      psbA-trnH  <  > trnL
[                                       1440      1450      1460  ||  1470      1480      1490      1500      1510      1520      1530      1540]

Berkheya                       TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGCACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
Gorteria                       ?????????????????????????????????????CGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
Hirpicium                      TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGCACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
caespitosa_RVC448              TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGCACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
caespitosa_RVC307              TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGCACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
ciliaris_RM1230                TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGCACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
ciliaris_RM1382                ????????????????????????????????????ACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
heterochaeta_RM1429            TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGCACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
heterochaeta_RM1451            TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGCACGGAATTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
jurineifolia_jur_SR682         TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGC??????????TTGGATTGAGCCCTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
jurineifoliajur_RM1518         TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGC?????????????????????????????????????ACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
jurineifolia_scab_CAM1604      TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGC??????????????????????????????????????????????????????????????????????????
jurineifolia_scab_CAM2652      TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGCACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
krebsiana_arctotoides_RM868    TTCGATAGCAGCTAAGTCTAGAG???????????????????????????????????????????????????????????????????????????????????????
krebsiana_arctotoides_RM876    TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGC??????????????????????????????????????????????????????????????????????????
krebsiana_krebisiana_RM1114    TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGC??GGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
krebsiana_krebsiana_RM1136     TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAG?ACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
krebsiana_serrulata_RM863      TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGCACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
krebsiana_serrulata_RM965      TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGC??????????????????????????????????CTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
leiopoda_M240901               TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGC??????????????????????????????????????????????????????????????????????????
leiopoda_RM1309                TTCGATAGCAGCTAAGGCTAGAGGGAAATTATGAGCACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
lichtenstenii_CAM1916          TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGC?????????????????????????????????????????????????????????????????????????A
lichtensteinii_RM1249          TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGCACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
linearis_linearis_RM1010       TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAG????GACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
linearis_linearis_SH113        TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGCACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
linearis_ovalis_NDsn           TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGCACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
linearis_ovalis_RM854          TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGC??????????????????????????????????????????????????????????????????????????
maritima_RM1038                T???????????????????????????????????ACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
maritima_M290606_6             TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGCACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
othonnites_RM1306              TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGCACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
pectinata_M120903              TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGCACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
pectinata_RM1044               ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
rigida_M280902                 TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGC??????????????????????????????????CTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
rigida_RM840                   TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGCACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
rigens_leucolaena_RM773        TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGC???????TAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
rigens_leucolaena_RM952_1      TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGC????????????????????????????????????????????????????????????????????CCTGGA
rigens_rigens_RM763            TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGC??????????????????????????????????????????????????????????????????????????
rigens_rigens_SR463            TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGC????????????GGATTGAGCCTCGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
rigens_uniflora_JC201205       TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGCACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
rigens_uniflora_RM920          TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGC??????????????????????????????????????????????????????????????????????????
schenckii                      TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGCACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
serrata_M250904_15             TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGC??????????????????????????????????????????????????????????????????????????
serrata_RM898                  TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGCACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
tenuifolia_CAM1601             TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAG??????????????????????????????CCTGTCTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
tenuifolia_M2730               TCCGATAGCAGCTAAGTCTAGA???????????????CGGACTTAATTGGATTGAGCCCTGGTATGGAAACTTACTAAGTGATAACTTTCAATTTCAGAGAAACCCTGGA
spnov_M040906_33               TTCGATAGCAGCTAAGTCTAGAGGGAAATTATGAGCACGGACTTAATTGGATTGAGCCTTGGTATGGAAACTTACTAAGTGATAACTTTCAAATTCAGAGAAACCCTGGA
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[                                       1550      1560      1570      1580      1590      1600      1610      1620      1630      1640      1650]

Berkheya                       ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATCAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
Gorteria                       ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
Hirpicium                      ATTAATAAAAATGGGCGATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAAAAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
caespitosa_RVC448              ATTAATAAAAATGGGTAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
caespitosa_RVC307              ATTAATAAAAATGGGTAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
ciliaris_RM1230                ATTAATAAAAATGGGTAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
ciliaris_RM1382                ATTAATAAAAATGGGTAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
heterochaeta_RM1429            ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
heterochaeta_RM1451            ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
jurineifolia_jur_SR682         ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
jurineifoliajur_RM1518         ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
jurineifolia_scab_CAM1604      ??????????????????????????????????????????????????????????????????????????????????????GCAGAGACTCGATGGAAGCTGTTC
jurineifolia_scab_CAM2652      ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
krebsiana_arctotoides_RM868    ???????????????????????????????????????????????????????GTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
krebsiana_arctotoides_RM876    ??????????????????????????????????????????????????????????????????????ATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
krebsiana_krebisiana_RM1114    ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
krebsiana_krebsiana_RM1136     ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
krebsiana_serrulata_RM863      ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
krebsiana_serrulata_RM965      ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
leiopoda_M240901               ???????????????????????AGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
leiopoda_RM1309                ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
lichtenstenii_CAM1916          ATT-ATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
lichtensteinii_RM1249          ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
linearis_linearis_RM1010       ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
linearis_linearis_SH113        ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
linearis_ovalis_NDsn           ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
linearis_ovalis_RM854          ????????????????????????????????????????????????????????????????????????AAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
maritima_RM1038                ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
maritima_M290606_6             ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
othonnites_RM1306              ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
pectinata_M120903              ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
pectinata_RM1044               ??????????????????????????????????????????????????????GGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
rigida_M280902                 ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
rigida_RM840                   ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
rigens_leucolaena_RM773        ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
rigens_leucolaena_RM952_1      ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
rigens_rigens_RM763            ????????????????????????????????????????????????????????????????????????????AAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
rigens_rigens_SR463            ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
rigens_uniflora_JC201205       ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
rigens_uniflora_RM920          ????????????????????????????????????????????????????????????????????????????????????GTGCAGAGACTCGATGGAAGCTGTTC
schenckii                      ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
serrata_M250904_15             ?????????????GGCAATCCTGAGCCCAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
serrata_RM898                  ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
tenuifolia_CAM1601             ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
tenuifolia_M2730               ATT-ATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGTAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
spnov_M040906_33               ATTAATAAAAATGGGCAATCCTGAGCCAAATCACGTTTTCCGAAAACAAACAAAGGTTCAGAAAGCGAAAATAAAAAAGGATAGGTGCAGAGACTCGATGGAAGCTGTTC
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[                                       1660      1670      1680      1690      1700      1710      1720      1730      1740      1750      1760]

Berkheya                       TAACGAATGGAGTTGGTTGTCTTACGTTAGTGAAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGTTGTGAATC
Gorteria                       TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAGAAG------GATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
Hirpicium                      TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGTTGTCAATC
caespitosa_RVC448              TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
caespitosa_RVC307              TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
ciliaris_RM1230                TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
ciliaris_RM1382                TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
heterochaeta_RM1429            TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
heterochaeta_RM1451            TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
jurineifolia_jur_SR682         TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
jurineifoliajur_RM1518         TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
jurineifolia_scab_CAM1604      TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
jurineifolia_scab_CAM2652      TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
krebsiana_arctotoides_RM868    TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
krebsiana_arctotoides_RM876    TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
krebsiana_krebisiana_RM1114    TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
krebsiana_krebsiana_RM1136     TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
krebsiana_serrulata_RM863      TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
krebsiana_serrulata_RM965      TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
leiopoda_M240901               TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
leiopoda_RM1309                TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
lichtenstenii_CAM1916          TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
lichtensteinii_RM1249          TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
linearis_linearis_RM1010       TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
linearis_linearis_SH113        TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
linearis_ovalis_NDsn           TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
linearis_ovalis_RM854          TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
maritima_RM1038                TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
maritima_M290606_6             TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
othonnites_RM1306              TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
pectinata_M120903              TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
pectinata_RM1044               TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
rigida_M280902                 TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
rigida_RM840                   TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
rigens_leucolaena_RM773        TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
rigens_leucolaena_RM952_1      TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
rigens_rigens_RM763            TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
rigens_rigens_SR463            TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
rigens_uniflora_JC201205       TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
rigens_uniflora_RM920          TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
schenckii                      TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
serrata_M250904_15             TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
serrata_RM898                  TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
tenuifolia_CAM1601             TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
tenuifolia_M2730               TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
spnov_M040906_33               TAACGAATGGAGTTGGTTGTCTTACGTTAGTGGAGGAATCATTCTATCGAAACTTCAGAAAAGATGAAGGATAAACCTGTATACATAATACAGAAGAATTGCTGTGAATC
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[                                      1770      1780      1790      1800      1810      1820      1830      1840      1850      1860      1870]

Berkheya                       GATTTCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-------ATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
Gorteria                       GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-------ATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
Hirpicium                      GATTTCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-------ATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
caespitosa_RVC448              GATTCCATATTCAAGAAAGAATCGAATATTCATTGATCAAACCATTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
caespitosa_RVC307              GATTCCATATTCAAGAAAGAATCGAATATTCATTGATCAAACCATTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
ciliaris_RM1230                GATTCCATATTCAAGAAAGAATCGAATATTCATTGATCAAACCATTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
ciliaris_RM1382                GATTCCATATTCAAGAAAGAATCGAATATTCATTGATCAAACCATTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
heterochaeta_RM1429            GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACCATTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
heterochaeta_RM1451            GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACCATTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
jurineifolia_jur_SR682         GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACCATTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
jurineifoliajur_RM1518         GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACCATTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
jurineifolia_scab_CAM1604      GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACCATTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
jurineifolia_scab_CAM2652      GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACCATTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
krebsiana_arctotoides_RM868    GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
krebsiana_arctotoides_RM876    GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
krebsiana_krebisiana_RM1114    GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
krebsiana_krebsiana_RM1136     GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
krebsiana_serrulata_RM863      GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
krebsiana_serrulata_RM965      GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
leiopoda_M240901               GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
leiopoda_RM1309                GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
lichtenstenii_CAM1916          GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACCATTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
lichtensteinii_RM1249          GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACCATTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
linearis_linearis_RM1010       GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
linearis_linearis_SH113        GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
linearis_ovalis_NDsn           GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
linearis_ovalis_RM854          GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
maritima_RM1038                GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
maritima_M290606_6             GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACCATTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
othonnites_RM1306              GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
pectinata_M120903              GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
pectinata_RM1044               GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
rigida_M280902                 GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
rigida_RM840                   GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
rigens_leucolaena_RM773        GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
rigens_leucolaena_RM952_1      GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
rigens_rigens_RM763            GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
rigens_rigens_SR463            GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
rigens_uniflora_JC201205       GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
rigens_uniflora_RM920          GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
schenckii                      GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACCATTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
serrata_M250904_15             GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACCATTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
serrata_RM898                  GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
tenuifolia_CAM1601             GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACCATTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
tenuifolia_M2730               GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACCATTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
spnov_M040906_33               GATTCCATATTGAAGAAAGAATCGAATATTCATTGATCAAACC-TTCACCATTCACTCCATAATCTGATAGATCTTTTGAAGAACTGATTAATCGGACGAGAATAAAGAT
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                                                                                                               trnL <  > trnL-F
[                                       1880      1890      1900      1910      1920      1930      1940      1950   || 1960      1970      1980]

Berkheya                       AGAGTCCT-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAAGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
Gorteria                       AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGGGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
Hirpicium                      AGAGTCCT-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
caespitosa_RVC448              AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
caespitosa_RVC307              AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
ciliaris_RM1230                AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATT????????????????????????????????????????????????????????????????????
ciliaris_RM1382                AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGA????????????????????????????????????????????
heterochaeta_RM1429            AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGG????AAGTCCCTCTATCCCCAAAAAGA
heterochaeta_RM1451            AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
jurineifolia_jur_SR682         AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
jurineifoliajur_RM1518         AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
jurineifolia_scab_CAM1604      AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
jurineifolia_scab_CAM2652      AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
krebsiana_arctotoides_RM868    AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
krebsiana_arctotoides_RM876    AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
krebsiana_krebisiana_RM1114    AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
krebsiana_krebsiana_RM1136     AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
krebsiana_serrulata_RM863      AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAATCGCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
krebsiana_serrulata_RM965      AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
leiopoda_M240901               AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
leiopoda_RM1309                AGAGTCCCCGTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGA???????????????????????????????????????????????????????
lichtenstenii_CAM1916          AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
lichtensteinii_RM1249          AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
linearis_linearis_RM1010       AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGA??????????CCCTCTATCCCCAAAAAGA
linearis_linearis_SH113        AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
linearis_ovalis_NDsn           AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGGGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
linearis_ovalis_RM854          AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
maritima_RM1038                AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGATGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
maritima_M290606_6             AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAAGCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
othonnites_RM1306              AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTTGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
pectinata_M120903              AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
pectinata_RM1044               AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
rigida_M280902                 AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
rigida_RM840                   AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAG???CTCTATCCCCAAAAAGA
rigens_leucolaena_RM773        AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
rigens_leucolaena_RM952_1      AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
rigens_rigens_RM763            AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
rigens_rigens_SR463            AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
rigens_uniflora_JC201205       AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
rigens_uniflora_RM920          AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
schenckii                      AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
serrata_M250904_15             AGAGTCCC-GCTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
serrata_RM898                  AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
tenuifolia_CAM1601             AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
tenuifolia_M2730               AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTCGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCAAAAAGA
spnov_M040906_33               AGAGTCCC-GTTCTACATGTCAATACCGGCAACAATGAAATTTATAGTAAGAGGAAAATCCGTTGATTTCAAAAATCGTGAGGGTTCAAGTCCCTCTATCCCCANNNNNN
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[                                       1990      2000      2010      2020      2030      2040      2050      2060      2070      2080      2090]

Berkheya                       GCTTTCGGCTCCTTATCGTATCCTTTTT--------------TCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGAATCTGGGCGGAA
Gorteria                       GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTTTTTATACAAATGGATCTGAGCGGAA
Hirpicium                      GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTT-CGTTAGCGGTTCAAAACT--------TTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
caespitosa_RVC448              GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
caespitosa_RVC307              GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
ciliaris_RM1230                ?????????????TATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAA-CTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
ciliaris_RM1382                ???TTCGGCTCCTTATCGTATACTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
heterochaeta_RM1429            GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
heterochaeta_RM1451            GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
jurineifolia_jur_SR682         GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTAACTACTCTTTATACAAATGGATCTGAGCGGAA
jurineifoliajur_RM1518         GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTAACTACTCTTTATACAAATGGATCTGAGCGGAA
jurineifolia_scab_CAM1604      GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTAACTACTCTTTATACAAATGGATCTGAGCGGAA
jurineifolia_scab_CAM2652      GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTAACTACTCTTTATACAAATGGATCTGAGCGGAA
krebsiana_arctotoides_RM868    GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
krebsiana_arctotoides_RM876    GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
krebsiana_krebisiana_RM1114    GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
krebsiana_krebsiana_RM1136     GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
krebsiana_serrulata_RM863      GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
krebsiana_serrulata_RM965      GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
leiopoda_M240901               GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTCTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
leiopoda_RM1309                ?????????????TATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAA-CTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
lichtenstenii_CAM1916          GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
lichtensteinii_RM1249          GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
linearis_linearis_RM1010       GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
linearis_linearis_SH113        GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
linearis_ovalis_NDsn           GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
linearis_ovalis_RM854          GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
maritima_RM1038                GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
maritima_M290606_6             GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
othonnites_RM1306              GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
pectinata_M120903              GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
pectinata_RM1044               GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
rigida_M280902                 GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
rigida_RM840                   GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
rigens_leucolaena_RM773        GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
rigens_leucolaena_RM952_1      GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
rigens_rigens_RM763            GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
rigens_rigens_SR463            GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAG
rigens_uniflora_JC201205       GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
rigens_uniflora_RM920          GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
schenckii                      GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
serrata_M250904_15             GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
serrata_RM898                  GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
tenuifolia_CAM1601             GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
tenuifolia_M2730               GCTTTCGGCTCCTTATCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
spnov_M040906_33               NNNNNNNNNNNNNNNNCGTATCCTTTTTATTTATCCTTTTTTTCGTTAGCGGTTCAAAACTCCTTATCTTTCTCATTCACTACTCTTTATACAAATGGATCTGAGCGGAA
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[                                       2100      2110      2120      2130      2140      2150      2160      2170      2180      2190      2200]

Berkheya                       ATGCTGTTTTCTTATCACA-GTGATATATATGATACATGTACAAATGAACATCTTTGAGGAAGGAATCCCC-------TGATTCACGATCGATATTTTTATTCATACTGA
Gorteria                       ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAATGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
Hirpicium                      ATGCTGTTCTCTTATCACACGTGATATATATGATACATGTACAAATGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
caespitosa_RVC448              ATGCGGTTCTCTTATCACATGTGATATATA-GATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
caespitosa_RVC307              ATGCGGTTCTCTTATCACATGTGATATATA-GATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
ciliaris_RM1230                ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATTGATATTTTTATTCATACTGA
ciliaris_RM1382                ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATTGATATTTTTATTCATACTGA
heterochaeta_RM1429            ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
heterochaeta_RM1451            ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
jurineifolia_jur_SR682         ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGAGATTTTTATTCATACTGA
jurineifoliajur_RM1518         ATGATGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGAGATTTTTATTCATACTGA
jurineifolia_scab_CAM1604      ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGTGGAAGGA-TCCCCATTTGGATGATTCCCGATCCGGATTTTTTTTCCTCCCG?
jurineifolia_scab_CAM2652      ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGGGGAAGGAATCCCCATTTGAATGATTCACGATCGAGATTTTTATTCATACTGA
krebsiana_arctotoides_RM868    ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
krebsiana_arctotoides_RM876    ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
krebsiana_krebisiana_RM1114    ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
krebsiana_krebsiana_RM1136     ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
krebsiana_serrulata_RM863      ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
krebsiana_serrulata_RM965      ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
leiopoda_M240901               ATGCGGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
leiopoda_RM1309                ATGCTGTTCTCTTATCACATGTGATATAT--GATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
lichtenstenii_CAM1916          ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
lichtensteinii_RM1249          ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
linearis_linearis_RM1010       ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
linearis_linearis_SH113        ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
linearis_ovalis_NDsn           ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
linearis_ovalis_RM854          ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCG???????????????????
maritima_RM1038                ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
maritima_M290606_6             ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
othonnites_RM1306              ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
pectinata_M120903              ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
pectinata_RM1044               ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
rigida_M280902                 ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
rigida_RM840                   ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
rigens_leucolaena_RM773        ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
rigens_leucolaena_RM952_1      ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
rigens_rigens_RM763            ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
rigens_rigens_SR463            ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
rigens_uniflora_JC201205       ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
rigens_uniflora_RM920          ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAA-CGAACATCTTTGAGGAAGGAATCCC-ATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
schenckii                      ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
serrata_M250904_15             ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
serrata_RM898                  ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
tenuifolia_CAM1601             ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
tenuifolia_M2730               ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
spnov_M040906_33               ATGCTGTTCTCTTATCACATGTGATATATATGATACATGTACAAACGAACATCTTTGAGGAAGGAATCCCCATTTGAATGATTCACGATCGATATTTTTATTCATACTGA
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[                                       2210      2220      2230      2240      2250      2260      2270      2280      2290      2300      2310]

Berkheya                       AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
Gorteria                       AA-CTTACAAAGTAGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
Hirpicium                      AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
caespitosa_RVC448              AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
caespitosa_RVC307              AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCTTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
ciliaris_RM1230                AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGGTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
ciliaris_RM1382                AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGGTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
heterochaeta_RM1429            AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
heterochaeta_RM1451            AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
jurineifolia_jur_SR682         AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
jurineifoliajur_RM1518         AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
jurineifolia_scab_CAM1604      ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
jurineifolia_scab_CAM2652      AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
krebsiana_arctotoides_RM868    AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
krebsiana_arctotoides_RM876    AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
krebsiana_krebisiana_RM1114    AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATTAGGATGA
krebsiana_krebsiana_RM1136     AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
krebsiana_serrulata_RM863      AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
krebsiana_serrulata_RM965      AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
leiopoda_M240901               AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAA???????????
leiopoda_RM1309                AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATTAGGATGA
lichtenstenii_CAM1916          AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAGGTTCTCTAGTAAAATGAAAATGAGGATGA
lichtensteinii_RM1249          AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
linearis_linearis_RM1010       AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
linearis_linearis_SH113        AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
linearis_ovalis_NDsn           AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
linearis_ovalis_RM854          ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
maritima_RM1038                AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATTAGGATGA
maritima_M290606_6             AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
othonnites_RM1306              AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATTAGGATGA
pectinata_M120903              AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATTAGGATGA
pectinata_RM1044               AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
rigida_M280902                 AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
rigida_RM840                   AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
rigens_leucolaena_RM773        AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATTAGGATGA
rigens_leucolaena_RM952_1      AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
rigens_rigens_RM763            AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGG???????????????????????????????????????????????????????????????????????????
rigens_rigens_SR463            AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATTAGGATGA
rigens_uniflora_JC201205       AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
rigens_uniflora_RM920          AA-CTTA???????????????????????????????????????????????????????????????????????????????????????????????????????
schenckii                      AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
serrata_M250904_15             AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTG??????????????????????????????????????????????????????????
serrata_RM898                  AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
tenuifolia_CAM1601             AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
tenuifolia_M2730               AAACTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGCTTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATGAGGATGA
spnov_M040906_33               AA-CTTACAAAGTTGTTCTTTTGACAAATTATAGGGCCTGGATGAGGCTTTGTAATACCCTTTCAATTGACATAGACCCAAGTTCTCTAGTAAAATGAAAATTAGGATGA
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[                                       2320      2330      2340      2350      2360    ]

Berkheya                       GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
Gorteria                       GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
Hirpicium                      GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGA????????????????
caespitosa_RVC448              GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
caespitosa_RVC307              GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
ciliaris_RM1230                GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
ciliaris_RM1382                GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
heterochaeta_RM1429            GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
heterochaeta_RM1451            GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
jurineifolia_jur_SR682         GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
jurineifoliajur_RM1518         GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
jurineifolia_scab_CAM1604      ?????????????????????????????????????????????????????????
jurineifolia_scab_CAM2652      GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
krebsiana_arctotoides_RM868    GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTC?
krebsiana_arctotoides_RM876    GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTC?
krebsiana_krebisiana_RM1114    GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
krebsiana_krebsiana_RM1136     GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
krebsiana_serrulata_RM863      GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
krebsiana_serrulata_RM965      GACATCAGGAATAGTCGGGATAGCTCAGTA???????????????????????????
leiopoda_M240901               ?????????????????????????????????????????????????????????
leiopoda_RM1309                GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
lichtenstenii_CAM1916          GACATCAGGAATAGTC?????????????????????????????????????????
lichtensteinii_RM1249          GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
linearis_linearis_RM1010       GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
linearis_linearis_SH113        GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
linearis_ovalis_NDsn           GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
linearis_ovalis_RM854          ?????????????????????????????????????????????????????????
maritima_RM1038                GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
maritima_M290606_6             GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
othonnites_RM1306              GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
pectinata_M120903              GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
pectinata_RM1044               GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
rigida_M280902                 GACATCAGGAATAGTCGGGATAG??????????????????????????????????
rigida_RM840                   GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAA???????
rigens_leucolaena_RM773        GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
rigens_leucolaena_RM952_1      GACATCAGGAATAGTCGGGATA???????????????????????????????????
rigens_rigens_RM763            ?????????????????????????????????????????????????????????
rigens_rigens_SR463            GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
rigens_uniflora_JC201205       GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
rigens_uniflora_RM920          ?????????????????????????????????????????????????????????
schenckii                      GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
serrata_M250904_15             ?????????????????????????????????????????????????????????
serrata_RM898                  GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAA???????
tenuifolia_CAM1601             GACATCAGGAATAGTC?????????????????????????????????????????
tenuifolia_M2730               GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAAGACTGAAA???????
spnov_M040906_33               GACATCAGGAATAGTCGGGATAGCTCAGTTGGTAGAGCAGAGGACTGAAAATCCTCG
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[                                    10        20        30        40        50        60        70        80        90       100       110]

lichtensteiniiRM1323         TCGAACCCTGCATAGCGGAACGACCCGCGAACACGTACATACAACCGGGTGTAAAGGGGGGCAGG-CTCTAGCCGGCGACCCTTGACGCCCTGCCTTCCTGCGTACATGT
lichtesteiniiM050906_2       TCGAACCCTGCATAGCRGAACGACCCGCGAACACGTACATACAACCGGGTGTAAAGGGGGGCAGG-CTCTAGCCGGCGACCCTTGACGCCCTGCCTTCCTGCGTACATGT
heterochaetaM160901_5g       TCGAACCCTGCATAGCAGAACGACCCGCGAACATGTACATACAACCGGGTGTAAAGGGG--CAGG-CTCTAGCCGGCGACCCTTGACGCCCTGCCTTCCTGCGTGCATGT
heterochaetaRM1348           TCGAACCCTGCATAGCAGAACGACCCGCGAACATGTACATACAACCGGGTGTAAAGGGG--CAGG-CTCTAGCCGGCGACCCTTGACGCCCTGCCTTCCTGCGTGCATGT
heterochaetaRM1255           TCGAACCCTGCATAGCAGAACGACCCGCGAACATGTACATACAACTGGGTGTAAAGGGGGGCAGG-CTCTAGCCGGCGACCCTTGATGCCCTGCTTTCCTGCGTGCATGT
tenuifoliaM7219_10           TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTAAAGGGGGACAGG-CTCTAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
tenuifoliaRM1352             TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTAAAGGGGGACAGG-CTCTAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
ciliarisSR705                TCGAACCCTGCAAAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACAGG-CACTAGCCGGCGACCGTTGATGCCCTGCCTACCTGCGTGCATGT
jurineifolia_scabCAM1953     TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAATCGGGTGTTAAGGGGGACAGG-CTATAGCCGGCGACCCTTGACGCCCTGCCTACCTGCGTGCATGT
rigens_unifl_Boknes1         ??????CCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGG-CTCTAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
linearis_linear_Boknes2      TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGG-CTCTAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
linearis_ovalM041001_2g      ?????CCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGG-CTCTAGCCGGCGACCCTTGATGCCCTGCCRACCTGCGTGCATGT
rigens_leuco_M070704_1       TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGG-CTCTAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
krebsiana_krebM071001_1g     TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGG-CTCTAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
krebsiana_krebM071001_3gl    TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGG-CTCTAGCCGGCGACCTTTGATGCCCTGCCTACCTGCGTTCATGT
krebsiana_arctM071001_3pg    TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGG-CTCTAGCCGGCGACCTTTGATGCCCTGCCTACCTGCGTTCATGT
rigidaM100903_4              TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGG-CTCTAACCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
rigidaM100904_4              TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGG-CTCTAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTTCATGT
rigidM110805_10              TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGG-CTCTAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
rigidaM120805_80             TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGG-CTCTAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
leiopodaM160704_5            TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGG-CTCTAGCCGGCGACCCTTGATGCCCTGCCAACCTGCGTGCATGT
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serrM230901_7g               TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGG-CTCTAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTACATGT
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pectinataM250901_37          TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGG-CTCTAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
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maritimaM260901              ??????????????????????????GCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGG-CTCTWGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
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linearis_linearRM1406_2      TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGG-CTCTAGCCGGCGACCCTTGATGCCCTGCCTACCTGCGTGCATGT
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krebsiana_RVC162             TCGAACCCTGCATAGCAGAACGACCCGCGAACACGTACATACAACCGGGTGTCAAGGGGGACTGG-CTCTAGCCGGCGACCYTTGATGCCCTGCCTACCTGCGTKCATGT
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[                                     120       130       140       150       160       170       180       190       200       210       220]

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krebsiana_krebM230803_8      AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
serrM230901_7g               AGCCCTTTCTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
leiopodaM250901_34           AGCCCTTTCTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
pectinataM250901_37          AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACYGTGGCGTCCCG
pectM260901_2g               AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
maritimaM260901              AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
krebsiana_krebM261001_2      AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
maritimaM270901_5g           AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
rigens_rigensM7293           AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
rigens_rigensM7298_2         AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
rigens_rigensM7527_2         AGCCCTTTTTRGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
leiopodaM200901_22g          AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATATGAAGGGCTCGTACCGTGGCGTCCCG
spnov_M7237_4                AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCSTCCCG
serrataHerm_NB               AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACYGTGGCGTCCCG
krebsiana_krebNB1465         AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCRTGGCGTCCCG
linearis_linearRM1013        AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
rigens_leucoRM1021           AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
pectinataRM1044_1            AGCCCTTTTTGGGGCTCGTGAAC--TYAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
hybrRM1061                   AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATATGAAGGGCTCGTACCGTGGCGTCCCG
leiopodaRM1063               AGCCCTTTCTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
rigidaRM1082                 AGCCCTTTTTGGGGCTCGTGAAC--TCAGTGTTGGCATCTAAACAAA-CCCMGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
linearis_linearRM1090        AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
linearis_linearRM1092        AGCCCTTTTTAGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
linearis_linearRM1094        AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
linearis_linearRM1103        AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
krebsiana_serrRM1137         AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
linearis_linearRM1182        AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
rigidaRM1210                 AGCCCTTTTTGGGGCTCGTGAAC--TCAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTTCCGTGGCGTCCCG
serrataRM1216                AGCCCTTTTTGGGGCTCGTGAAC--TCAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
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serrataRM1245                AGCCCTTTTTGGGGCTCGTGAAC--TYAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
rigidaRM1254                 AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
serrataRM1260                AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGTCGTCCCG
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serrataRM1280                AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
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leioRM1320                   AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATATGAAGGGCTCGTACCGTGGCGTCCCG
pectinataRM1390              AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
krebsiana_krebRM713          AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
krebsiana_arctRM770_2        AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
rigens_rigensRM772_1         AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
linearis_linearRM780         AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACTGTGGCGTCCCG
rigens_uniflRM782_1          AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
rigens_uniflRM783            AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
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linearis_linearRM787         AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCRTGGCGTCCCG
linearis_linearRM789         AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
linearis_linearRM794         AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
linearis_linearRM804         AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
serrataRM812                 AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
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rigidaRM813                  AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
serrataRM821                 AGCCCTTTTTGGGGCTCGTGAAC--TCAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
krebsiana_arctRM831_1        AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
krebsiana_krebRM856          AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
krebsiana_krebRM874          AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
krebsiana_serrRM877          AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
linearis_linearRM884         AGCCCTTTTTAGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
linearis_linearRM885         AGCCCTTTTTAGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
krebsianaRM888               AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCC-
rigidaRM900_1                AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
krebsiana_arctRM903          AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
krebaRM904                   AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
krebsiana_krebRM906          AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
rigens_leucoRM919            AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
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krebsiana_krebRM949          AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCRTGGCGTCCCG
krebsiana_krebRM950          AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCRTGGCGTCCCG
linearis_linearRM951         AGCCCTTTTTGGGGCTCGTGAAC--TTAGTATTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
krebsiana_krebRM960          AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
krebsiana_krebRM962          AGCCCTTTTTAGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
krebsianaRM966               AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
krebsiana_krebRM968          AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
krebsiana_krebRM992          AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
krebsiana_RM996              AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
krebsiana_krebRM1403         AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
linearis_linearRM1406_1      AGCCCTTTTTAGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
linearis_linearRM1406_2      AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
leiopodaRM1466               AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
serrataHerm_RM               AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
krebsiana_RVC162             AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
krebsiana_krebSH110          AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
krebsiana_krebSH111_1        AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
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krebsianaSH115               AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
linearis_linearSH116         AGCCCTTTTTGGGGCTYGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
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krebsianaSH118               AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
linearis_linearSH131         AGCCCTTTTTRGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
linearis_linearSH132         AGCCCTTTTTAGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
krebsianaSH133               AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
krebsianaSH135               AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACTGTGGCGTCCCG
krebsianaSR480               AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
krebsianaSR520               AGCCCTTTTTGGGGCTTGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
linearis_linearSR523         AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
krebsianaSR564               AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
linearis_linearSR571         AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
rigens_rigSR574              AGCCCTTTTTRGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCRTGGCGTCCCG
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rigensSR581                  AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
rigens_uniflSR625            AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCGTGGCGTCCCG
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krebsiana_krebSVHF1          AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCATGGCGTCCCG
krebsiana_arctSV_HF2         AGCCCTTTTTGGGGCTCGTGAAC--TTAGTGTTGGCATCTAAACAAA-CCCCGGCACGGCATGTGCCAAGGAAAACAAAACATAGGAAGGGCTCGTACCRTGGCGTCCCG



[                                     230       240       250       260       270       280       290       300       310       320       330]

lichtensteiniiRM1323         TT-GCGGTGTACGCATGTGCGTGTCTCTTTTATAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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heterochaetaM160901_5g       TTTGCGGTGTACGCATGTGCGTGTCTCTTTTATAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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jurineifolia_scabCAM1953     TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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linearis_linear_Boknes2      TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
linearis_ovalM041001_2g      TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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rigidaM100903_4              TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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leiopodaM160704_5            TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
pectinataM180904_5           TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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krebsiana_krebM230803_8      TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
serrM230901_7g               TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
leiopodaM250901_34           TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
pectinataM250901_37          TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
pectM260901_2g               TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
maritimaM260901              TTCGCGGTGTRYGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
krebsiana_krebM261001_2      TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
maritimaM270901_5g           TTCGCGGTGTRYGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
rigens_rigensM7293           TTTGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
rigens_rigensM7298_2         TTTGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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leiopodaM200901_22g          TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
spnov_M7237_4                TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
serrataHerm_NB               TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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linearis_linearRM1013        TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
rigens_leucoRM1021           TTTGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
pectinataRM1044_1            TTCGCGGTGTATGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
hybrRM1061                   TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
leiopodaRM1063               TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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linearis_linearRM1103        TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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leioRM1320                   TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
pectinataRM1390              TTCGCGGTGTRYGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
krebsiana_krebRM713          TTCGCGGTGTGCGCATGTGCTTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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linearis_linearRM780         TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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rigens_uniflRM785            TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
linearis_linearRM787         TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
linearis_linearRM789         TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAGCGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
linearis_linearRM794         TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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serrataRM812                 TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAGCGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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serrataRM821                 TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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krebsiana_serrRM877          TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
linearis_linearRM884         TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAA-TGCGATACTTGGTG
linearis_linearRM885         TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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rigidaRM900_1                TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
krebsiana_arctRM903          TTCGCGGTGTGCGCATGTGCTTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
krebaRM904                   TTCGCGGTGTGCGCATGTGCTTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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rigens_leucoRM919            TTTGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAA-TGCGATACTTGGTG
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linearis_linearRM951         TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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krebsiana_krebRM968          TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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krebsiana_RM996              TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
krebsiana_krebRM1403         TTCGCGGTGTGCGCATGTGCKTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAA-TGCGATACTTGGTG
linearis_linearRM1406_1      TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
linearis_linearRM1406_2      TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAA-TGCGATACTTGGTG
leiopodaRM1466               TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
serrataHerm_RM               TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
krebsiana_RVC162             TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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linearis_linearSH116         TTCGCGGTGTGCGCATGTGCTTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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linearis_linearSH131         TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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krebsianaSH135               TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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rigens_rigSR574              TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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rigensSR581                  TTTGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
rigens_uniflSR625            TTTGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG
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krebsiana_arctSV_HF2         TTCGCGGTGTGCGCATGTGCGTGTCTCTTTTGTAATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAGAACGTAGCAAAATGCGATACTTGGTG

[                                    340       350       360       370       380       390       400       410       420       430       440]

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heterochaetaM160901_5g       TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
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tenuifoliaM7219_10           TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
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jurineifolia_scabCAM1953     TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
rigens_unifl_Boknes1         TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
linearis_linear_Boknes2      TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
linearis_ovalM041001_2g      TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
rigens_leuco_M070704_1       TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_krebM071001_1g     TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
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leiopodaM160704_5            TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
pectinataM180904_5           TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_krebM210902_1      TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
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serrM230901_7g               TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
leiopodaM250901_34           TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
pectinataM250901_37          TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
pectM260901_2g               TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
maritimaM260901              TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_krebM261001_2      TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
maritimaM270901_5g           TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
rigens_rigensM7293           TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
rigens_rigensM7298_2         TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
rigens_rigensM7527_2         TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
leiopodaM200901_22g          TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
spnov_M7237_4                TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
serrataHerm_NB               TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_krebNB1465         TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
linearis_linearRM1013        TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
rigens_leucoRM1021           TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
pectinataRM1044_1            TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
hybrRM1061                   TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
leiopodaRM1063               TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
rigidaRM1082                 TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAY
linearis_linearRM1090        TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
linearis_linearRM1092        TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
linearis_linearRM1094        TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
linearis_linearRM1103        TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_serrRM1137         TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
linearis_linearRM1182        TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
rigidaRM1210                 TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
serrataRM1216                TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
serrataRM1241                TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTYGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGSGTCGCCCCCTCAC
serrataRM1245                TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
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pectinataRM1390              TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_krebRM713          TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_arctRM770_2        TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
rigens_rigensRM772_1         TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
linearis_linearRM780         TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
rigens_uniflRM782_1          TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
rigens_uniflRM783            TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
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linearis_linearRM789	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
linearis_linearRM794	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
linearis_linearRM804	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
serrataRM812	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
rigidaRM813	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
serrataRM821	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_arctRM831_1	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_krebRM856	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_krebRM874	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_serrRM877	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
linearis_linearRM884	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
linearis_linearRM885	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsianaRM888	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
rigidaRM900_1	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_arctRM903	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCCCCCCCTCAC
krebaRM904	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_krebRM906	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
rigens_leucoRM919	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_krebRM929	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_krebRM949	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_krebRM950	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
linearis_linearRM951	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTTGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
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krebsianaRM966	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_krebRM968	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
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krebsiana_RM996	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_krebRM1403	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
linearis_linearRM1406_1	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
linearis_linearRM1406_2	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
leiopodaRM1466	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
serrataHerm_RM	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_RVC162	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_krebSH110	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_krebSH111_1	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_krebSH111_2	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_krebSH112	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsianaSH115	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
linearis_linearSH116	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCSGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
linearis_linearSH117	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTMGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsianaSH118	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
linearis_linearSH131	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
linearis_linearSH132	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsianaSH133	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsianaSH135	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsianaSR480	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsianaSR520	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCTAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
linearis_linearSR523	TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
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rigens_rigSR574              TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
rigens_rigSR575              TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
rigensSR581                  TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
rigens_uniflSR625            TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_krebSVHF1          TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC
krebsiana_arctSV_HF2         TGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCGCCCGAAACCATTCGGTCGAGGGCACGTCTGCCTGGGCGTCACGCATCGCGTCGCCCCCTCAC


[                                     450       460       470       480       490       500       510       520       530       540       550]

lichtensteiniiRM1323         AAC-CCTCCTTGTTGGGAACACGTTGTGTCAGGGGGCGGATATTGGTCTCCCATGCCTTTGGTGTGGTTGGCCTAAATCAGAGTCCCCTYGGTGGACGCACGGCTAGTGG
lichtesteiniiM050906_2       AAC-CCTCCYTGTTGGGAACACGTTGTGTCAGGGGGCGGATATTGGTCTCCCATGCCTTTGGTGTGGTTGGCCTAAATCAGAGTCCCCTYGGTGGACGCACGGCTAGTGG
heterochaetaM160901_5g       TAC-CCTTCCTGTTGGGAACACGTTGTGTGAGGGGGCGGATATTGGTCTCCCATGCCTTTGGTGTGGTTGGCCTAAATCAGAGTCCCCTTGGTGGACGCACGGCTAGTGG
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tenuifoliaRM1352             AACTCCTCCCTGTTGGGAACACGTTGTGTCA-GGGGCGGATATTGGTCTCCCATGCCTTTGGTGTGGTTGGCCTAAATCAGAGTCCCCTCGGTGGACGCACGGCTAGTGG
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jurineifolia_scabCAM1953     AACTCCTCCCTGTTGGGATCACGTTGGGTT-GGGGGCGGATATTGGCCTCCCATGCCTTTGGTGTGGTTGGCCTAAATCAGAGTCCCCTCGGTGGACGCACGGCTAGTGG
rigens_unifl_Boknes1         AACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTTGGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACSCACGGCTAGTGG
linearis_linear_Boknes2      AACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTTGGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
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rigidaM100904_4              AACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTTGGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
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pectinataM180904_5           AACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTTGGTGTGGCTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
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serrM230901_7g               AACTCCTCCCTGTTGGGAAAACGTTGTGTC-GGGGGCGGATATTGGTCTCCCATGCCTTCGGTGTGGCTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
leiopodaM250901_34           AACTCCTCCCTGTTGGGAAAACGTTGTGTC-GGGGGCGGATATTGGTCTCCCATGCCTTCGGTGTGGCTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
pectinataM250901_37          AACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTTGGTGTGGYTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
pectM260901_2g               AACTCCTCCCTGTTGGGAAAACGTTGTGTC-GGGGGCGGATATTGGTCTCCCATGCCTTTGGTGTGGATGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
maritimaM260901              AACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTTGGTGTGGCTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
krebsiana_krebM261001_2      AACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTTGGTGTGGTTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
maritimaM270901_5g           AACTCCTCCCTGTTGGGAAAACGTTGTGTCGGGGGGCGGATATTGGTCTCCCATGCCTTTGGTGTGGCTGGCCTAAATCTGAGTCCCCTCGGTGGACGCACGGCTAGTGG
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linearis_linearRM1013        TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGYAATGGAAGTRCTCATGAAAAGACCCAAAYGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
rigens_leucoRM1021           TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
pectinataRM1044_1            TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
hybrRM1061                   TGGTTGACAAGACCCTCTTCTGGTGTCGTGGTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGA????????????????????????????
leiopodaRM1063               TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
rigidaRM1082                 TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearRM1090        TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearRM1092        TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearRM1094        TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearRM1103        TGGTTGACAAGACCCTCTTATGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCATTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_serrRM1137         TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearRM1182        TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
rigidaRM1210                 TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
serrataRM1216                TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
serrataRM1241                TGGTTGACAASACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
serrataRM1245                TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCSACCGCGACCCCAGGTCAG
rigidaRM1254                 TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
serrataRM1260                TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
rigidaRM1270                 TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCGGACGATGCTTCGACCGCGACCCCAGGTCAG
serrataRM1280                TGGTTGACAASACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
leiopodaRM1291               TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
leioRM1320                   TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
pectinataRM1390              TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_krebRM713          TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGYAATGGAAGTRCTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_arctRM770_2        TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCRTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
rigens_rigensRM772_1         TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
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linearis_linearRM780         TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
rigens_uniflRM782_1          TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAT
rigens_uniflRM783            TGGTTGACAAGACCCTCTTCTGGTGTCRTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
rigens_uniflRM785            TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearRM787         TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearRM789         TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGCAATGGAAGTGCTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearRM794         TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearRM804         TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
serrataRM812                 TGGTTGAAAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAATGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
rigidaRM813                  TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGA????????????????????????????
serrataRM821                 TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_arctRM831_1        TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_krebRM856          TGGTTGACAAGACCCTCTTCTGGTGTGGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_krebRM874          TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_serrRM877          TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearRM884         TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearRM885         TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsianaRM888               TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
rigidaRM900_1                TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_arctRM903          TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebaRM904                   TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_krebRM906          TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
rigens_leucoRM919            TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_krebRM929          TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_krebRM949          TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGYAATGGAAGTRCTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_krebRM950          TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGYAATGGAAGTRCTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearRM951         TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_krebRM960          TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_krebRM962          TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsianaRM966               TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGCAATGGAAGTGCTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_krebRM968          TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_krebRM992          TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGCAATGGAAGTGCTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_RM996              TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTRCTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_krebRM1403         TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearRM1406_1      TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearRM1406_2      TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
leiopodaRM1466               TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
serrataHerm_RM               TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_RVC162             TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_krebSH110          TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_krebSH111_1        TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_krebSH111_2        TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_krebSH112          TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsianaSH115               TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearSH116         TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearSH117         TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsianaSH118               TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearSH131         TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearSH132         TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAGTGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCRGGTCAG
krebsianaSH133               TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACAATGCTTCGACCGCGACCCCAGGTCAG
krebsianaSH135               TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
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krebsianaSR480               TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsianaSR520               TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearSR523         TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsianaSR564               TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGCAATGGAAGTGCTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
linearis_linearSR571         TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGYAATGGAAGTRCTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
rigens_rigSR574              TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
rigens_rigSR575              TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
rigensSR581                  TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
rigens_uniflSR625            TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_krebSVHF1          TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG
krebsiana_arctSV_HF2         TGGTTGACAAGACCCTCTTCTGGTGTCGTGCTAAACCGTAATGGAAGTACTCATGAAAAGACCCAAACGCGTTGTCTTCTGACGATGCTTCGACCGCGACCCCAGGTCAG


[                                     670       680       690       700       710       720       730       740       750       760       770]

lichtensteiniiRM1323         GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACACATGGACTAGCCAACACACGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACACTAAACGA
lichtesteiniiM050906_2       GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACACATGGACTAGCCAACACACGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACACTAAACGA
heterochaetaM160901_5g       GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACGCGTCACACATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACACTAAACGA
heterochaetaRM1348           GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGTCACACATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACACTAAACGA
heterochaetaRM1255           GCGGGACTACCCGCTGAGGGTAGCATTCTTCTTCGACGCAACCCGTCACACATGGACTAGCCAACGCGCAACGAG-TG-ATCGTTTTAGAGAAGCGAGAACACTAAAGGA
tenuifoliaM7219_10           GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCACGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGTGAGAACACTAAACGA
tenuifoliaRM1352             GCGGGACTACCCG?????GGTAGCATTCCTCTTCGACGCAACCCGCCACGCACGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGTGAGAACACTAAACGA
ciliarisSR705                GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCATGCATGGACTTGCCAACGCACGACGAG-TG-ATCGTAATAGAGAAGCGAGAACGCTAAACGA
jurineifolia_scabCAM1953     GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGATGCARCCCGCCATGCATGGACTTGCCAACACACGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACGA
rigens_unifl_Boknes1         GCG???????????????GGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAATCAA
linearis_linear_Boknes2      GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
linearis_ovalM041001_2g      GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGTCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
rigens_leuco_M070704_1       ??????????????????GGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAATCAA
krebsiana_krebM071001_1g     GCGGGACTACCCGCTGAG?GTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
krebsiana_krebM071001_3gl    GCGGGACTACCCGCTGAG?GTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
krebsiana_arctM071001_3pg    GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
rigidaM100903_4              GCGG??????????????GGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
rigidaM100904_4              G?????????????????GGTAGCATTCCTCTTCGACGCAACCCGTCACACATGGACTAGCCAACGCGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
rigidM110805_10              GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGTCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
rigidaM120805_80             GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGTCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
leiopodaM160704_5            GCGGGACTACCCGCTGAG??TAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAG
pectinataM180904_5           GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
krebsiana_krebM210902_1      GCGG??????????????GGTAGCATTCCTCTTCGACGCAACCCGTCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
krebsiana_krebM230803_8      GCGGGACTACCCGCTGAG???????????????????????????????????????????????????GACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACGA
serrM230901_7g               GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAGCAA
leiopodaM250901_34           ??????????????????GGTAGCATTCCTCTTCGACGCAACCAGTCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
pectinataM250901_37          GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCACTCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
pectM260901_2g               GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCATCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
maritimaM260901              GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGTCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
krebsiana_krebM261001_2      GCGGGACTACCC??????GGTAGCATTCCTCTTCGACGCAACCAGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
maritimaM270901_5g           GCGGGACTACCCGCTGAG???????????????????????????????????????????????ACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
rigens_rigensM7293           GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCAGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAATCAA
rigens_rigensM7298_2         GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAATCAA
rigens_rigensM7527_2         GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCATCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
leiopodaM200901_22g          GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGTCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
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spnov_M7237_4              GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
serrataHerm_NB             GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
krebsiana_krebNB1465       GCGGGACTACCCGCTGAG??????????????????????????????????????????????????????GAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
linearis_linearRM1013      GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
rigens_leucoRM1021         GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAATCAA
pectinataRM1044_1          GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
hybrRM1061                 ??????????????????GGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
leiopodaRM1063             GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
rigidaRM1082               GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCATGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
linearis_linearRM1090      GCGGGACTACCCGCTGAG???????????????????????CCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACACTAAACAA
linearis_linearRM1092      GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
linearis_linearRM1094      GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
linearis_linearRM1103      GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
krebsiana_serrRM1137       GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
linearis_linearRM1182      GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
rigidaRM1210               GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGTCACACATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
serrataRM1216              GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
serrataRM1241              GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGACACCCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
serrataRM1245              GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
rigidaRM1254               GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGC-ACACATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
serrataRM1260              GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACCCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
rigidaRM1270               GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
serrataRM1280              GCGGGACTACCCGCTGAG??TAGCATTCCTCTTCGACGCAACCCATCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
leiopodaRM1291             GCGGGACTACCCGCTGAG????????????????????????????????????????????????????ACGAG-TG-ATCGTTTTACAGAAGCGAGAACGGTAAACAG
leioRM1320                 GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGGCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAG
pectinataRM1390            GCGGGACTACCC???????GTAGCATTCCTCTTCGACGCAACCAGTCACGCATGGTCTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
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krebsiana_arctRM770_2      GCGGGACTACCCGCTGAG?GTAGCATTCCTCTTCGACGCAACCCATCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
rigens_rigensRM772_1       GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCATCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAATCAA
linearis_linearRM780       GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
rigens_uniflRM782_1        GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCAATCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
rigens_uniflRM783          GCGGGACTACCCGCTGAG????????????????????????????CACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
rigens_uniflRM785          GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
linearis_linearRM787       GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
linearis_linearRM789       GCGG-ACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
linearis_linearRM794       GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
linearis_linearRM804       GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
serrataRM812               GCGGGACTACCCG?????GGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
rigidaRM813                ??????????????????GGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
serrataRM821               GCGGGACTACCCGCTGAG??TAGCATTCCTCTTCGACGCAACCCGTCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
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krebsiana_serrRM877        GCGG-ACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
linearis_linearRM884       GCGG-ACT??????????GGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
linearis_linearRM885       GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
krebsianaRM888             GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
rigidaRM900_1              GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
krebsiana_arctRM903        GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
krebaRM904                 GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
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rigens_leucoRM919             GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAATCAA
krebsiana_krebRM929           GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
krebsiana_krebRM949           GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
krebsiana_krebRM950           GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
linearis_linearRM951          GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
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linearis_linearRM1406_1       GCGGGACTACCCGCTGAG???????????????????????????????CATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
linearis_linearRM1406_2       GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCCTCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
leiopodaRM1466                GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAG
serrataHerm_RM                GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
krebsiana_RVC162              GCGGGACTACCCGCTGAG??TAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGC-ACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
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linearis_linearSR523          GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
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rigens_rigSR574               GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA
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rigensSR581                   GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAATCAA
rigens_uniflSR625             GCGGGACTACCC?????????????????????????????CCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAATCAA
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krebsiana_arctSV_HF2          GCGGGACTACCCGCTGAGGGTAGCATTCCTCTTCGACGCAACCCGCCACGCATGGACTAGCCAACACGCGACGAG-TG-ATCGTTTTAGAGAAGCGAGAACGCTAAACAA

[                                       780       790       800       810       820       830       840       850       860       870       880]

lichtensteiniiRM1323          GGACATAAAAAGATCATCTAAGACCCCATGCCCACATCAGGTTCCGTATCCAAGACACCAAGCGAAACTCAACAAGCCACATCGACGAA-G--TGTTTACAACGACAAAA
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rigens_unifl_Boknes1          GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_linear_Boknes2       GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_ovalM041001_2g       GGACATAAAAAGATCATTAAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGGCGAT-G--TGTACACAACGACAAGA
rigens_leuco_M070704_1        GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_krebM071001_1g      GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
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serrM230901_7g                GGACATAAGATGATCGTTTACCACCC-ATGACAACATTAGGT-CCATATCCAAGAAACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
leiopodaM250901_34            GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
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serrataHerm_NB                GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_krebNB1465          GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_linearRM1013         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
rigens_leucoRM1021            GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
pectinataRM1044_1             GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
hybrRM1061                    GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCRCCGAT-G--TGTACACAACGACAAGA
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rigidaRM1082                  GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_linearRM1090         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGACGAT-G--TGTACACAACGACAAGA
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linearis_linearRM1094         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_linearRM1103         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_serrRM1137          GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_linearRM1182         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
rigidaRM1210                  GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
serrataRM1216                 GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
serrataRM1241                 GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGGGAAACTCAGCAAGCCACATCGGCGAT-G--TGTACACAACGACAAGA
serrataRM1245                 GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
rigidaRM1254                  GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
serrataRM1260                 GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
rigidaRM1270                  GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
serrataRM1280                 GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
leiopodaRM1291                GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGGCACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACAACAAGA
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leioRM1320                   GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
pectinataRM1390              GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_krebRM713          GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_arctRM770_2        GGACATAAAAAGATCATCTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGACGAT-G--TGTACACAACGACAAGA
rigens_rigensRM772_1         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_linearRM780         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
rigens_uniflRM782_1          GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
rigens_uniflRM783            GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
rigens_uniflRM785            GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_linearRM787         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTTAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_linearRM789         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTYAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_linearRM794         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_linearRM804         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
serrataRM812                 GGACATAAAAAGATCATCTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
rigidaRM813                  GGACATAAAAAGATCATCTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
serrataRM821                 GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_arctRM831_1        GGACATAAAAAGATCATCTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGACGAT-G--TGTACACAACGACAAGA
krebsiana_krebRM856          GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_krebRM874          GGACATAAAAAGATCATYTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_serrRM877          GGACATAAAAAGATCATYTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_linearRM884         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTRGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_linearRM885         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsianaRM888               GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
rigidaRM900_1                GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_arctRM903          GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebaRM904                   GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTRCACAACGACAAGA
krebsiana_krebRM906          GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
rigens_leucoRM919            GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_krebRM929          GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_krebRM949          GGACATAAAAAGATCATTTWAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_krebRM950          GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_linearRM951         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_krebRM960          GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_krebRM962          GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT---------------------
krebsianaRM966               GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_krebRM968          GGACATAAAAAGATCATCTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_krebRM992          GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_RM996              GGACATAAAAAGATCATYTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_krebRM1403         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_linearRM1406_1      GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_linearRM1406_2      GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
leiopodaRM1466               GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
serrataHerm_RM               GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_RVC162             GGACATAAAAAGATCATYKAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_krebSH110          GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_krebSH111_1        GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCRAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_krebSH111_2        GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_krebSH112          GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsianaSH115               GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_linearSH116         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_linearSH117         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
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krebsianaSH118               GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_linearSH131         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_linearSH132         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsianaSH133               GGACATAAAAAGATCATTTAAGACCC-ATGCCCACAWTAGGTTCCATATCCAAGACAACAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsianaSH135               GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsianaSR480               GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsianaSR520               GGACATAAAAAGATCATCTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCARGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_linearSR523         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsianaSR564               GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
linearis_linearSR571         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
rigens_rigSR574              GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
rigens_rigSR575              GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
rigensSR581                  GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
rigens_uniflSR625            GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_krebSVHF1          GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA
krebsiana_arctSV_HF2         GGACATAAAAAGATCATTTAAGACCC-ATGCCCACATTAGGTTCCATATCCAAGACACCAAGCGAAACTCAGCAAGCCACATCGCCGAT-G--TGTACACAACGACAAGA

[                                     890       900       910       920       930       940       950       960       970       980       990]

lichtensteiniiRM1323         TGGCTTACAGAGACCACTTACTGGTCCGTCATGCACCACAAGTGCGATGCGTGACGGAAACAGATTCAATCGGTCCATACAATGCCTTTGATTAGGTACGCAACACAGGA
lichtesteiniiM050906_2       TGGCTTACAGAGACCACTTACTGGTCCGTCATGCACCACAAGTGCGATGCGTGACGGAAACAGATTCAATCGGTCCATACAATGCCTTTGATTAGGTACGCAACACAGGA
heterochaetaM160901_5g       TGGCTTACAGAGACCACTTACTGGTCCGTCATGCACCAC-AGTGCGATGCGTGACAAAAACAGATTCAATCGGTCCATACAATGCCTTTGATTAGGAACGCAACACAGGA
heterochaetaRM1348           TGGCTTACAGAGACCACTTACTGGTCCGTCATGCACCAC-AGTGCGATGCGTGACAAAAACAGATTCAATCGGTCCATACAATGCCTTTGATTAGGAACGCAACACAGGA
heterochaetaRM1255           TGGCTTACAAAGACCACTTACTGGTCCGTCATGCACCACAAGTGCGATGAGCGACGAAAACAGATTCAATCGGTCCATACAATGCCTTTGATTAGGTACTCAACACAGGA
tenuifoliaM7219_10           TGGATTACGGAGACCACTTACTGGTCCGTCATGCACCACAAGTGCGATGCGTGACGGAAAAAGATTCAATCTGT-CATACAATGCCCTCAATCTGTCATACATCATCTAG
tenuifoliaRM1352             TGGATTACGGAGACCACTTACTGGTCCGTCATGCACCACAAGTGCGATGCGTGACGGAAAAAGATTCAATCAGT-CATACAATGCCCTTGATTAGGTACGCAACACAGGA
ciliarisSR705                CGGATTACAGAGAATGCTTACTGGTCCGTCATGCACCACATGTGCGATGCGTGACGGAAACAGATTCAATCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGGA
jurineifolia_scabCAM1953     TGGATTACAGAGACCACTTGCTGGTCCGTCATGCACCACAAGTGCGATGCGTGACGGAAACAGATTCAATCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGAA
rigens_unifl_Boknes1         TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
linearis_linear_Boknes2      TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
linearis_ovalM041001_2g      TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigens_leuco_M070704_1       TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsiana_krebM071001_1g     TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGYGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsiana_krebM071001_3gl    TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsiana_arctM071001_3pg    TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigidaM100903_4              TGGATTACTAAGACCACTTACTGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTTGATTAGGTACGCAACACAGTA
rigidaM100904_4              TGGATTACTAAGAACACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACTGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigidM110805_10              TGGATTACTGAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigidaM120805_80             TGGATTACTGAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTTGATTAGGTACGCAACACAGTA
leiopodaM160704_5            TGGATTACTGAGACCACTTACCGGTCCATCATGCAGCACATGTGCGATGCATGACGGAAACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGCA
pectinataM180904_5           TGGATTACTGAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsiana_krebM210902_1      TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsiana_krebM230803_8      TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
serrM230901_7g               TGGATTACTGAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
leiopodaM250901_34           TGGATTACTGAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
pectinataM250901_37          TGGATTACTRAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
pectM260901_2g               TGGATTACTGAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
maritimaM260901              TGGATTACTGAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsiana_krebM261001_2      TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
maritimaM270901_5g           TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigens_rigensM7293           TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
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rigens_rigensM7298_2        TGGATTACTAAGACCACTTACCGGKCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigens_rigensM7527_2        TGGATTACTAAGACCACTTACTGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
leiopodaM200901_22g         TGGATTACTGAGACCACTTACCGGTCCATCATGCACCACATGTGCGATGCATGACAGAAACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
spnov_M7237_4               TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
serrataHerm_NB              TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsiana_krebNB1465        TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
linearis_linearRM1013       TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGAYGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigens_leucoRM1021          TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
pectinataRM1044_1           TGGATTACTGAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
hybrRM1061                  TGGATTACTRAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
leiopodaRM1063              TGGATTACTGAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigidaRM1082                TGGATTACTGAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
linearis_linearRM1090       TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
linearis_linearRM1092       TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
linearis_linearRM1094       TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
linearis_linearRM1103       TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCACGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsiana_serrRM1137        TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
linearis_linearRM1182       TGGATTACTAAGAACACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigidaRM1210                TGGATTACTGAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
serrataRM1216               TGGATTACTGAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
serrataRM1241               TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACTGATACATATTCATTCGGTCCATACAATGCCTTCTATTAGGTACGCAACACATTA
serrataRM1245               TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigidaRM1254                TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
serrataRM1260               TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigidaRM1270                TGGATTACTRAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
serrataRM1280               TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGAGTAGGTACGCAACACAGTA
leiopodaRM1291              TGGATTACTGAGACCACTTACCGGTCCATCATGCACCACATGTGCGATGCATGACGGAAACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGCA
leioRM1320                  TGGATTACTGAGACCACTTACCGGTCCATCATGCAGCACATGTGCGATGCATGACGGAAACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGCA
pectinataRM1390             TGGATTACTGAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsiana_krebRM713         TGGATTACTAAGAACACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsiana_arctRM770_2       TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigens_rigensRM772_1        TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
linearis_linearRM780        TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigens_uniflRM782_1         TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigens_uniflRM783           TGGATTACTAAGAACACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
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linearis_linearRM804        TGGATTACTAAGAACACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
serrataRM812                TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigidaRM813                 TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCAGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
serrataRM821                TGGATTACTGAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
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krebsiana_krebRM874         TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsiana_serrRM877         TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
linearis_linearRM884        TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
linearis_linearRM885        TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsianaRM888              TGGATTACTAAGAACACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
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krebsiana_krebRM906          TGGATTACTAAGAACACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigens_leucoRM919            TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
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krebsiana_krebRM950          TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
linearis_linearRM951         TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsiana_krebRM960          TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
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krebsiana_RM996              TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
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leiopodaRM1466               TGGATTACTGAGACCACTTACCGGTCCATCATGCAGCACATGTGCGATGCATGACGAAAACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
serrataHerm_RM               TGGATTACTAAGACCACTTACYGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsiana_RVC162             TGGATTACTAAGASCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsiana_krebSH110          TGGATTACTAAGAACACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
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krebsianaSH135               TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsianaSR480               TGGATTACTAAGAACACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
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linearis_linearSR523         TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
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linearis_linearSR571         TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigens_rigSR574              TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigens_rigSR575              TGGATTACTAAGAACACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACACAACACAGTA
rigensSR581                  TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
rigens_uniflSR625            TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
krebsiana_krebSVHF1          TGGATTACTAAGACCACTTACCGGTCCATCATGCACCACTTGTGCGATGCATGACGGATACATATTCATTCGGTCCATACAATGCCTTCGATTAGGTACGCAACACAGTA
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[                                     1000      1010      1020      1030      1040      1050      1060      1070      1080      1090      1100]

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lichtesteiniiM050906_2       AACCCACAATACGAGCAAGTCTACAACAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
heterochaetaM160901_5g       AACCCACAAAACGAGCAAGTCTACAACAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
heterochaetaRM1348           AACCCACAAAACGAGCAAGTCTACAACAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
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rigens_unifl_Boknes1          AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_linear_Boknes2       AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_ovalM041001_2g       AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
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serrataHerm_NB                AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
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linearis_linearRM1013         AACCCACAATACGAGCAACACTAAATTATGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
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pectinataRM1044_1             AACCCACAATACGAGCAACACTAAAATAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
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leiopodaRM1063                AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigidaRM1082                  AACCCACAATACGAGCAACACTAAAATAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
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krebsiana_serrRM1137          AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_linearRM1182         AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigidaRM1210                  AACCCACAATACGAGCAACACTAAAATAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
serrataRM1216                 AACCCACAATACGAGCAACACTAAAATAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
serrataRM1241                 AACCCACAATACTAGCAAGACTGAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
serrataRM1245                 AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigidaRM1254                  AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
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serrataRM1280                AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
leiopodaRM1291               AACCCGCAATACGAGCAACACTAAAATAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
leioRM1320                   AACCCGCAATACGAGCAACACTAAAATAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
pectinataRM1390              AACCCACAATACGAGCAACACTAAAATAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_krebRM713          AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_arctRM770_2        AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigens_rigensRM772_1         AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_linearRM780         AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigens_uniflRM782_1          AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigens_uniflRM783            AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigens_uniflRM785            AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_linearRM787         AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_linearRM789         AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_linearRM794         AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_linearRM804         AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
serrataRM812                 AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigidaRM813                  AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTAYGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
serrataRM821                 AACCCACAATACGAGCAACACTAAAATAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_arctRM831_1        AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_krebRM856          AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_krebRM874          AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_serrRM877          AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_linearRM884         AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_linearRM885         AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsianaRM888               AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigidaRM900_1                AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_arctRM903          AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebaRM904                   AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_krebRM906          AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigens_leucoRM919            AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_krebRM929          AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_krebRM949          AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_krebRM950          AACCCRCAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_linearRM951         AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_krebRM960          AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_krebRM962          --------------------------------------------------------------------------------------------------------------
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krebsiana_krebRM968          AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_krebRM992          AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_RM996              AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_krebRM1403         AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_linearRM1406_1      AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_linearRM1406_2      AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
leiopodaRM1466               AACCCGCAATACGAGCAACACTAAAATAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
serrataHerm_RM               AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_RVC162             AACCCACAATACGAGCAASACTRAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_krebSH110          AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_krebSH111_1        AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_krebSH111_2        AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_krebSH112          AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
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krebsianaSH115               AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_linearSH116         AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_linearSH117         AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsianaSH118               AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_linearSH131         AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_linearSH132         AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsianaSH133               AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsianaSH135               AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsianaSR480               AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsianaSR520               AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_linearSR523         AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsianaSR564               AACCCACAATACGAGCAACACTAAATTATGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
linearis_linearSR571         AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigens_rigSR574              AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigens_rigSR575              AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigensSR581                  AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
rigens_uniflSR625            AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_krebSVHF1          AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA
krebsiana_arctSV_HF2         AACCCACAATACGAGCAACACTAAATTAAGCCTTGCTACGTAAATGAAGAGGTAAGCACGCATGGAAGTTGCTTCGCTAGAAGACATCCAACCACCCGTAACAAACCAAA


[                                     1110      1120      1130      1140      1150      1160      1170      1180      1190      1200      1210]

lichtensteiniiRM1323         CACCACTCATGCACCTTTACGGTAAACATTCCCCGAAACCACCCGACTAGTAGCCACCCACTTAACACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
lichtesteiniiM050906_2       CACCACTCATGCACCTTTACGGTAAACATTCCCCGAAACCACCCGACTAGTAGCCACCCACTTAACACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
heterochaetaM160901_5g       CACCACTCATGCACCTTTACGGTAAACATTCCCCGAAACCACCCGACTAGTAGCCACCCACTTAGCACAGA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
heterochaetaRM1348           CACCACTCATGCACCTTTACGGTAAACATTCCCCGAAACCACCCGACTAGTAGCCACCCACTTAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
heterochaetaRM1255           CACCACTCATGCACCTTTACGGTAAACATTCCCCGAAACCACCCGACTAGTAGCCACCCACTTAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
tenuifoliaM7219_10           --------------------------------------------------------------------------------------------------------------
tenuifoliaRM1352             CACCACTCATGCACCTTTACGGTAAACATTTCCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAGAGCAATCCCAAAA
ciliarisSR705                CACCACTCATGCACCTTTACGGTAAACATTTCCCGAAACCACCCAACTAGTAGCCACCCACATAGCACAAA--GGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
jurineifolia_scabCAM1953     CACCACTCATGCACCTTTACKGTAAACATTTCCCGGAACCACCCGACTAGTAGCCACCCACGTAGCACAAAAGGCCAAGCAAGCAACCAAAAGCCGAAGCAATCCCAAAA
rigens_unifl_Boknes1         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCAAAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linear_Boknes2      CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_ovalM041001_2g      CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigens_leuco_M070704_1       CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCAAAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_krebM071001_1g     CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAGCCAAAAGCCAAAGCAATCCCAAAA
krebsiana_krebM071001_3gl    CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_arctM071001_3pg    CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigidaM100903_4              CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigidaM100904_4              CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigidM110805_10              CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigidaM120805_80             CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
leiopodaM160704_5            CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
pectinataM180904_5           CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAacCACCCGACTAGTAGCCACCCACATAGCACAAa--TGCAAGCAaGCAACCAAAAGC????????????????
krebsiana_krebM210902_1      CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_krebM230803_8      CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
serrM230901_7g               CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
leiopodaM250901_34           CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGAAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
pectinataM250901_37          CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
pectM260901_2g               CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCGCATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
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maritimaM260901              CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_krebM261001_2      CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
maritimaM270901_5g           CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigens_rigensM7293           CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCAAAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigens_rigensM7298_2         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCAAAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigens_rigensM7527_2         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCTATCCCAAAA
leiopodaM200901_22g          CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
spnov_M7237_4                CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
serrataHerm_NB               CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_krebNB1465         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearRM1013        CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigens_leucoRM1021           CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCAAAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
pectinataRM1044_1            CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
hybrRM1061                   CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
leiopodaRM1063               CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGAAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigidaRM1082                 CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearRM1090        CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearRM1092        CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearRM1094        CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearRM1103        CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_serrRM1137         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearRM1182        CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigidaRM1210                 CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
serrataRM1216                CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
serrataRM1241                CACCACTCATGCGCCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
serrataRM1245                CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigidaRM1254                 CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
serrataRM1260                CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigidaRM1270                 CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
serrataRM1280                CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
leiopodaRM1291               CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
leioRM1320                   CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCCAGCAACCAAAAGCCAAAGCAATCCCAAAA
pectinataRM1390              CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_krebRM713          CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_arctRM770_2        CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigens_rigensRM772_1         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCAAAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearRM780         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigens_uniflRM782_1          CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigens_uniflRM783            CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigens_uniflRM785            CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearRM787         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearRM789         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearRM794         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearRM804         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
serrataRM812                 CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigidaRM813                  CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
serrataRM821                 CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_arctRM831_1        CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_krebRM856          CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_krebRM874          CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_serrRM877          CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
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linearis_linearRM884         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearRM885         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsianaRM888               CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigidaRM900_1                CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_arctRM903          CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebaRM904                   CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_krebRM906          CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigens_leucoRM919            CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCAAAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_krebRM929          CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_krebRM949          CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_krebRM950          CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearRM951         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_krebRM960          CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_krebRM962          --------------------------------------------------------------------------------------------------------------
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krebsiana_krebRM968          CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_krebRM992          CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_RM996              CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_krebRM1403         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearRM1406_1      CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearRM1406_2      CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
leiopodaRM1466               CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
serrataHerm_RM               CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_RVC162             CACCACTCATGCGCCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_krebSH110          CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
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krebsianaSH115               CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearSH116         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearSH117         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsianaSH118               CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearSH131         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearSH132         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsianaSH133               CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsianaSH135               CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsianaSR480               CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsianaSR520               CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearSR523         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsianaSR564               CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
linearis_linearSR571         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigens_rigSR574              CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCTATCCCAAAA
rigens_rigSR575              CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCTATCCCAAAA
rigensSR581                  CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCAAAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
rigens_uniflSR625            CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_krebSVHF1          CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA
krebsiana_arctSV_HF2         CACCACTCATGCACCTTTACGGTAAACATTTTCCGAAACCACCCGACTAGTAGCCACCCACATAGCACAAA--TGCAAGCAAGCAACCAAAAGCCAAAGCAATCCCAAAA

[                                     1220      1230      1240      1250      1260      1270      1280      1290      1300      1310      1320]

lichtensteiniiRM1323         ATGAACCGAACGATGCGAGAAACAATAAAGCTACGAAACCGACACGATCGCCTCATCAAAACGCTCGCTTCATGMTTTTCT-A-CACACAACGCATCGCAAGACTAGGCT
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lichtesteiniiM050906_2	ATGAACCGAACGATGCGAGAAACAATAAAGCTACGAAACCGACACGATCGCCTCATCAAAACGCTCGCTTCATGCTTTTCT-A-CACACAACGCATCGCAAGACT--AGG
heterochaetaM160901_5g	ATGCACCGAACGACGCGAGAAACAATTAAGCTACGAAACCGACACGATCGCCTCATCAAAACGCTCGCTTCATGATTTTCT-A-CACACAACGCATCGCTAGACTAGGCT
heterochaetaRM1348	ATGCACCGAACGACGCGAGAAACAATTAAGCTACGAAACCGACACGATCGCCTCATCAAAACGCTCGCTTCATGATTTTCT-A-CACACAACGCATCGCTAGACTGGGCT
heterochaetaRM1255	ATGCACCGAACGATGCGAGAAACAATAAAGCTACGCAACCAACACGATCGCCTCATCAAAACGCTCGCTTCATGATTTTCT-A-GACACAATGCATCGCCAGACTGGGCT
tenuifoliaM7219_10	--CCAACCCGCCTCATCAAAACGCTCGCTTCATCGTTTTCC-A-CACACAACGCATCGCAAGCCA-GGCT
tenuifoliaRM1352	ATGCACCGAACGATGCGAGAAACAATTAAGCTACGAAACCGACACGATCGCCTCATCAAAACGCTCGCTTCATGGTTTTCC-A-CACACAACGCATCACAAGCCA-GGCT
ciliarisSR705	ATGCACCGAACGATGCGAGAAATAATAAAGCTACGAACCCGACATGATCGCCTCATCAAAACGCTCGCTTCACGATTTTCTTA-GACACCACGCATCGCTAGCCG-GGCT
jurineifolia_scabCAM1953	ATGCACCGAACGATGCGAGAAACAATAAAGCTACGAAACCAACATGATCGCCTCATTAAAACGCTCGCTTCATGATTTTCT-A-CGCACAACGTATCGCTAGCCG-GGCT
rigens_unifl_Boknes1	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
linearis_linear_Boknes2	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
linearis_ovalM041001_2g	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
rigens_leuco_M070704_1	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_krebM071001_1g	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATGATTTCCG-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_krebM071001_3gl	ATGTACCGAACGATGCGAGAAACAATAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_arctM071001_3pg	ATGTACCGAACGATGCGAGAAACAATAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
rigidaM100903_4	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GACT
rigidaM100904_4	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CGCACAACGCATCGCTAGCAA-GGCT
rigidM110805_10	ATGCACCGAACGATGCGAGAAACAGAAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTACCA-A-GACACAACGCATCGCTAGCAA-GGCT
rigidaM120805_80	ATGCACCGAACGATGCGAGAAACAGAAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTACCA-A-GACACAACGCATCGCTAGCAA-GGCT
leiopodaM160704_5	ATGCACCGAACGATGCGAGAAACAGTAACGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCGG-GGCT
pectinataM180904_5	??
krebsiana_krebM210902_1	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_krebM230803_8	ATGTACCGAACGATGCGAGAAACATTAAAGCTACGAAACCAACACGATCGCCTCATACAAAAGCTCGCTTCATTATTTCCA-A-GACACAACGCATCGCTAGCAA-GGCT
serrM230901_7g	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
leiopodaM250901_34	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCACCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
pectinataM250901_37	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
pectM260901_2g	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
maritimaM260901	ATGCACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_krebM261001_2	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
maritimaM270901_5g	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
rigens_rigensM7293	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
rigens_rigensM7298_2	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
rigens_rigensM7527_2	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
leiopodaM200901_22g	ATGCACCGAACGATGCGAGAAACAGTAACGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGC???????
spnov_M7237_4	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACACTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
serrataHerm_NB	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_krebNB1465	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
linearis_linearRM1013	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
rigens_leucoRM1021	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
pectinataRM1044_1	ATGCACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
hybrRM1061	ATGYACCGAACGATGCGAGAAACAGTAACGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACAC?????????????????????
leiopodaRM1063	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCACCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
rigidaRM1082	ATGCACCGAACGATGCGAGAAACAGAAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
linearis_linearRM1090	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGGTTACAA-GGCT
linearis_linearRM1092	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
linearis_linearRM1094	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCWACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
linearis_linearRM1103	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAAAACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_serrRM1137	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
linearis_linearRM1182	ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CGCACAACGCATCGCTAGCAA-GGCT
rigidaRM1210	ATGCACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTACCA-A-GACACAACGCATCGCTAGCAA-GGCT
serrataRM1216	ATGCACCGAACGATGCGAGAAACAGAAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTWCCA-A-SACACAACGCATCGCTAGCAA-GGCT

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serrataRM1241                ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGCAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
serrataRM1245                ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
rigidaRM1254                 ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATGCAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
serrataRM1260                ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
rigidaRM1270                 ATGTACCGAGCGATGCGAGAAACAGTAAAGCTACGAAACCAACASGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
serrataRM1280                ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAAGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
leiopodaRM1291               ATGCACCGAACGATGCAAGAAACAGTAACGCTACGAAACCAACACGATCGGCTCATACAAACACTCRCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCGG-GGCT
leioRM1320                   ATGCACCGAACGATGCGAGAAACAGTAACGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTTCC-AACACACAACGGCATCGC??????????
pectinataRM1390              ATGCACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_krebRM713          ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CGCACAACGCATCGCTAGCAA-GGCT
krebsiana_arctRM770_2        ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
rigens_rigensRM772_1         ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
linearis_linearRM780         ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
rigens_uniflRM782_1          ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
rigens_uniflRM783            ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGAC??????
rigens_uniflRM785            ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CGCACAACGCATCGCTAGCAA-GGCT
linearis_linearRM787         ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
linearis_linearRM789         ATGTACCGAACGATGCGAGAAACAGTAAAGCTATGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CGCACAACGCATCGCTAGCAA-GGCT
linearis_linearRM794         ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CGCACAACGCATCGCTAGCAA-GGCT
linearis_linearRM804         ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CRCACAACGCATCGCTAGCAA-GGCT
serrataRM812                 ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
rigidaRM813                  ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
serrataRM821                 ATGCACCGAACGATGCGAGAAACAGAAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTACCA-A-GACACAACGCATCGCTAGCAA-GGCT
krebsiana_arctRM831_1        AWGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_krebRM856          ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_krebRM874          ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_serrRM877          ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
linearis_linearRM884         ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
linearis_linearRM885         ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsianaRM888               ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CGCACAACGCATCGCTAGCAA-GGCT
rigidaRM900_1                ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_arctRM903          ATGTACCGAACGATGCGAGAAACAGTAAAGCTACAAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CGCACAACGCATCGCTAGCAA-GGCT
krebaRM904                   ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CGCACAACGCATCGCTAGCAA-GGCT
krebsiana_krebRM906          ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CRCACAACGCATCGCTAGCAA-GGCT
rigens_leucoRM919            ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_krebRM929          ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_krebRM949          ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CGCACAACGCATCGCTAGCAA-GGCT
krebsiana_krebRM950          ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
linearis_linearRM951         ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCRCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_krebRM960          ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_krebRM962          -------------------------------------------------GCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsianaRM966               ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_krebRM968          ATGTACCGAACGATGCGAGAAACAATAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_krebRM992          ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCTACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_RM996              ATGTACCGAACGATGCGAGAAACATTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_krebRM1403         ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
linearis_linearRM1406_1      ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
linearis_linearRM1406_2      ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
leiopodaRM1466               ATGCACCGAACGATGCGAGAAACAGTAACGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATTGCTAGCGG-GGCT
serrataHerm_RM               ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_RVC162             ATGTACCGAACGATGCGAGAAACAT?????????????????????????????????????????????????????????????????????????????????????
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krebsiana_krebSH110          ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CGCACAACGCATCGCTAGCA??????
krebsiana_krebSH111_1        ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CGCACAACGCATCGCTAGCAA-GGCT
krebsiana_krebSH111_2        ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CGCACAACGCATCGCTAGCAA-GGCT
krebsiana_krebSH112          ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsianaSH115               ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CGCACAAGCGCATCCTAGCAA-GGCT
linearis_linearSH116         ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CRCACAACGCATCGCTAGCAA-GGCT
linearis_linearSH117         ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsianaSH118               ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
linearis_linearSH131         ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
linearis_linearSH132         ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsianaSH133               ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CGCACAACGCATCGCTAGCAA-GGCT
krebsianaSH135               ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACASGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsianaSR480               ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CGCACAACGCATCGCTAGCAA-GGCT
krebsianaSR520               ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
linearis_linearSR523         ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsianaSR564               ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
linearis_linearSR571         ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
rigens_rigSR574              ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
rigens_rigSR575              ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
rigensSR581                  ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
rigens_uniflSR625            ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACAGGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_krebSVHF1          ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT
krebsiana_arctSV_HF2         ATGTACCGAACGATGCGAGAAACAGTAAAGCTACGAAACCAACACGATCGCCTCATACAAACGCTCGCTTCATTATTTCCA-A-CACACAACGCATCGCTAGCAA-GGCT

[                                     1330      1340      1350      1360      1370      1380      1390      1400      1410      1420      1430]

lichtensteiniiRM1323         --TGCGAACA-CGTCATGCATCGAAAAGTAATCA--GCTTGCCATCCTCCATGGTGTTGCGAAGCGACAACACCACATCATCG???????????????????????????
lichtesteiniiM050906_2       CTTGCGAACA-CGTCATGCATCGAAAAGTAATCA--GCTTGCCATCCTCCATGGTGTTGCGAAGCGACAACACCACATCATCGGT---AAACCGTTAACTACGTCGCCTT
heterochaetaM160901_5g       --TGCAAACA-CGTCATGCATCGAAAACAAATCA--GCTTGCCACCCTCCATGGTGTTGCGAAGCGACAACACCACATCATTGGC---ACACCGTTAACTACGTCGCCTT
heterochaetaRM1348           --TGCAAACA-CGTCATGCATCGAAAACAAATCA--GCTTGCCACCCTCCATGGTGTTGCGAAGCGACAACACCACAT????????????????????????????????
heterochaetaRM1255           --TGCAAACA-CGTCATRCATCGAAAACCAATCA--GCTTGCCACCCTCAATGGTGTTGCGAAGCGACAACACCACATCATTG????????????????????????????
tenuifoliaM7219_10           TGTGCCAACA-CGTCATGCATCGAAAACAAATCA--GCTTGCCACCCTCCATGGTGATGCGAAGCGACATCACCACATCATCGGGTACGCACCGTTCACTACGTCGCCTT
tenuifoliaRM1352             TGTGCCAACA-CGTCATGCATCGAAAACAAATCA--GCTTGCCACCCTCCATGGTGATGCGAAGCGACAT????????????????????????????????????????
ciliarisSR705                TGTGCGAACA-CGTCATGCTTCGAAAACAAATCA--GCTTGCCACCCTCCATGGTGTTGCGAAGCGACACCACCAGATCCTCGGGTACGCACCGTTCACTACGTCGCGTT
jurineifolia_scabCAM1953     AGTGCCAACA-CGTCATGCGTCGAAAACTAATCA--GCTTGCCACCCTCAATGG????????????????????????????????????????????????????????
rigens_unifl_Boknes1         AGTGCCAACA-CGTCGTGCTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCAT?????????????????????????????
linearis_linear_Boknes2      AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCAG----TCACCGTTCACTACGTCGCCTT
linearis_ovalM041001_2g      AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
rigens_leuco_M070704_1       AGTGCCAACA-CGTCGTGCTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsiana_krebM071001_1g     AGTGCCAACA-CGTCGTGCTTTGAAAACAAATCA--GCTTG?????????????????????????????????????????????????????????????????????
krebsiana_krebM071001_3gl    AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsiana_arctM071001_3pg    AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
rigidaM100903_4              AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
rigidaM100904_4              AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
rigidM110805_10              AGTGCCAACA-CGTCGTGCTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
rigidaM120805_80             AGTGCCAACA-CGTCGTGCTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
leiopodaM160704_5            AGTGCCAACA-CGTCGTGC???????????????????????????????????????????????????????????????????????????????????????????
pectinataM180904_5           ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
krebsiana_krebM210902_1      AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsiana_krebM230803_8      AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCACCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
serrM230901_7g               AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----ACACCGTTCACTACGTCGCCTT
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leiopodaM250901_34	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGC???
pectinataM250901_37	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
pectM260901_2g	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTAATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
maritimaM260901	AGTGGCAACA-CGTCGTGCTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCA??????????????????????????????
krebsiana_krebM261001_2	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
maritimaM270901_5g	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
rigens_rigensM7293	AGTGCCAACA-CGTCGTGCTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
rigens_rigensM7298_2	AGTGCCAACA-CGTCGTGCTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
rigens_rigensM7527_2	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
leiopodaM200901_22g	??
spnov_M7237_4	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATC??
serrataHerm_NB	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsiana_krebNB1465	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
linearis_linearRM1013	AGTGCCAACAGCGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTC???
rigens_leucoRM1021	AGTGCCAACA-CGTCGTGCTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCA??????????????????????????????
pectinataRM1044_1	AGTGCCAACA-CGTCGTGCTT???
hybrRM1061	??
leiopodaRM1063	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGC???
rigidaRM1082	AGTGCCAACA-CGTCGTGCTTTGAAAACAAACCA--GCTTGCCACCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
linearis_linearRM1090	AGTGCCAACA-CGTCGTGCTTCGAAAACAAATCA??
linearis_linearRM1092	AGTGCCAACA-CGTCGTGGTTTGAAAAC??
linearis_linearRM1094	AGTGCCAACA-CGTCGTGSTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCC??
linearis_linearRM1103	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsiana_serrRM1137	AGTGCCAACA-CGTCATGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
linearis_linearRM1182	AGTGCCAACA-CGTCGTGG???
rigidaRM1210	AGTGCCAACA-CGTCGTGCTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTC?????
serrataRM1216	AGTGCCAACA-CGTCGTGCTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
serrataRM1241	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
serrataRM1245	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCT--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
rigidaRM1254	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCG???????????????????????????
serrataRM1260	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
rigidaRM1270	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
serrataRM1280	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
leiopodaRM1291	AGTGCCAACA-CGTCGTGCTTTGAAAACAAATCA--GCTTGCCACCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGGC---ACACCGTTCACTACGTCGCCTT
leioRM1320	??
pectinataRM1390	AGTGCCAACA-CGTCGTGCTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsiana_krebRM713	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsiana_arctRM770_2	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCT?
rigens_rigensRM772_1	AGTGCCAACA-CGTCGTGCTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
linearis_linearRM780	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
rigens_uniflRM782_1	AGTGCCAACA-CGTCGTGCTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
rigens_uniflRM783	??
rigens_uniflRM785	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
linearis_linearRM787	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
linearis_linearRM789	AGTGCCAACA-CGTCATGG???
linearis_linearRM794	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
linearis_linearRM804	AGTGCCAACA-CGTCGTG??
serrataRM812	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCAG----TCACCGTTCACTACGTCGCCTT
rigidaRM813	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATC????????????????????????????
serrataRM821	AGTGCCAACA-CGTCGTGCTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACGGTTCACTACGTCGCCT?
krebsiana_arctRM831_1	AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT

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krebsiana_krebRM856          AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsiana_krebRM874          AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsiana_serrRM877          AGTGCCAACA-CGTCGTGSTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAWCACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
linearis_linearRM884         AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
linearis_linearRM885         AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCATCAGCTGCCATCCTCACTGATGTTGCGAAGCGACA?????????????????????????????????????????
krebsianaRM888               AGTGCCAACA-CGTCGTGGTTTGAAAAC???????????????????????????????????????????????????????????????????????????????????
rigidaRM900_1                AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsiana_arctRM903          AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebaRM904                   AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATC????????????????????????????
krebsiana_krebRM906          AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
rigens_leucoRM919            AGTGCCAACA-CGTCGTGCTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsiana_krebRM929          AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsiana_krebRM949          AGTGCCAACA-CGTCGTGGTTGGAAA-CAAATCA--GCTTGCCATCCTCACTGATGTTGCGAA???????????????????????????????????????????????
krebsiana_krebRM950          AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
linearis_linearRM951         AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsiana_krebRM960          AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsiana_krebRM962          AGTGCCAACA-CGTCGTGCTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCATTACGTCGCCTT
krebsianaRM966               AGTGCCAACA-CGTCATGGTTTGAAAACAAATCA--GCTTGCCATCCTCCCTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsiana_krebRM968          AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsiana_krebRM992          AGTGCCAACA-CGTCATGGTTTGAAAACAAATCA--GCTTGCCATCCTCCCTGATGTTGCGAAGCGACAACACCAGATCAT?????????????????????????????
krebsiana_RM996              AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsiana_krebRM1403         AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
linearis_linearRM1406_1      AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
linearis_linearRM1406_2      AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
leiopodaRM1466               AGTGCCAACA-CGTCGTGCTTTGAAAACAAATCA--GCTTGCCACCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG---CACACCGTTCACTACGTCGCCTT
serrataHerm_RM               AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTT??????????????????????????????????????????????????????????????????????
krebsiana_RVC162             ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
krebsiana_krebSH110          ??????????????????????????????????????????????????????????????????????????????????????????????????????????????
krebsiana_krebSH111_1        AGT???????????????????????????????????????????????????????????????????????????????????????????????????????????
krebsiana_krebSH111_2        AGTGCCAACA-CGTCG??????????????????????????????????????????????????????????????????????????????????????????????
krebsiana_krebSH112          AGTGCCAACA-CGTCGWGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsianaSH115               AGTGCCAACA-C??????????????????????????????????????????????????????????????????????????????????????????????????
linearis_linearSH116         AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATC????????????????????????????
linearis_linearSH117         AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATC????????????????????????????
krebsianaSH118               AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
linearis_linearSH131         AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
linearis_linearSH132         AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGC???
krebsianaSH133               AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCTGATCATCGG----TCACCGTTCACTACGTCGC???
krebsianaSH135               AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsianaSR480               AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsianaSR520               AGTGCCAACA-CGTCGTGGTTTGAAAAC???????????????????????????????????????????????????????????????????????????????????
linearis_linearSR523         AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsianaSR564               AGTGCCAACA-CGTCATGGTTTGAAAACAAATCA--GCTTGCCATCCTCCCTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
linearis_linearSR571         AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
rigens_rigSR574              AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
rigens_rigSR575              AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCC??
rigensSR581                  AGTGCCAACA-CGTCGTGCTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
rigens_uniflSR625            AGTGCCAACA-CGTCGTGCTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsiana_krebSVHF1          AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
krebsiana_arctSV_HF2         AGTGCCAACA-CGTCGTGGTTTGAAAACAAATCA--GCTTGCCATCCTCACTGATGTTGCGAAGCGACAACACCAGATCATCGG----TCACCGTTCACTACGTCGCCTT
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