MORPHOMETRIC ANALYSIS AND MONOGRAPH OF *MONARDA* SUBGENUS *CHEILYCTIS* (LAMIACEAE)

By

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ABSTRACT

MONOGRAPHY AND MORPHOMETRIC ANALYSIS OF *MONARDA* SUBGENUS *CHEILYCTIS* (LAMIACEAE)

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Monarda subgenus *Cheilyctis* (Lamiaceae) is a monophyletic group comprised of 16 species of annual and perennial herbs, subshrubs, and shrubs. It has a temperate North American distribution that extends from southern Canada, across much of the United States, into Mexico as far south as Michoacán. The group is most easily characterized by strongly arching upper corolla lips, inserted stamens, and verticillate glomerules. A multivariate morphometric analysis was performed to assess species circumscriptions. Fifty morphological characters were measured from 386 herbarium specimens. Gower's similarity coefficient was used to perform unweighted pair-group method using arithmetic averages (UPGMA) and principal coordinates analysis (PCOA). The results revealed 11 distinct clusters that correspond to previously accepted species (*M. austromontana*, *M. citriodora*, *M. clinopodioides*, *M. fruticulosa*, *M. humilis*, *M. maritima*, *M. mexicana*, *M. pectinata*, *M. punctata*, *M. stanfieldii*, and *M. viridissima*) and five clusters that represent new species or combinations (see below). Boxplots of the data elucidate the characters important to the circumscription of the species. A monograph of this group, including a morphological cladistic analysis, is also presented. Sections covering taxonomic history, morphology, phylogeny, and taxonomy, as well as a key to the species of the subgenus are provided. In addition to a full synonymy and description, phenology, distribution, a specimen image, and a list of representative specimens is also provided for each species. Two species are described (*Monarda n. sp.* 1, *Monarda n. sp.* 2), and three new combinations are proposed (*M. arkansana ined., M. occidentalis ined., M. villicaulis, ined.*)

ACKNOWLEDGMENTS

There are a number of people and agencies I wish to acknowledge for their contribution to this research, but before I proceed in listing them I wish to express particular gratitude to several individuals whose assistance during these long years has been invaluable. I thank my major professor and mentor, Alan Prather, who has given me help, advice, interminable patience, and inspiration; and also my research committee members Jeff Conner, Andy Jarosz, and Tao Sang whose insights into plant science have refined and enhanced this project.

I also wish to thank the curators of the herbaria ARIZ, FLAS, CAS, GH, KNK, MEXU, MICH, MO, MSC, NCU, NMC, OKL, RM, TAMU, TEX, UARK, UNM, and US for graciously making their material available. Many thanks are also due to Paul Taylor, whose grants funded two collection trips to Texas, and to Cecile Gordon and Jack Sammons, the best field assistants in all of Texas. My sincere appreciation also goes to Jan Szyren, and Richard Triemer for aid in digitizing the dissection slides.

I also extend special thanks to Rachel Carter for digging me out again and again and always seeing things from the exact right perspective; and Robert Misner for giving, so abundantly, the encouragement, support, and understanding that has made this effort possible.

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CHAPTER 1

INTRODUCTION TO THE GENUS

AND THE DISSERTATION

Monarda L. (Lamiaceae) is a temperate North American genus with a natural distribution that extends from southern Canada, across much of the United States, and into Mexico as far south as Michoacán (Scora 1967). It has bright colored flowers and is commonly grown ornamentally. The genus has agricultural value as companion plants used to encourage pollinator visits and *Monarda punctata* L. has been shown to be a good choice for habitat manipulation projects that focus on the maintenance of natural enemy arthropod populations to minimize the use of poisons on adjacent crop fields (Frank, Shrewsbury et al. 2008).

Monarda is perhaps most widely utilized for its phytochemistry though it is not cultivated expressly for such purposes. Essential oils and extracts (chiefly thymol, carvacrol, and phenolic monoterpenes) from species in this genus have long been recognized as having therapeutic and bioactive properties (Pammel 1911) and they have been used to treat nausea, swelling, rheumatic pain, fever, and coughs (Chevallier 1996). Thymol, in particular, has been used to kill parasites such as ascarids and hookworms and is used as an antiseptic in soaps, mouthwashes, and toothpastes. Dorman and Deans (2004) show that *M. citriodora* Cerv *ex* Lag., oils are strong antioxidants, and *M. fistulosa* L. extracts, long used as a stimulant and to remove colic pain, is recommended as a treatment to Seborrhea (Zhilyakova, Novikov et al. 2009) because it demonstrates antibacterial, antimycotic, and anti-inflammatory properties. Yamada et al (2010) recently isolated seven novel glycosides from *M. punctata* and found that carvacrol isolated from *M. punctata* has an inhibitory effect on the hydrolysis of triacylglycerols. They further suggest it as a candidate for treating and preventing metabolic syndrome.

Despite this interest in *Monarda*, the taxonomy of this group remains problematic. Even with Scora's (1967) detailed and comprehensive examination of the genus, new work has emerged regarding its pollination ecology (Whitten 1981; Cresswell 1990), new interest has arisen concerning evolution within the genus (Prather, Monfils et al. 2002; Keith 2003), and there has been continued debate on its taxonomy (Correll and Johnston 1979; Turner 1994; Prather and Keith 2003). In this light it is time to reexamine the portion of the genus (*Monarda* subgenus *Cheilyctis*) which continues to be characterized by high degrees of taxonomic uncertainty. The objectives of this research are to 1) construct a current taxonomic hypothesis of *Monarda* subgenus *Cheilyctis*, 2) produce a traditional monograph for the subgenus, and 3) create a web-based monograph providing additional features not available in a traditional paper-bound manuscript.

The remaining chapters of this dissertation address the three above-mentioned objectives. Chapter 2 contains a morphometric analysis that uses descriptive statistics to examine the variation among the taxa of the subgenus as well as multivariate statistics to examine species distinctiveness and groupings. A morphometric analysis was chosen over a DNA-based analysis because of the availability of herbarium material used in the study. To collect DNA samples from a similar number of individuals across the same distributions would have been prohibited by time and financial constraints. A species list is also presented in chapter 2, and characters that are useful in developing that circumscription are discussed. Chapter 3 contains the traditional monograph for *Monarda* subgenus *Cheilyctis*. It covers morphology, taxonomic history, phylogeny, keys, synonymy, phenology, distribution, specimen images, species descriptions, and representative specimens for each taxon in the group. The final chapter presents an overview of the online monograph and provides a list of features it contains. It also discusses some other works that highlight internet-based technologies in plant systematics.

CHAPTER 2

MORPHOMETRIC ANALYSIS OF MONARDA SUBGENUS CHEILYCTIS

INTRODUCTION

Though the taxonomy of *Monarda* subgenus *Cheilyctis* has had an incremental increase in the number of species in the last 200 years, the taxonomic history of the group is best characterized by a persistent shifting in the ranks of the existing taxa. In the last five decades, even though there has only been one new species and three new varieties (Scora 1965; Scora 1967; Correll 1968; Turner 1994) there have been 10 new combinations (Waterfall 1950; Cory 1953; Shinners 1953; Scora 1965; Scora 1967; Turner 1994; Prather and Keith 2003), each of which involved rank shifts between species, subspecies, or variety. Of the 11 varieties of *Monarda punctata* published in Scora's (1967) treatment of the genus, only *M. punctata* var. *maritima* had not already received at least one rank change. *Monarda punctata* var. *maritima* would later be elevated to species by B.L. Turner (1994).

Much of the taxonomic juggling these taxa have received stems from the fact that the majority are regionally endemic and morphologically very similar, or from the fact that the traits being used to separate the groups are often less conspicuous (calyx lobe width, angle of stem indumentum). The hurdles, then, in building a complete taxonomy of this group lies in developing a solid understanding of what role the morphological variation plays at both the inter and intraspecific levels of the subgenus.

While there have indeed been detailed works examining the morphological differences present among the species of the group, these putative differences have not been studied quantitatively. The goals of this investigation are to 1) evaluate the morphological variation between the species of the subgenus, and among the varieties of *M. punctata*, in particular, and 2) propose and test my circumscription of the taxa in this subgenus.

MATERIALS AND METHODS

Taxon sampling

The following is (based on preliminary observations of herbarium specimens) my putative species taxonomy for *Monarda* subgenus *Cheilyctis*:

<u>Section Cheilyctis</u>

M. fruticulosa Epling

M. humilis (Torrey) Prather & J.A. Keith

M. maritima (Cory) B.L. Turner

M. occidentalis ined

M. punctata L.

var. *punctata*

var. *arkansana* (McClintock and Epling) Shinners

var. *correllii* B.L. Turner

var. *intermedia* (McClintock and Epling) Waterfall

var. *lasiodonta* Gray

M. villicaulis ined

M. stanfieldii Small

M. viridissima Correll

<u>Section Aristatae</u>

M. austromontana Epling

M. citriodora Cervantes ex Lagasca

var. citriodora

var. parva Scora

M. clinopodioides Gray

M. pectinata Nuttall

M. mexicana Epling

Species and variety identity for each specimen was consistent with Turner (1994) for all Texas collections, Prather and Keith (2003) for *Monarda humilis* and Scora (1967) for all other collections. The new combinations I propose in my taxonomy

(*M. occidentalis ined*, *M. villicaulis ined*) and *M. austromontana* were also identified as above, though they are all identified as intraspecific taxa by those authors, but treated as species in my taxonomic circumscriptions. Traits were measured from 381 specimens in anthesis from the following herbaria: ARIZ, FLAS, CAS, GH, KNK, MEXU, MICH, MO, MSC, NCU, NMC, OKL, RM, TAMU, TEX, UARK, UNM, and US standardized abbreviation from Index Herbariorum (The New York Botanical Garden 2007). These taxa represent populations from across the distribution of *Monarda* subgenus *Cheilyctis*.

Herbarium specimens were measured and treated as an independent operational taxonomic units (OTU) (Appendix A, B). I sampled 30 specimens of each OTU (species/variety of *Monarda* subgenera *Cheilyctis* and *Aristatae*) where possible. Due to lack of equal representation in the loan/collections, this was not an option for all taxa. The number of specimens I measured per taxon is as follows: 27 for *M. austromontana ined*, 25 for *M. citriodora* var. *citriodora*, 3 for *M. citriodora* var. *parva*, 30 for *M. clinopodioides*, 30 for *M. fruticulosa*, 15 for *M. humilis*, 20 for *M. maritima*, 25 for *M. occidentalis ined*, 28 for *M. pectinata*, 15 for *M. punctata* var. *arkansana*, 30 for *M. punctata* var. *intermedia*, 30 for *M. punctata* var. *lasiodonta*, 30 for *M. punctata* var. *punctata*, 20 for *M. stanfieldii*, 30 for *M. villicaulis ined*, and 25 for *M. viridissima*.

Character sampling

The characters selected for the analysis were chosen because they 1) were considered important by previous investigators of *Monarda* 2) demonstrated variability between and within taxa or 3) have been of historical interest in the taxonomy of Lamiaceae.

Measurements were taken either by direct measuring (with a linear rule), measuring using a dissection scope and ocular micrometer, or measurements made from a digital image taken through a dissection scope (list of traits measured by each method is discussed below). For the traits that were imaged, measurements were taken using tpsDig2 (Rohlf 2004). This software package measures the distance between user-specified landmark points on a digital image, and, given an accurate scaling standard, converts the measurements to a standard measuring unit (µm or mm). The techniques employed to measure a specific character were used consistently among all individuals.

Quantitative traits. Most vegetative characters were measured using a binocular dissection scope with an ocular micrometer. Large characters (leaf and stem dimensions) were measured with a 10cm plastic rule. All measurements were taken at standardized reference points (see below). The leaves and nodes that were measured were found at the second node subtending the basal glomerule. The internodes were those which immediately subtended the above mentioned node.

1. Internode Length – taken from the penultimate node subtending the inflorescence to the next lower node.
2. Internode Width – taken from at the mid-point of the penultimate internode subtending the inflorescence.
3. Leaf Length – taken from the tip of the leaf to the base of the petiole.
4. Leaf Width – taken from the widest point of the leaf.
5. Leaf Widest Point – distance from the base of the petiole to the widest point of the leaf.
6. Petiole Length – taken from the base of the lowermost portion of the leaf blade to the leaf node.
7. Length of Serrated Margin – taken from tip of leaf to basal most serration.
8. Serration Distance – distance from the distal point of attachment of one tooth to the distal point of attachment of an adjacent tooth. Measurement taken at the approximate midpoint of the serrated region of the leaf.
9. Leaf Tooth Size – taken from the distal point of attachment to the tip of the tooth.

10. Length Laminar Tissue – taken from tip of petiole to tip of leaf.
11. Number of Flowering Branches – number of inflorescences on the plant.
12. Lower Bract Length – taken from the tip of the lower bract to the attachment point.
13. Lower Bract Width – taken from the widest point of the lower bract.
14. Lower Bract Widest Point – distance from the base of the lower bract to the widest point.
15. Upper Bract Length – taken from the tip of the upper bract to the attachment point.
16. Upper Bract Width – taken from the widest point of the upper bract.
17. Upper Bract Widest Point – distance from the base of the upper bract to the widest point.

All floral characters were measured using tpsDig. The image files were generated by taking an image with a digital camera (Nikon cool-pix) mounted onto a dissecting microscope. Wet mounts of the flowers were prepared by teasing the corolla from the calyx, flattening the upper and lower corolla lips, exposing the stigma and stamens, and flattening the lobes of the upper and lower corolla lips. The floral tissues were suspended on the slide in permount and covered with a 0.1 mm cover slip. Slides were preserved by sealing the cover slip with fingernail polish. Raw jpg images were converted to tps files using tps_util software. The images were scaled by taking a digital image of a 10cm plastic rule at the same magnification as the floral slides. This image was used to calibrate tpsDig before taking the measurements. The following is a list of the standard points where each floral character was measured.

18. Calyx Length – taken from the base of the calyx to the base of a calyx lobe.
19. Calyx Width – taken from one side of the flattened calyx to the other, or when the calyx is open, the distance across half of the calyx veins.
20. Calyx Orifice Pubescence Length – taken from the hairs at the base of the adaxial side of the calyx lobe.
21. Calyx Lobe Length – taken from the base of the calyx lobe to the tip of the calyx lobe.
22. Calyx Lobe Width – taken from the middle of the calyx lobe.
23. Calyx Lobe Margin Pubescence Length – taken from the hairs on the margin of the calyx lobe.

24. Lower Corolla Lip Length – taken from the upper lip/lower lip connection fold to the terminus of the mid-limb of the lower lip.
25. Lower Corolla Lip Width – taken from one lateral margin of the lip to the other lateral margin of the lip at the base of the limbs.
26. Mid-limb Length – taken from the tip of the middle limb of the lower corolla lip to the base of the cleft along the midpoint of the middle limb
27. Mid-limb Width – taken from one lateral margin of the middle limb of the lower corolla lip to the other lateral margin of the middle limb at the widest point of the mid-limb.
28. Lateral-limb Length – taken from the tip of the lateral limb of the lower corolla lip to the base of the cleft along the midpoint of the lateral limb.
29. Lateral-limb Width – taken from one margin of the lateral limb of the lower corolla lip to the other margin of the lateral limb.
30. Upper Corolla Lip Length – taken from upper lip/lower lip connection fold to the tip of the upper lip.
31. Upper Corolla Lip Width – taken from one lateral margin of the lip to the other lateral margin of the lip at roughly half-way up the lip.

32. Limb Length (cleft depth) – taken from the tip of the upper corolla limb to the base of the cleft along the midpoint of the limb.
33. Limb Width – taken from one lateral margin of the upper corolla limb to the other lateral margin of the limb at the base of the limb.
34. Hair Length - taken from the hairs on the outer surface of the upper corolla lip.

Qualitative traits. These characters were observed with a compound dissection scope to detect the presence (scored as "1") or absence (scored as "0") of hair types on the surface of various plant parts. In the characters described below "<3" and ">5" refer to the presence of hairs comprised of less than three cells or greater than five cells, respectively. Organ selection was consistent with the methods used in the quantitative traits (as described above).

35. Internode <3 – examined on the facial surface of the internode.
36. Internode >5 – same as above.
37. Nodal Ridges <3 – examined at the edges of the node, which are the corners formed by fibrous bundles.

38. Nodal Ridges >5 – same as above.

39. Inter-ridge Region <3 – examined on the facial surface of the node.

40. Inter-ridge Region >5 – same as above.

41. Interpetiolar Plane <3 – examined at the equatorial region of the node.

42. Interpetiolar Plane >5 – same as above.

43. Petiole <3 – examined on the petiole of the selected leaf.

44. Petiole >5 – same as above.

45. Leaf Midvein <3 – examined on the midvein of the selected leaf.

46. Leaf Midvein >5 – same as above.

47. Abaxial Surface <3 – examined on the laminar region of the abaxial side of the leaf.

48. Abaxial Surface >5 – same as above.

49. Calyx Facial Tissue <3 – examined between the veins of the calyx tubes

50. Calyx Facial Tissue >5 – same as above.

Data Analysis

Cluster Analysis. All quantitative data were standardized to zero mean and variance in an effort to reduce the effects of different scales of measurement for the different characters. The standardized data were then used to create a similarity matrix based on the Gower coefficient (Gower 1971; Sneath and Sokal 1973). This metric was selected because of its flexibility in using both quantitative and qualitative data (Gower 1971; Binns, Baum et al. 2002; Podani and Schmera 2006). Standardization and the computation of the similarity matrix were performed using the statistical package, MVSP (Kovach Computing Services 1998). Using NTSYSpc 2.1 (Rohlf 2000), dendrograms were generated with the unweighted pair-group method using arithmetic averages (UPGMA) clustering algorithm (Sneath and Sokal 1973; SAHN module with UPGMA as clustering method).

Ordination. Data were standardized as above, and the Gower similarity matrix was used to complete a Principal Coordinate Analysis (Sneath and Sokal 1973; Reyment, Blackith et al. 1984; Marcus 1996; Anderson and Willis 2003). This ordination method was chosen over the more commonly used Principal Components Analysis (PCA) because it can be applied to many different kinds of similarity or distance measures. It is implicit with PCA that a covariance or correlation matrix be used, which is not the case for this investigation (see above for explanation). PCOA is also preferred because it focuses on the relationship among individuals as opposed to the relationship among characters (as in PCA) and evaluates OTU's individually instead of under the assumptions of group membership (Reyment, Blackith et al. 1984; Marcus 1996; McCauley and Ballard 2007). NTSYSpc 2.1 was used to double-center (convert the triangular Gower matrix into a square matrix) the data matrix (DCENTER module with square distances selected), to calculate the eigenvectors and eigenvalues (EIGEN module with four dimensions selected and a vector scaling of SQRT(LAMBDA)) and to examine the axes.

Descriptive statistics. Boxplots were generated using the default boxplot command in R (R Development Core Team 2009). The upper and lower region of the boxes correspond to the upper (75th percentile) and lower (25th percentile) quartiles, respectively. The line in the box is the median, and the dashed lines represent one standard deviation above and below the mean. Outliers are represented by open-faced circles.

Because the sections of *Monarda* subgenus *Cheilyctis* are monophyletic (Prather et al. 2002) the analyses were performed separately for each section, to keep the interpretation of the results from becoming too cumbersome.

The taxonomic hypotheses for the subgenus are based on the phenetic species concept (Sokal and Crovello 1970; De Queiroz 2007), which assigns individuals into groups (species) which are defined by morphological gaps. My species circumscriptions will be tested based on how well the individuals of those putative species are separated morphologically. If there are sufficient morphological gaps between individuals of two species, then they will cluster on different branches of the UPGMA dendrogram. Likewise, individuals of different species will cluster away from each other in the multidimensional space of the PCOA map. However, if complete agreement between the analyses does not occur, either the UPGMA or the PCOA must suggest that a taxon is distinct from the others and there must be some support from individual morphological characters (possession of a novel qualitative trait or non-overlapping quartiles (as described above) for a quantitative traits or the taxon will not be recognized.

It should also be noted that interpretations of the two analyses may have varying degrees of subjectivity. Because branches connect at discrete locations in the UPGMA dendrograms, interpretation of groups is a very direct process. In contrast, clusters in PCOA are more subject to interpretation, as gaps between taxa or groups of taxa are dependent on 1) how many dimensions are being shown (with all but the first three dimensions unusable because of our inability to perceive beyond three dimensions) and 2) at what angle the groups are being observed. Taxa appearing clustered together in two dimensions can actually be separated by very large gaps when adding a third dimension, and taxa appearing clustered at one angle can be seen not to be by rotating the view to a different angle. Furthermore, the incapacity to utilize data beyond the third dimension may result in more conservative groupings because it actually employs less of the data for demonstrating putative gaps. The UPGMA tends to be more sensitive to outliers as well, and large outliers can result in large branch lengths. As a result of the aforementioned properties of the analyses, discrete clusters in the PCOA analysis tend to show less distance between them than they do in the UPGMA analysis.

RESULTS

Section *Aristatae*

UPGMA

The dendrogram of section *Aristatae* shows four major groups (Fig. 1 shows a synopsis of the entire dendrogram) as well as a long branch that represents the single specimen from Chihuahua, Mexico (referred hereafter as *Monarda n. sp.* 1) and another long branch that encompasses the two specimens of *M. mexicana*. Where there are groups of taxa belonging to the same species, all those individuals are represented by one branch. Groups 1 and 2 (Figs. 2 and 3) are comprised entirely of individuals of *M. clinopodioides* and *M. pectinata*, respectively. Group 3 (Fig. 4) is comprised of specimens of *M. citriodora* var. *citriodora* and *M. citriodora* var. *parva*. Group 4 (Fig. 5) is comprised of all of the *M.* var. *austromontana* specimens. *Monarda n. sp.* 1 and *M. mexicana* can also be seen in Figure 5.

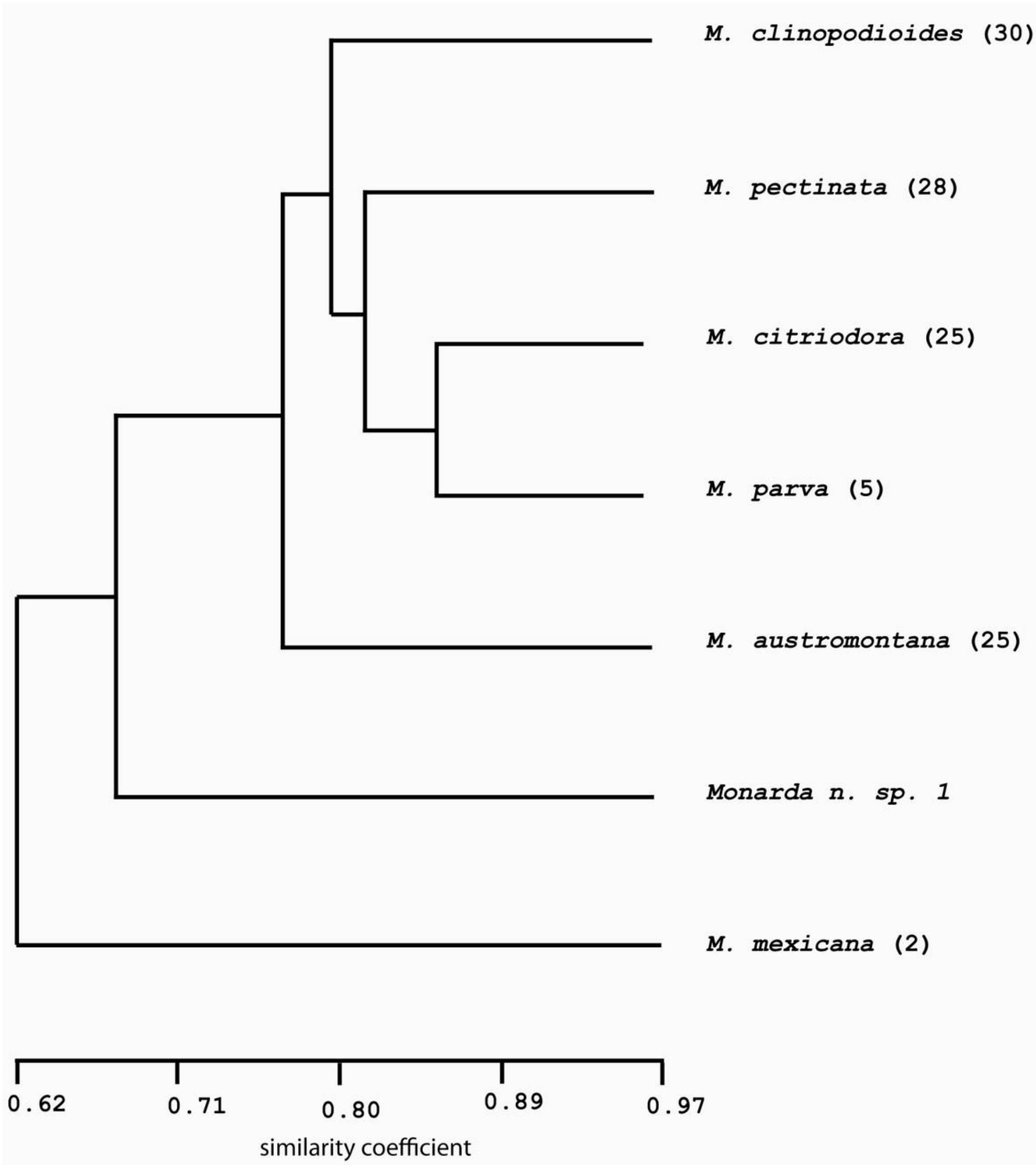

Figure 1. Synopsis of the *Monarda* section *Aristatae* UPGMA dendrogram based on Gower similarity estimates of 116 taxa. Clusters of individuals of the same species (or intraspecific rank) are represented by a single branch, and the number of individuals in that branch is indicated in parentheses, if more than one.

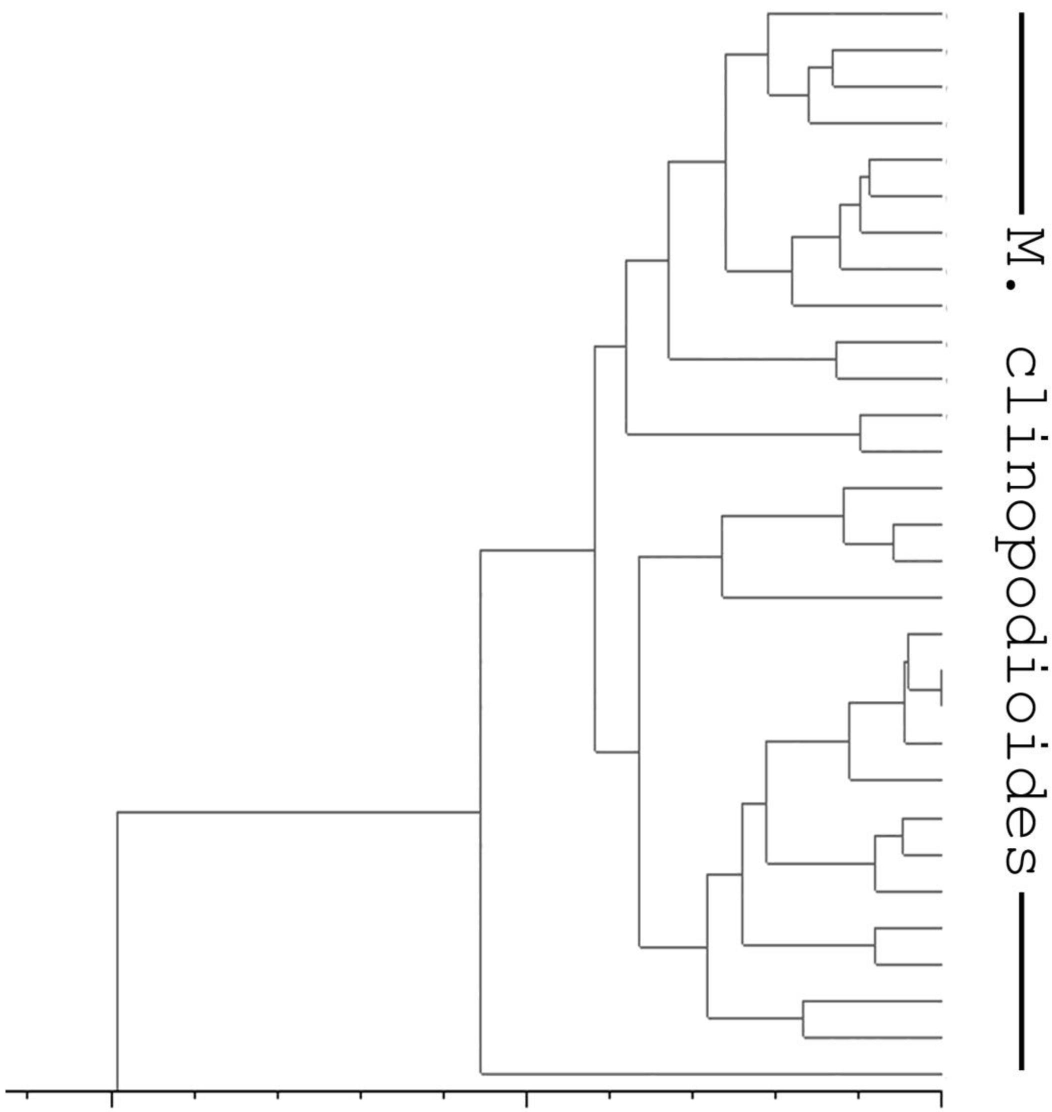

Fig. 2. Group one in the UPGMA dendrogram of *Monarda* section *Aristatae* based on the Gower coefficient of similarity.

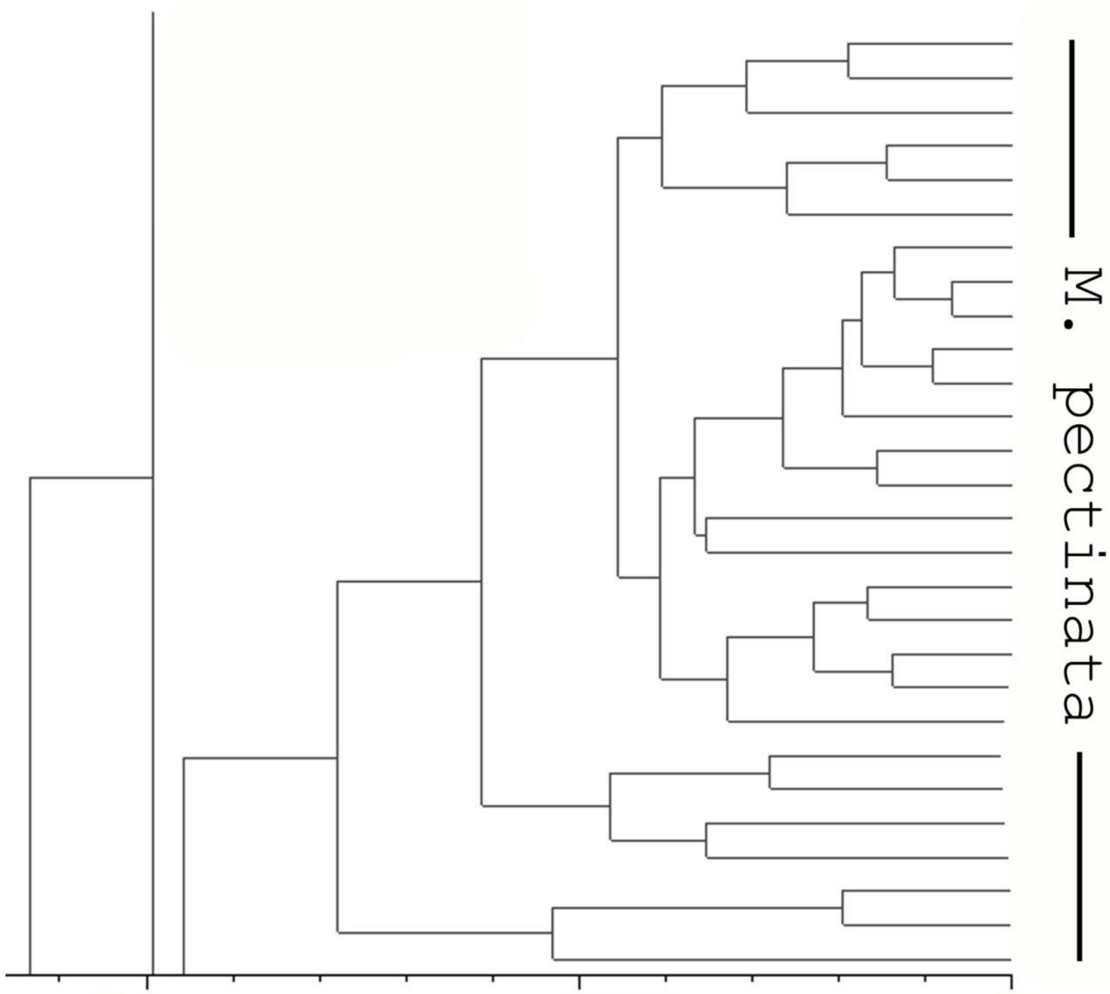

Figure 3. Group two in the UPGMA dendrogram of *Monarda* section *Aristatae* based on the Gower coefficient of similarity.

Figure 4. Group three in the UPGMA dendrogram of *Monarda* section *Aristatae* based on the Gower coefficient of similarity.

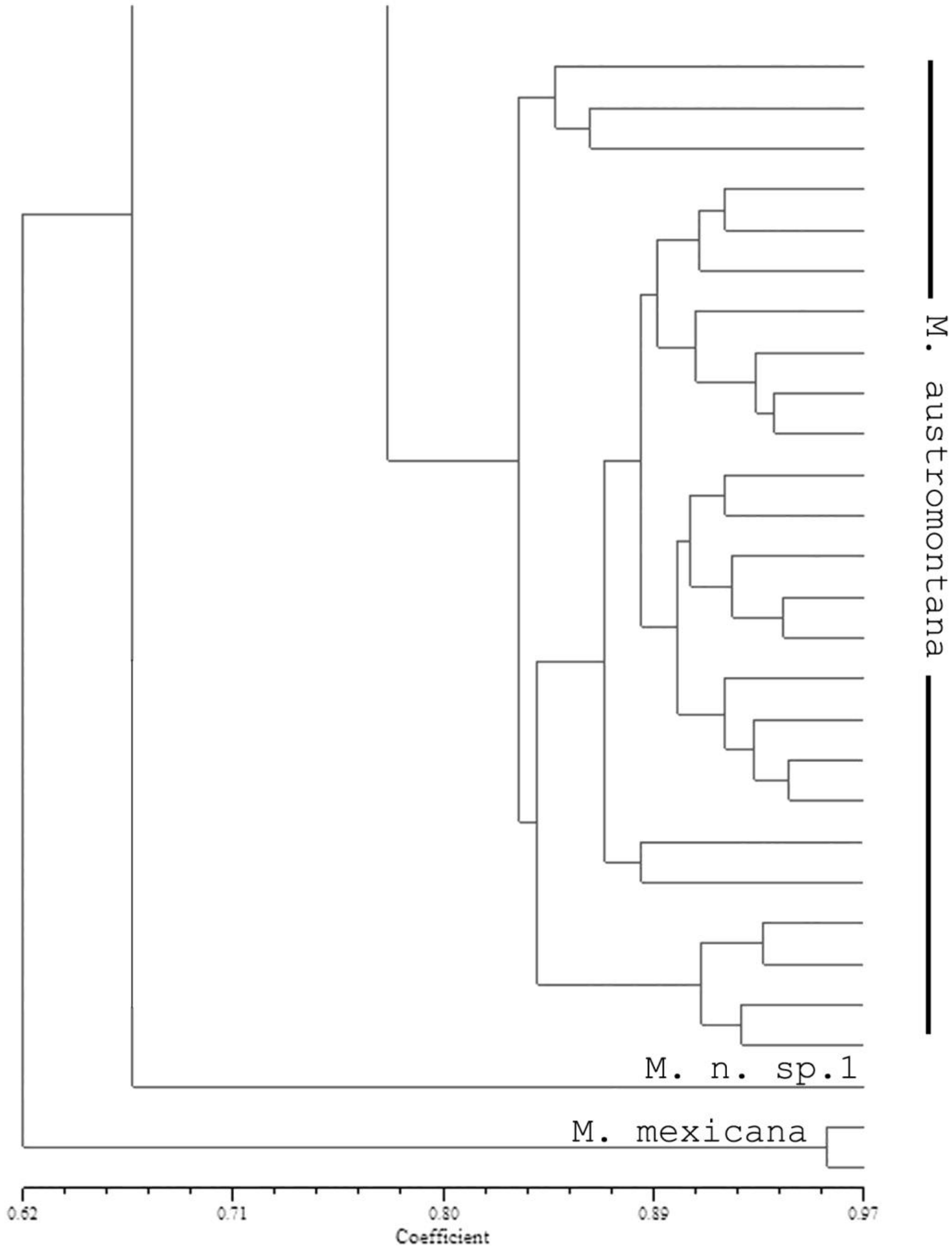

Figure 5. Group four in the UPGMA dendrogram of *Monarda* section *Aristatae* based on the Gower coefficient of similarity.

PCOA

A scatter plot (Fig. 6) of the first three principal coordinates shows four main clusters of taxa. The first cluster is comprised of *M. pectinata* with the two specimens of *M. mexicana* found just below that cluster. The second contains *M. austromontana* and the single specimen of *Monarda n. sp.* 1. The third is comprised exclusively of *M. clinopodioides*, and the fourth cluster contains specimens of both *M. citriodora* var. *citriodora* and *M. citriodora* var. *parva*. A rotation of that plot (Fig. 7) reveals further separation between the specimens of *M. mexicana* and *M. pectinata* and *Monarda n. sp.* 1 from *M. austromontana*.

For this analysis the first three principal coordinates accounted, cumulatively, for 19.5%, 33.5%, and 43.5% of the total variation, respectively, which is consistent with PCOA values of similar analyses (McCauley and Ballard 2007; Pereira, Perez et al. 2007; Morawetz and Wolfe 2011). The remaining principal coordinates each summarize 6.5% or less of the total variation.

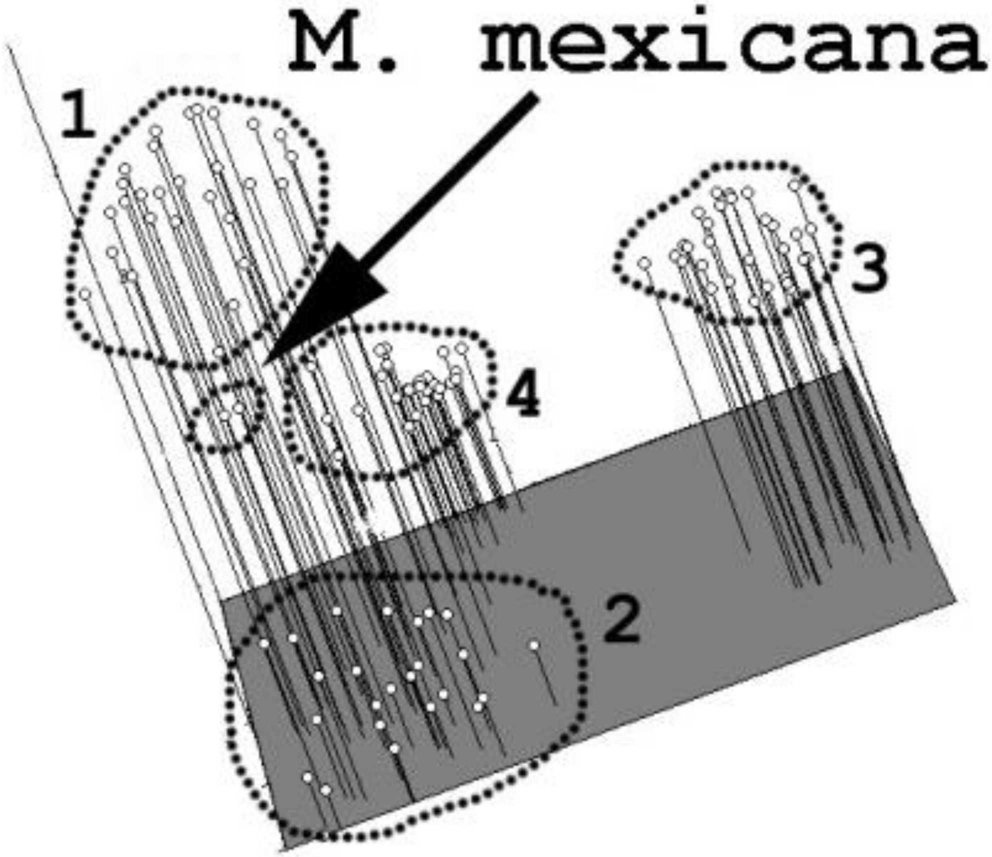

Figure 6. PCoA plot of the first three principal coordinates. The variability accounted for by each axis is 19.5% for the first, 14% for the second, and 10% for the third. Outlined regions correspond to groups discussed in text.

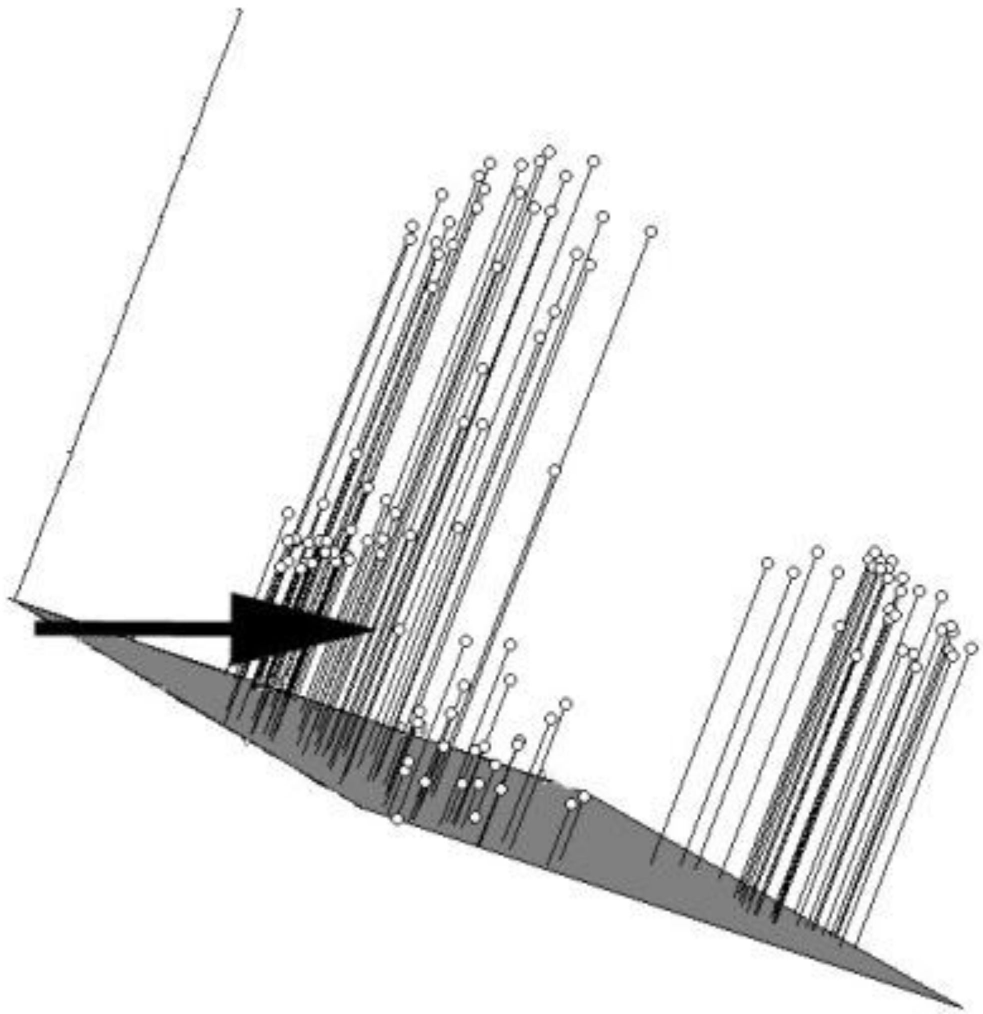

Figure 7. PCoA plot of the first three principal coordinates. The variability accounted for by each axis is 19.5% for the first, 14% for the second, and 10% for the third. This is a rotation of the same plot shown in Fig. 6. Arrow highlights the the single specimen of *Monarda n. sp.* 1.

Descriptive Statistics

Box plots showed 13 characters that may be useful (defined as non-overlapping upper and lower quartiles (Pereira, Perez et al. 2007) in differentiating the taxa in this section. Vegetative traits (Figs. 8, 9 and 10) include Petiole Length, Serration Distance, Leaf Length, Leaf Widest Point, Width Lower Bract, Widest Point of Lower Bract, Length Upper Bract, Width Upper Bract, Widest Point of Upper Bract. Floral traits (figs 11 and 12) include Calyx Length, Calyx Lobe Width, Lower Lip Width, Lateral Limb Length.

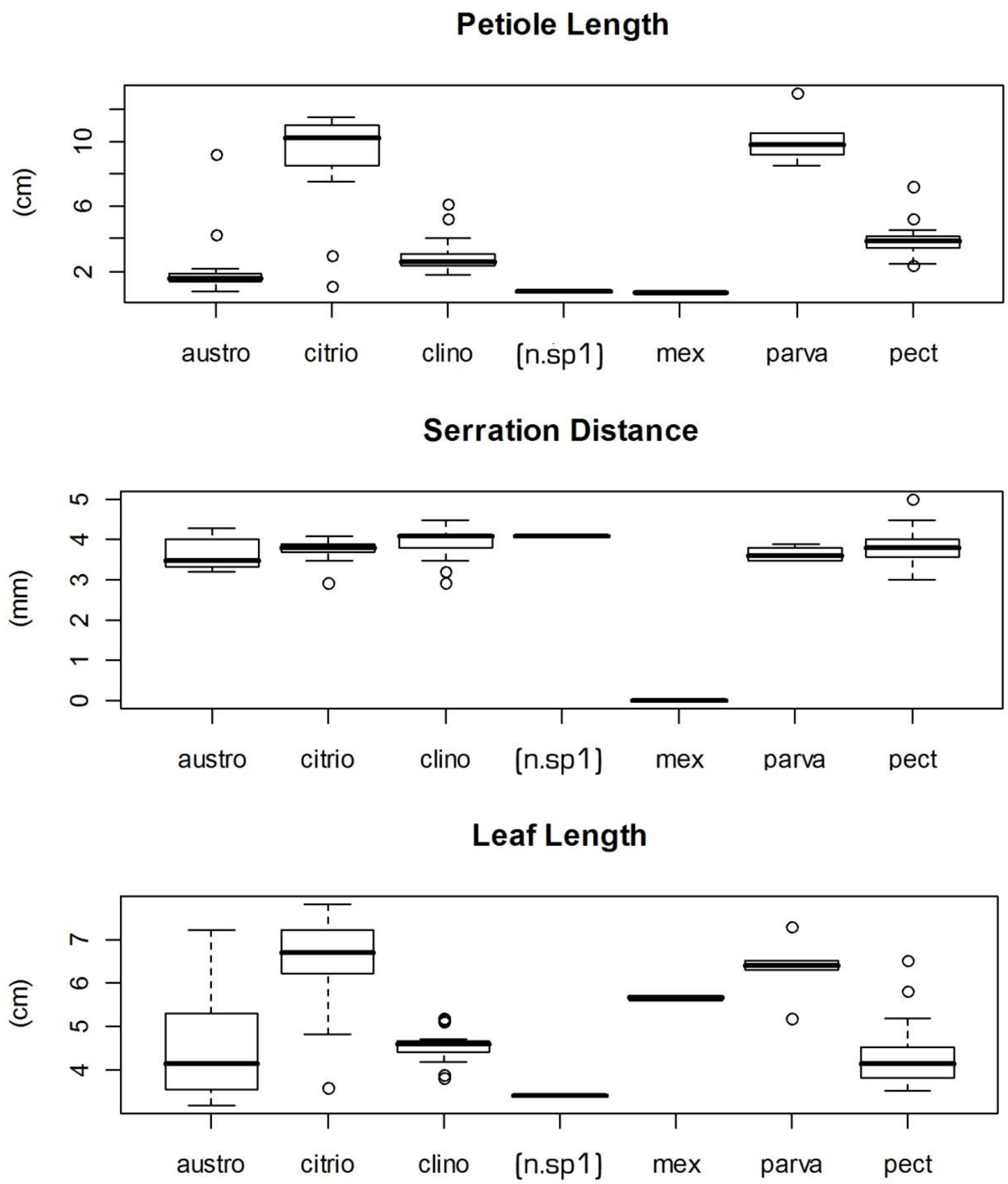

Figure 8. Box plots of Petiole Length (mm), Serration Distance (mm), and Leaf Length (cm) of *Monarda* section *Aristatae*.

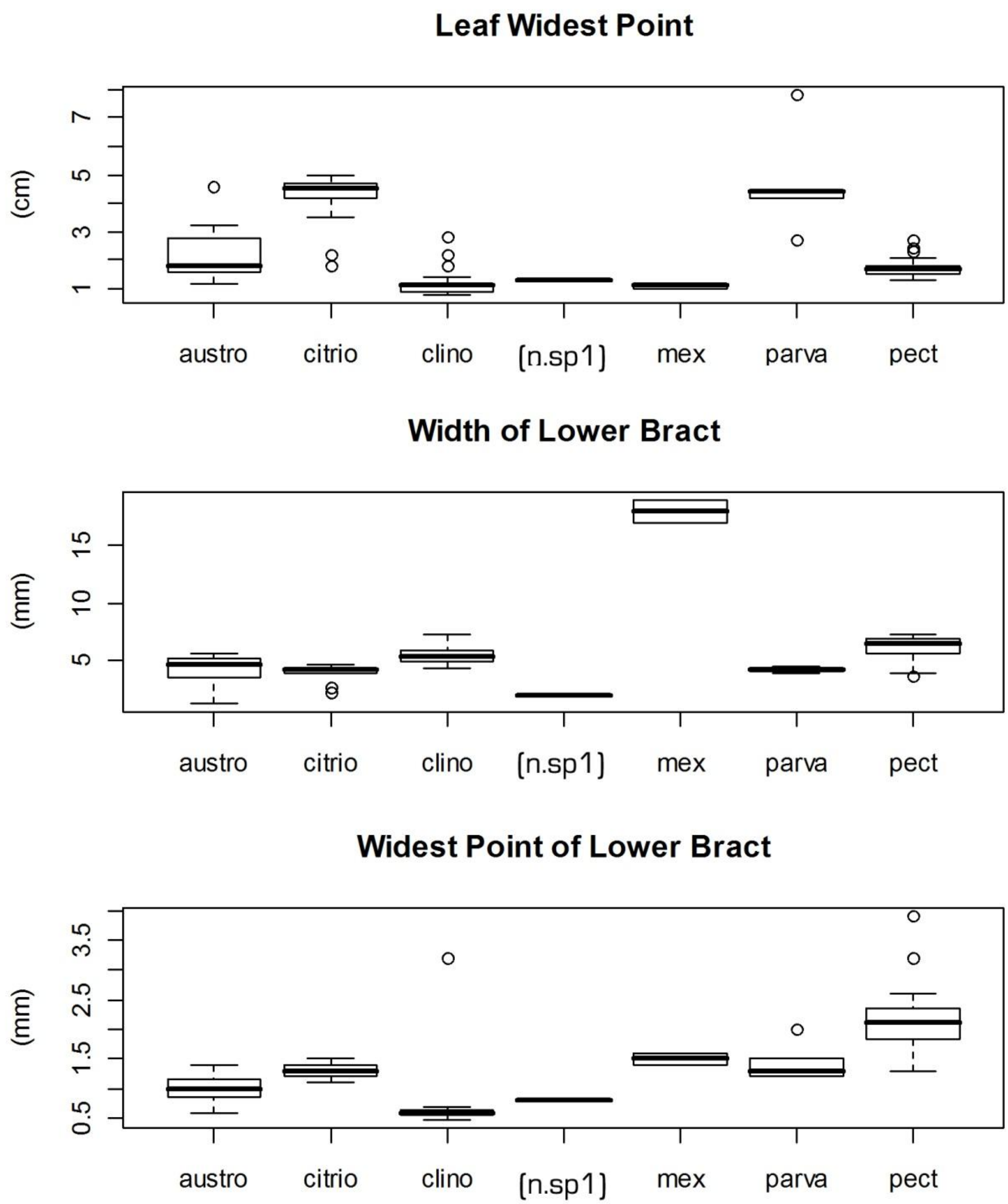

Figure 9. Box plots of Leaf Widest Point (cm), Width of Lower Bract (mm), and Widest Point of Lower Bract (mm) of *Monarda* section *Aristatae*.

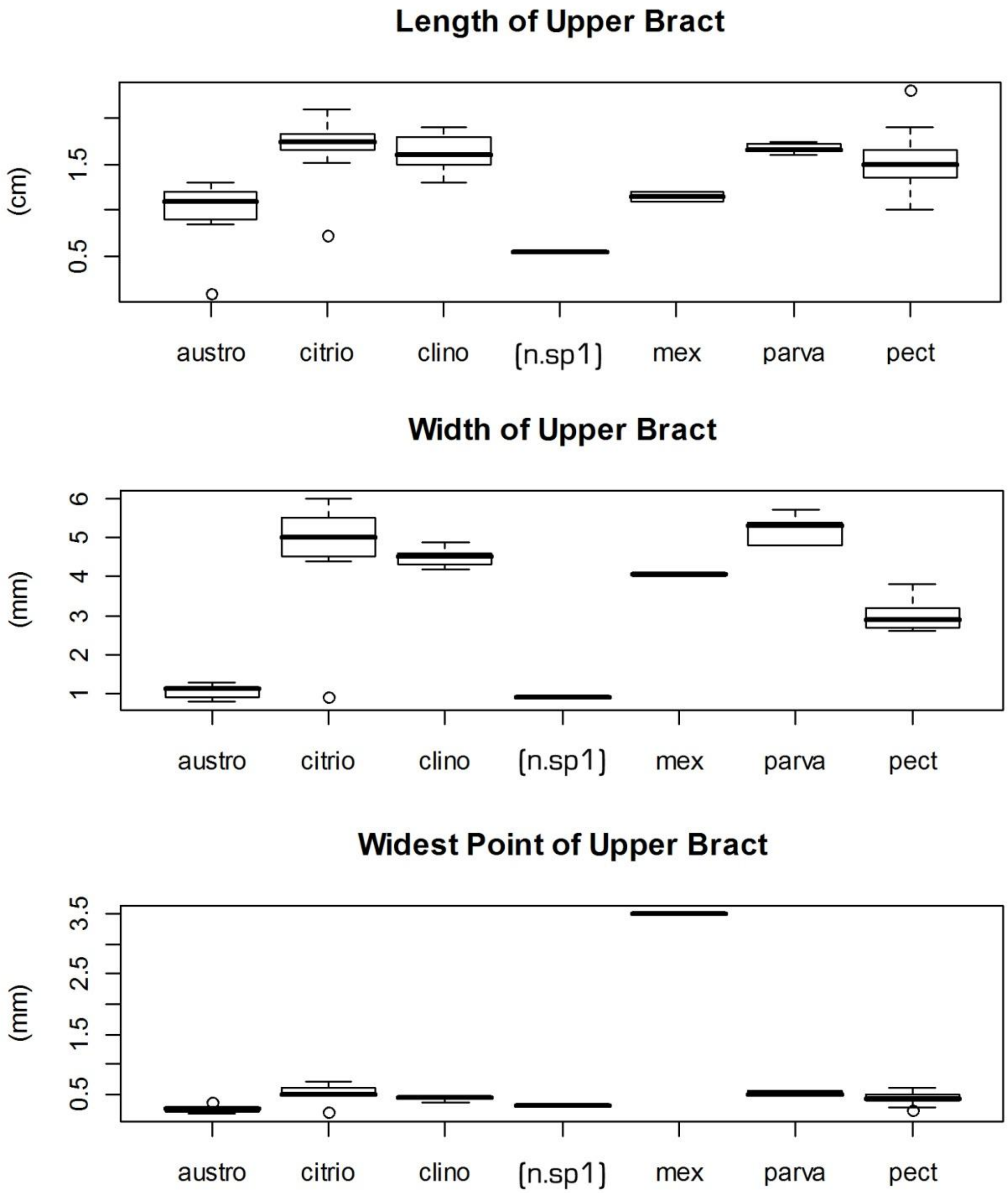

Figure 10. Box plots of Length of Upper Bract (cm), Width of Upper Bract (mm), and Widest Point of Upper Bract (mm) of *Monarda* section *Aristatae*.

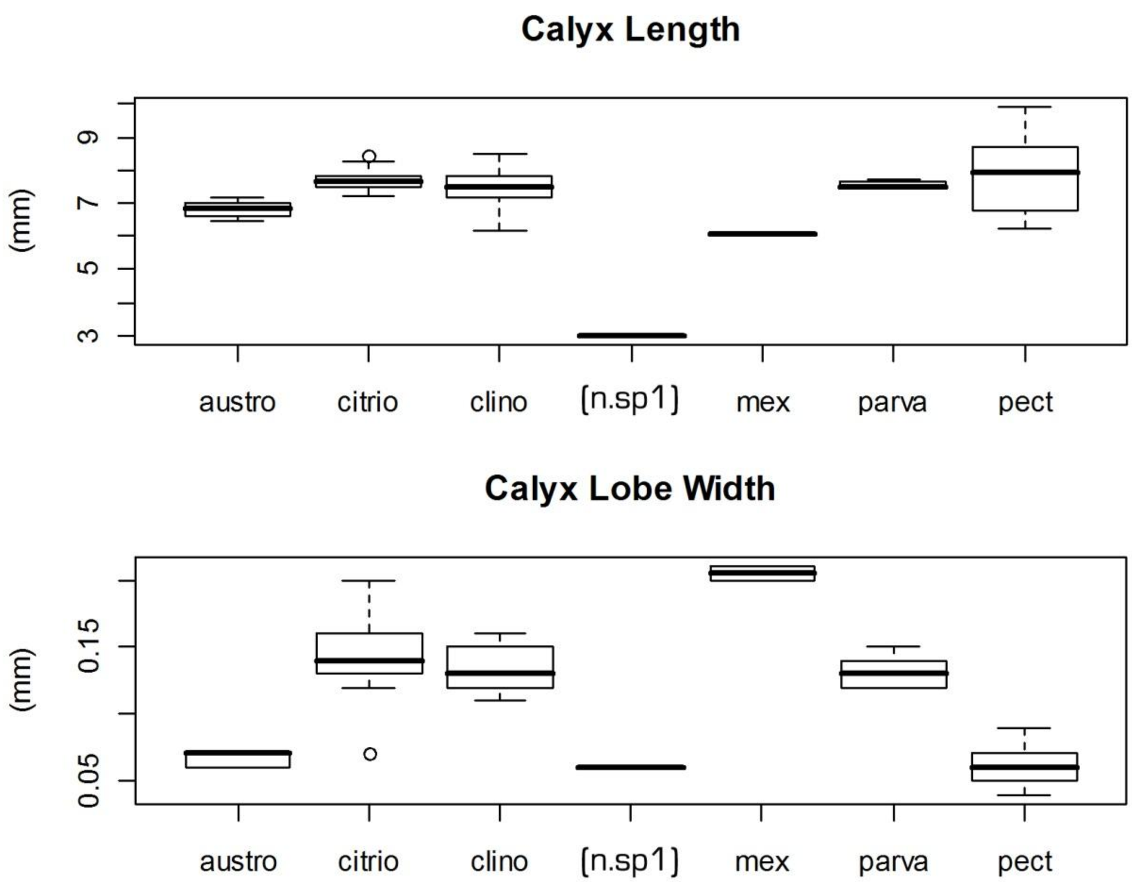

Figure 11. Box plots of Calyx Length (mm) and Calyx Lobe Width (mm) of *Monarda* section *Aristatae*.

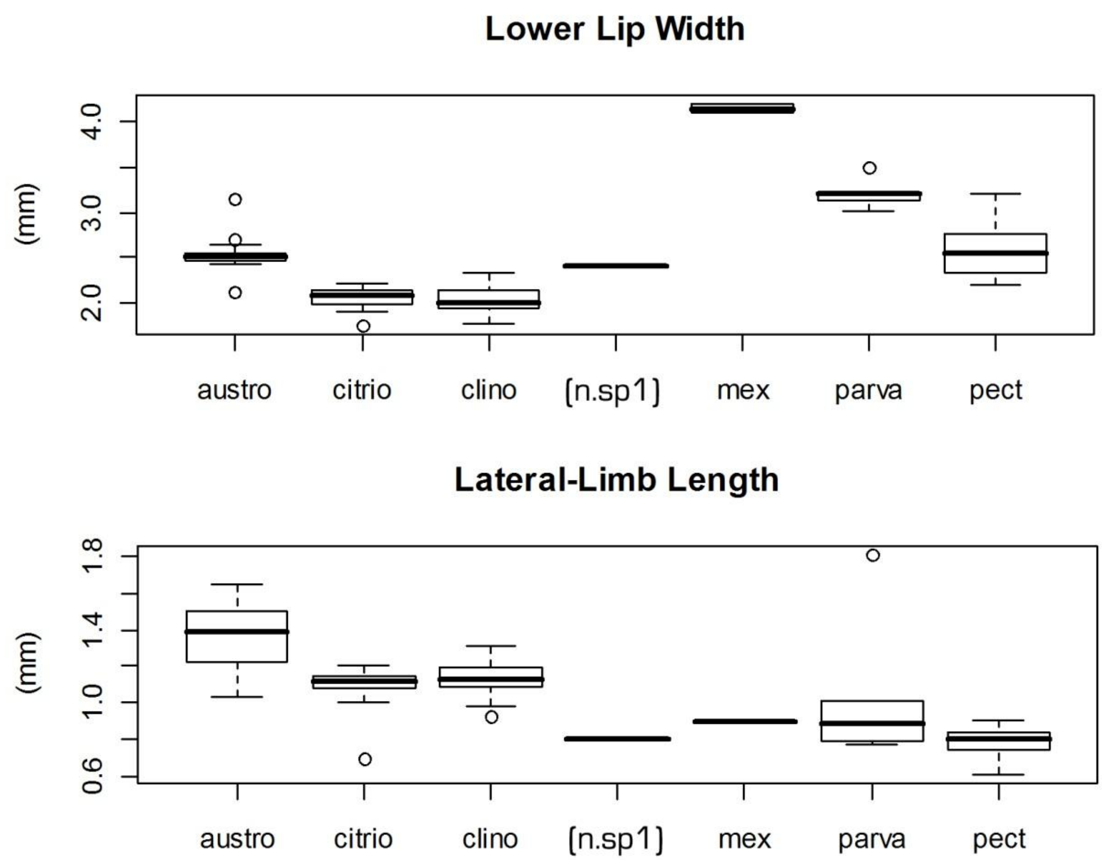

Figure 12. Box plots of Lower Lip Width (mm) and Lateral-Limb Length (mm) of *Monarda* section *Aristatae*.

Section Cheilyctis

UPGMA

The dendrogram of section *Cheilyctis* shows five major groups (Fig. 13 shows a synopsis of the entire dendrogram). Detailed regions of the tree are referenced in the figures below. Groups 1 (Fig. 14) and 5 (Fig. 15) are comprised of only *M. fruticulosa* and *M. maritima*, respectively, while groups 2, 3, and 4 contain a number of different taxa. Group 2 (Fig. 16) contains three main clusters (subgroups) that correspond to *M. humilis*, *M. stanfieldii*, *M. occidentalis ined*, and a small cluster of four individuals of various *M. punctata* varieties. Group 3 shows three clusters: two clusters of *M. punctata* varieties (Fig. 17) and one large cluster that contains mostly *M. punctata* var. *arkansana* and *M. villicaulis ined* plus two samples of *M. punctata* vars. (Fig. 18). Finally, group 4 (Fig. 19) contains two main clusters as well as a single specimen of *M. punctata* var. *correllii* which is attached at the base of the two main clusters. The first of the two above-mentioned clusters corresponds to *M. viridissima.* The other branch is comprised of seven specimens of *M. punctata* var. *punctata* (hereafter referred in the text as *Monarda n. sp.* 2) found in Florida and the southeast U.S. which have leaves that are greatly reduced in size compared to other specimens of *M. punctata* var. *punctata* in that region. A more detailed discussion of additional traits that differentiate these taxa is found in the Discussion section.

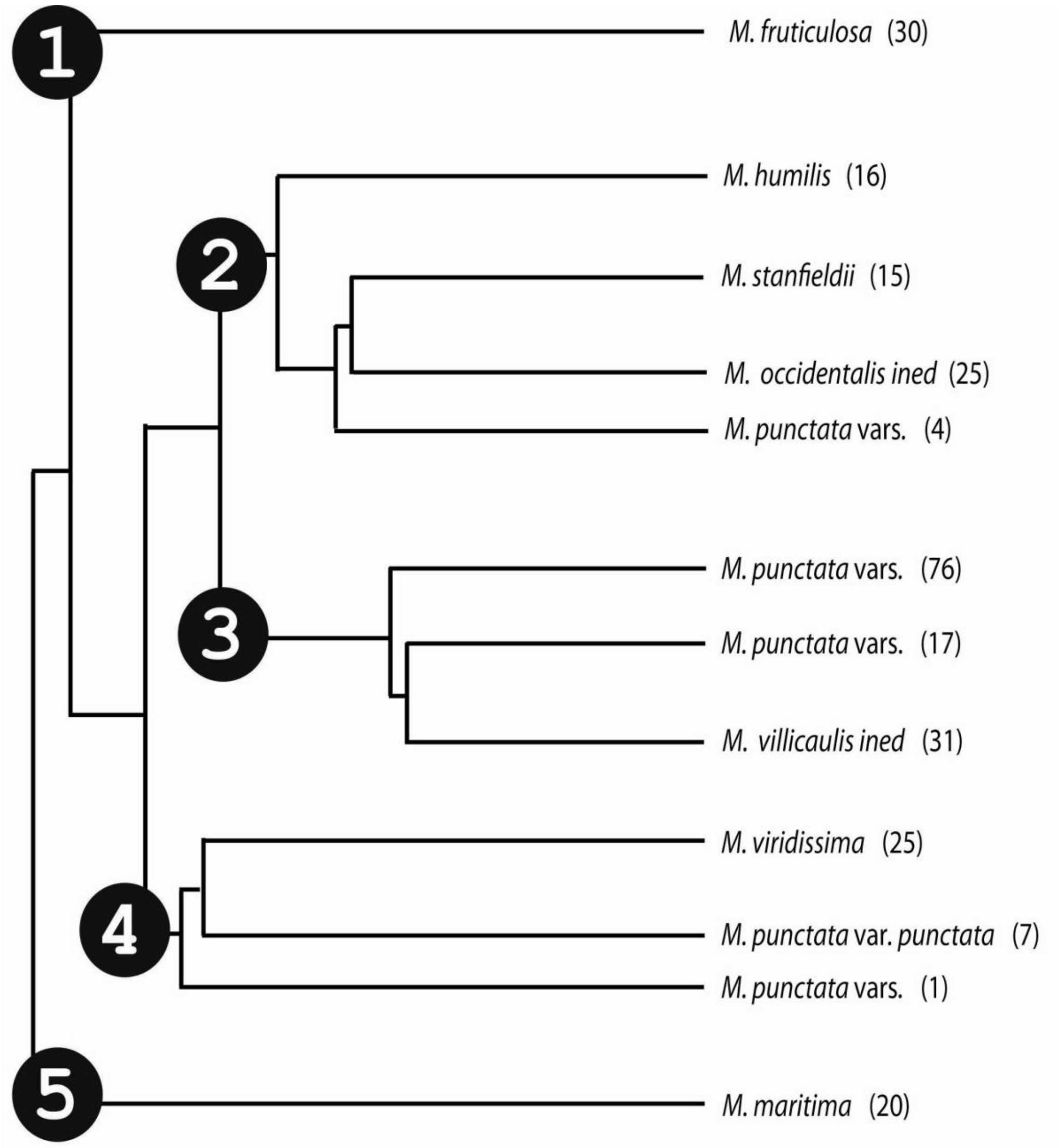

Figure 13. Synopsis of the *Monarda* section *Cheilyctis* UPGMA dendrogram based on Gower similarity estimates of 170 OTUs. Clusters of individuals of the same species (or intraspecific rank) are represented by a single branch, and the number of individuals in that branch is indicated in parentheses.

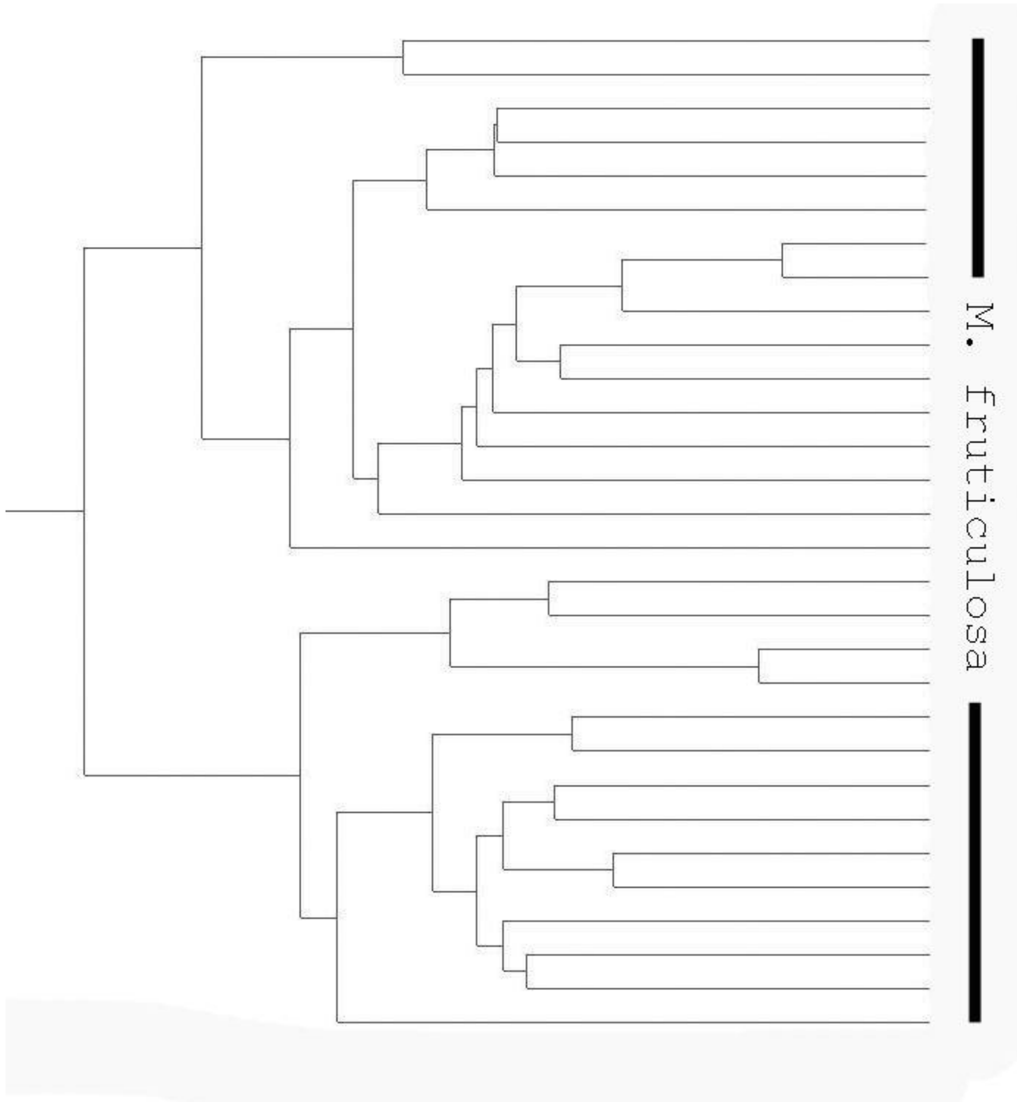

Figure 14. Group one in the UPGMA dendrogram of *Monarda* section *Cheilyctis* based on the Gower coefficient of similarity.

Monarda maritima is found in southeastern Texas along the Gulf of Mexico. In the UPGMA tree it is found clustered among other OTU's of the same rank (Fig. 15).

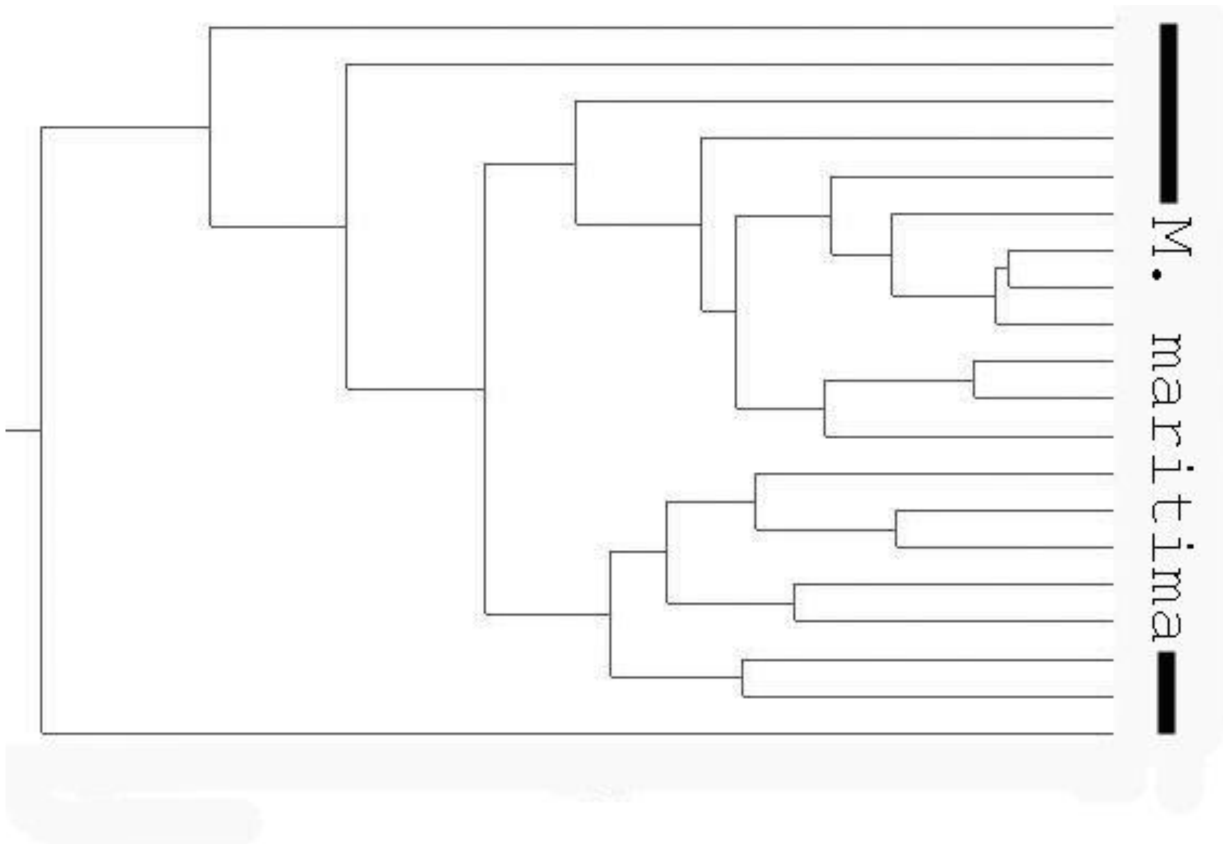

Figure 15. Group five in the UPGMA dendrogram of *Monarda* section *Cheilyctis* based on the Gower coefficient of similarity.

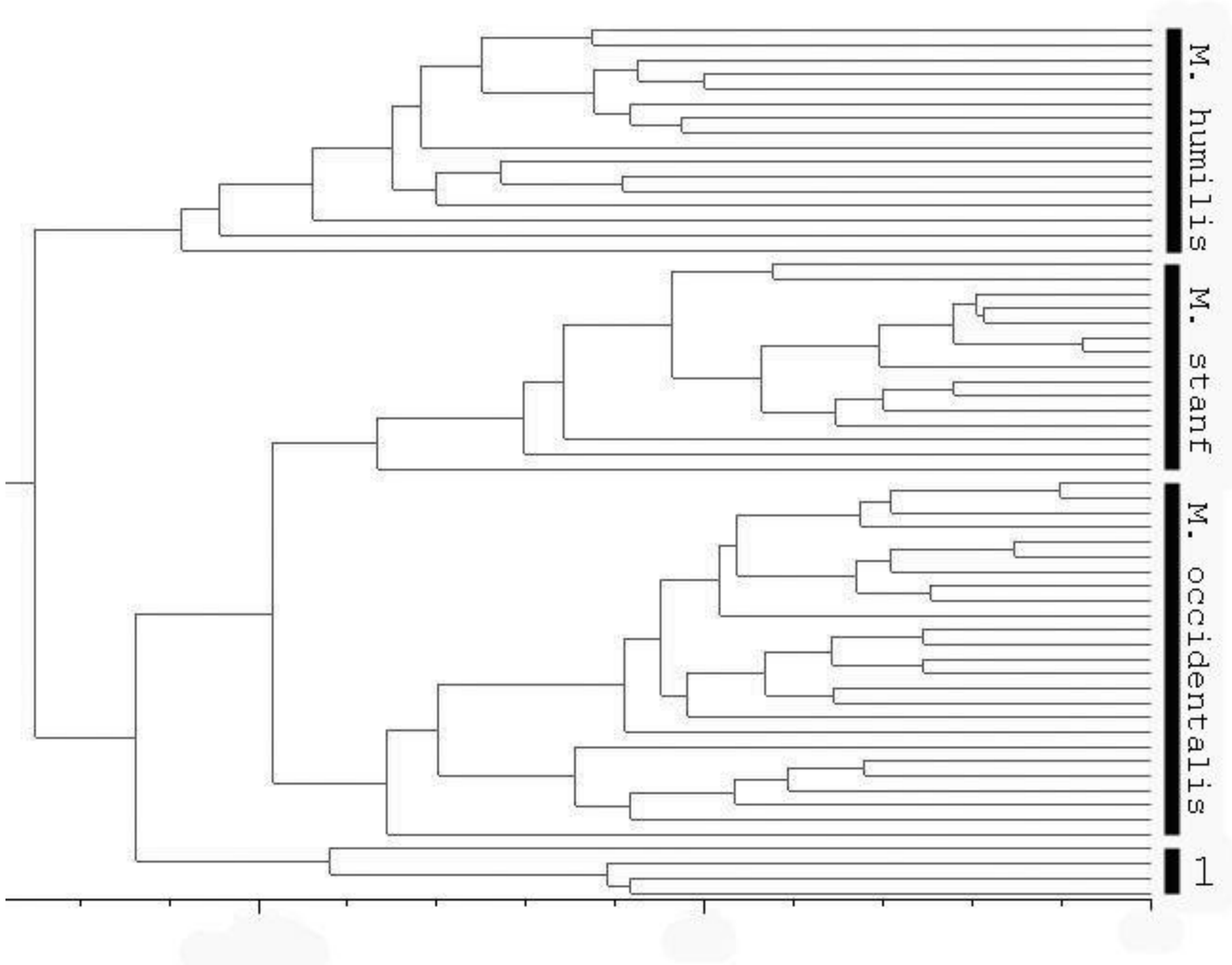

Figure 16. Group two in the UPGMA dendrogram of *Monarda* section *Cheilyctis* based on the Gower coefficient of similarity. The number "1" represents two specimens of M. punctata var. lasiodonta and one specimen of M. punctata var. correllii.

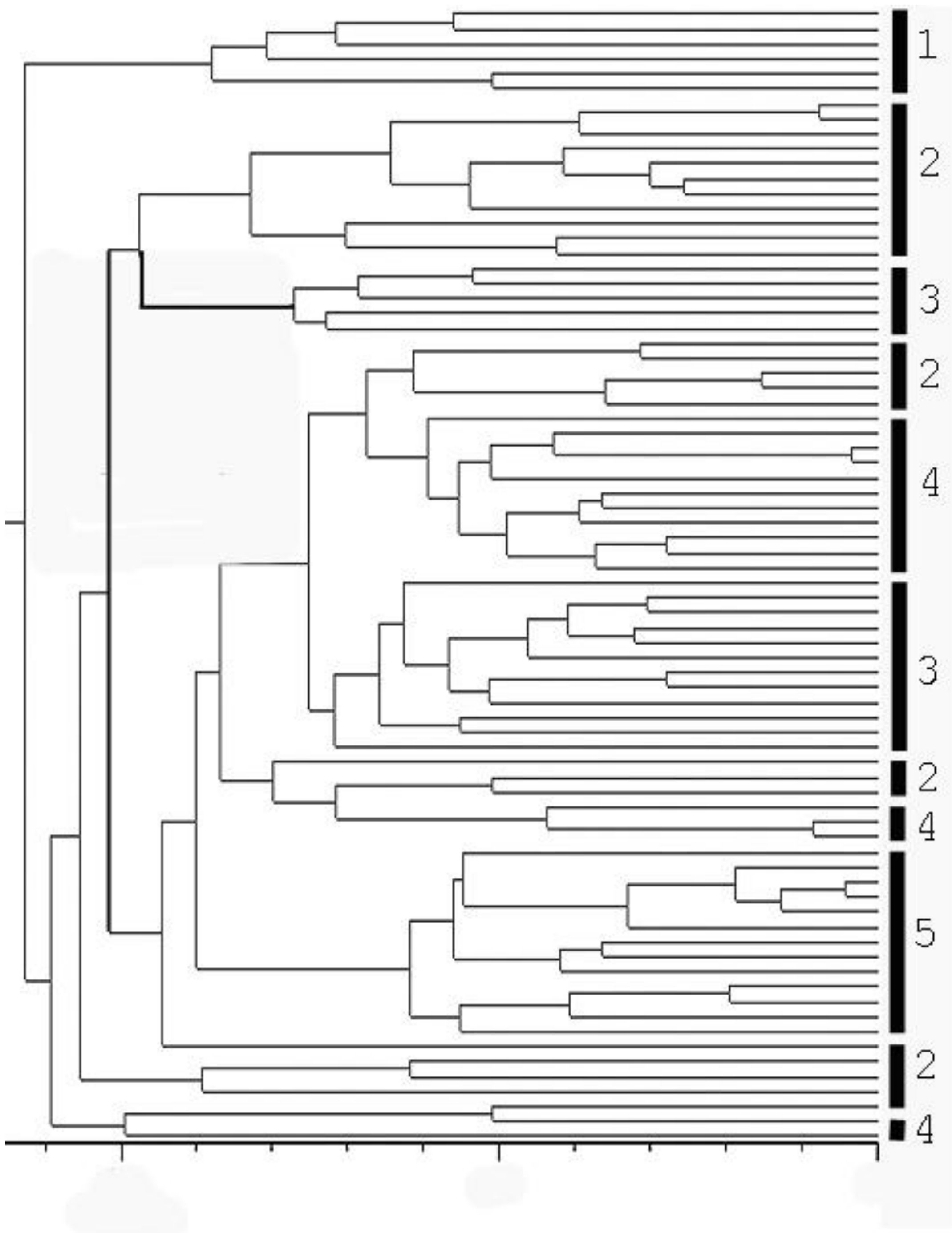

Figure 17. Portion of group 3 in the UPGMA dendrogram of *Monarda* section *Cheilyctis* based on the Gower coefficient of similarity. 1=var. arkansana, 2=var. lasiodonta, 3=var. correllii, 4=var. intermedia, 5=var. punctata.

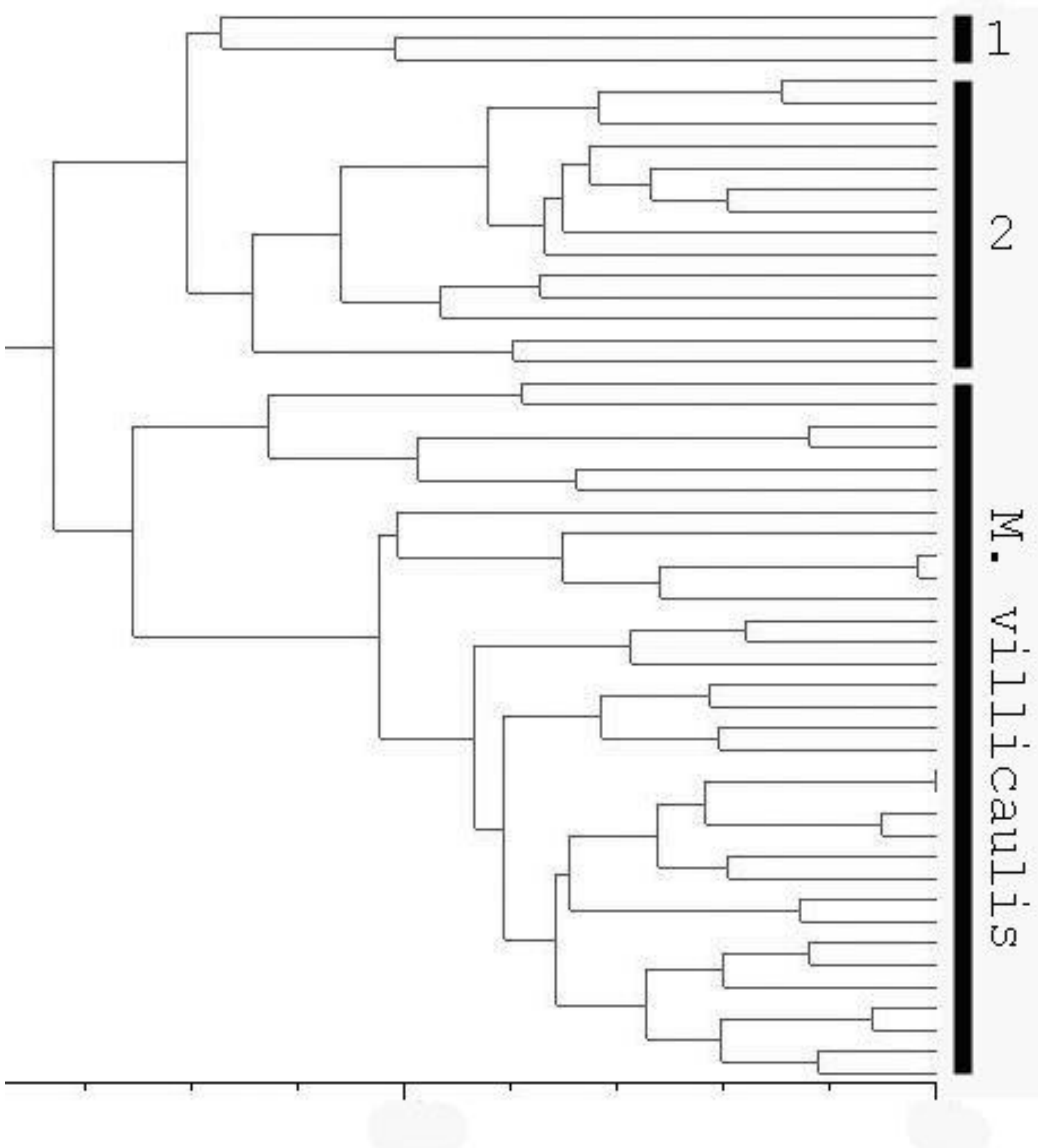

Figure 18. Second branch in group three in the UPGMA dendrogram of *Monarda* section *Cheilyctis* based on the Gower coefficient of similarity. 1=var. arkansana, var. lasiondonta, var. punctata; 2=M.arkansana.

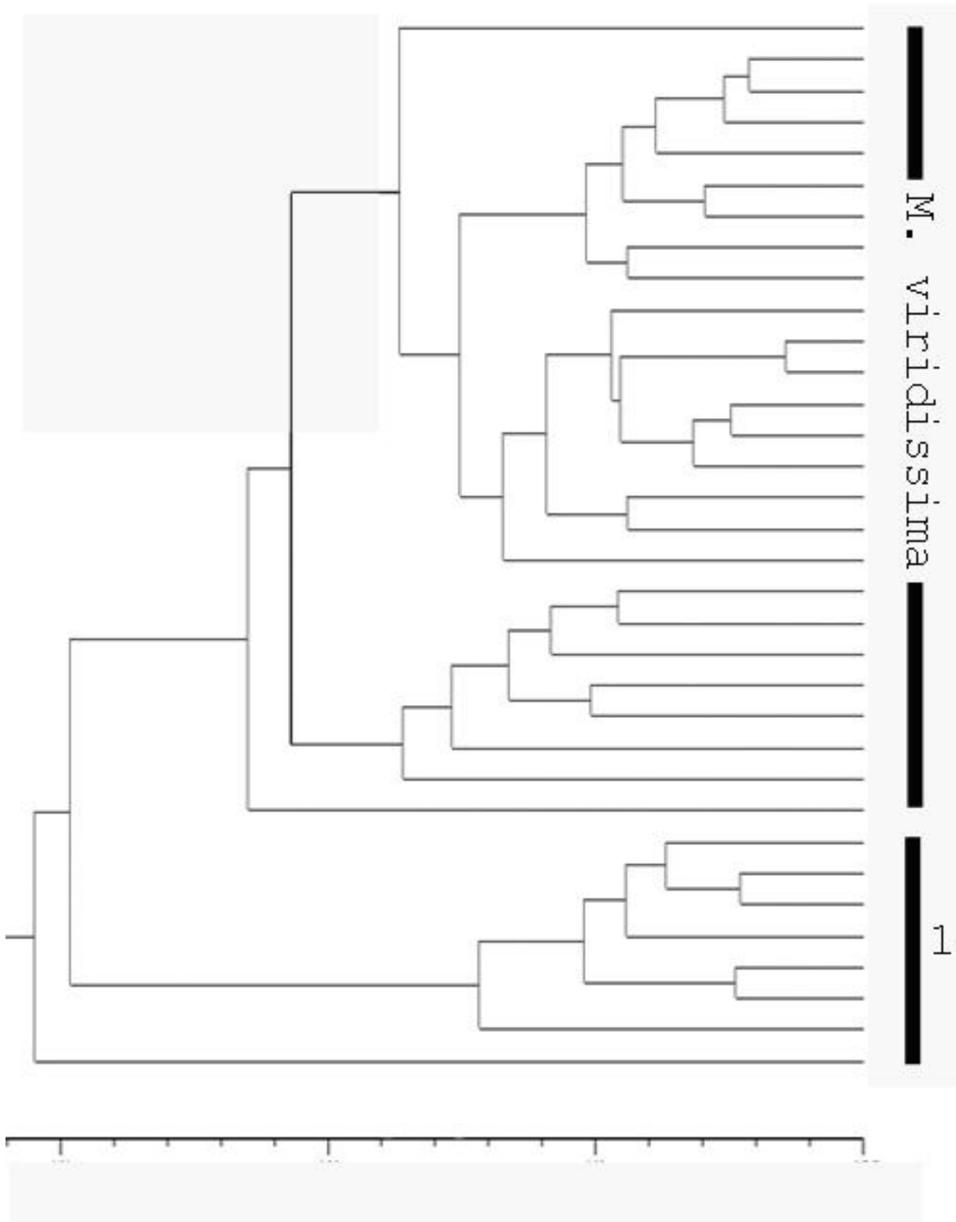

Figure 19. Group four in the UPGMA dendrogram of *Monarda* section *Cheilyctis* based on the Gower coefficient of similarity. 1= *M.punctata* var. *punctata*

PCOA

A scatter plot (Fig. 20) of the first two principal coordinates shows seven main clusters of taxa. The first group is comprised of all of the *M. maritima*. The second group contains the *Monarda n. sp.* 2 specimens. Group 3 contains all of the *M. viridissima* samples. The fourth group has all of *M. fruticulosa* as well as some *M. humilis*. The rest of *M. humilis* is found in the fifth group, along with all of the specimens of *M. stanfieldii* and *M. occidentalis ined*. Group six contains several specimens of *M. punctata* var. *lasiodonta*, *M. punctata* var. *punctata*, *M. punctata* var. *intermedia*, *M. punctata* var. *correllii*, and *M. punctata* var. *arkansana*. Group seven contains all of *M. villicaulis ined* as well as some individuals of *M. punctata* var. *arkansana*.

Adding the third coordinate (Fig. 21) demonstrates that *M. maritima* and *Monarda n. sp.* 2 (groups 1 and 2 from figure 20) are actually separated by a larger gap than appears from the Fig. 20. *Monarda n. sp*. 1 (“a” in Fig. 21) can be seen with better separation from *M. maritima* (“b” in Fig. 21). This is also the case for the *M. humilis* individuals (“c” in Fig. 21) from groups 4 and 5. In figure 21 they can be seen clustered together, though they are still in close proximity to *M.*

occidentalis (not labeled) which are positioned immediately below the *M. humilis* individuals. Figure 21 also reveals that group 7 should be divided further. *Monarda villicaulis ined* ("d" in Fig. 21) is clustered separately from the *M. punctata* var. arkansana ("e" in Fig. 21) in that original grouping.

For this analysis the first three principal coordinates accounted, cumulatively, for 18.1%, 30.1%, and 36.3% of the total variation, respectively. The remaining principal coordinates each summarize 5.3% or less of the total variation.

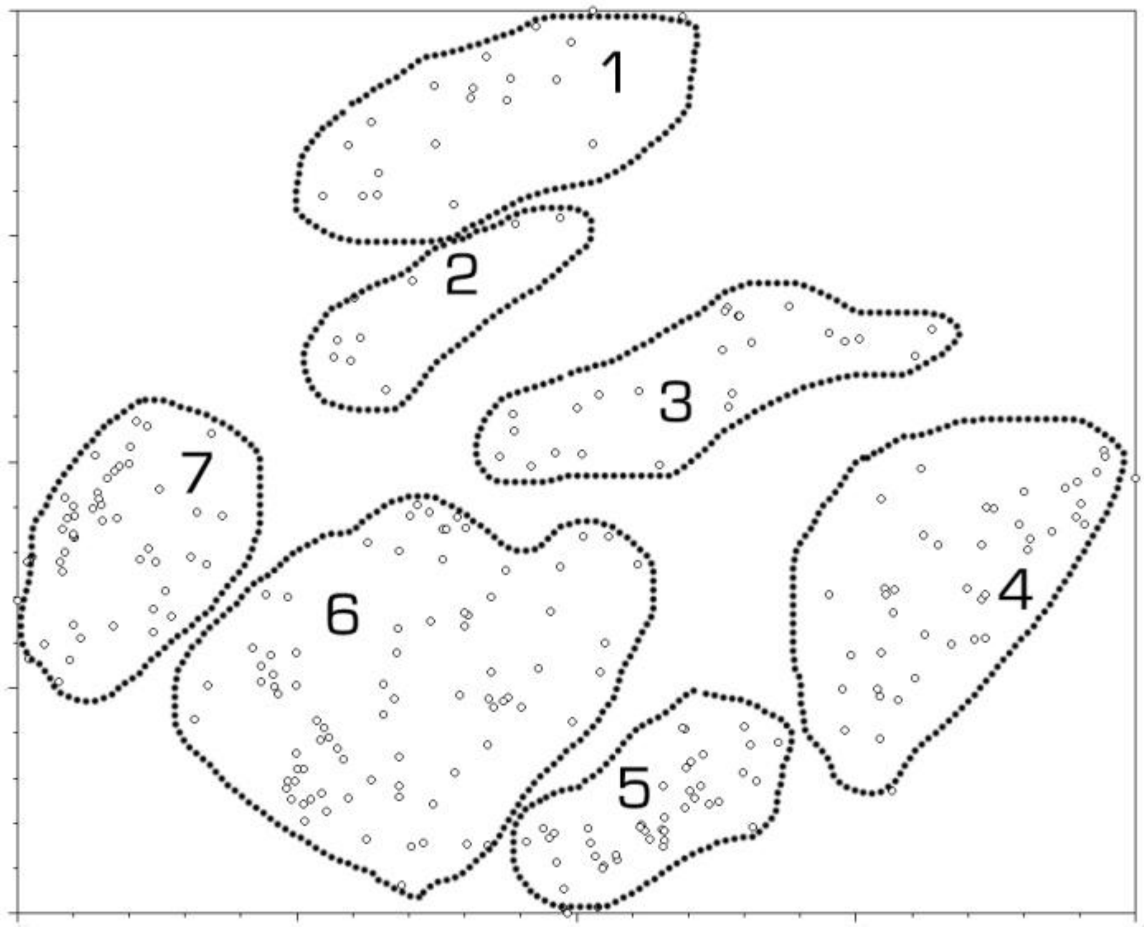

Figure 20. PCoA plot of the first two principal coordinates. The variability accounted for by each axis is 18.1 for the first and 12 for the second. Groups encircled by the dotted lines are discussed in the text.

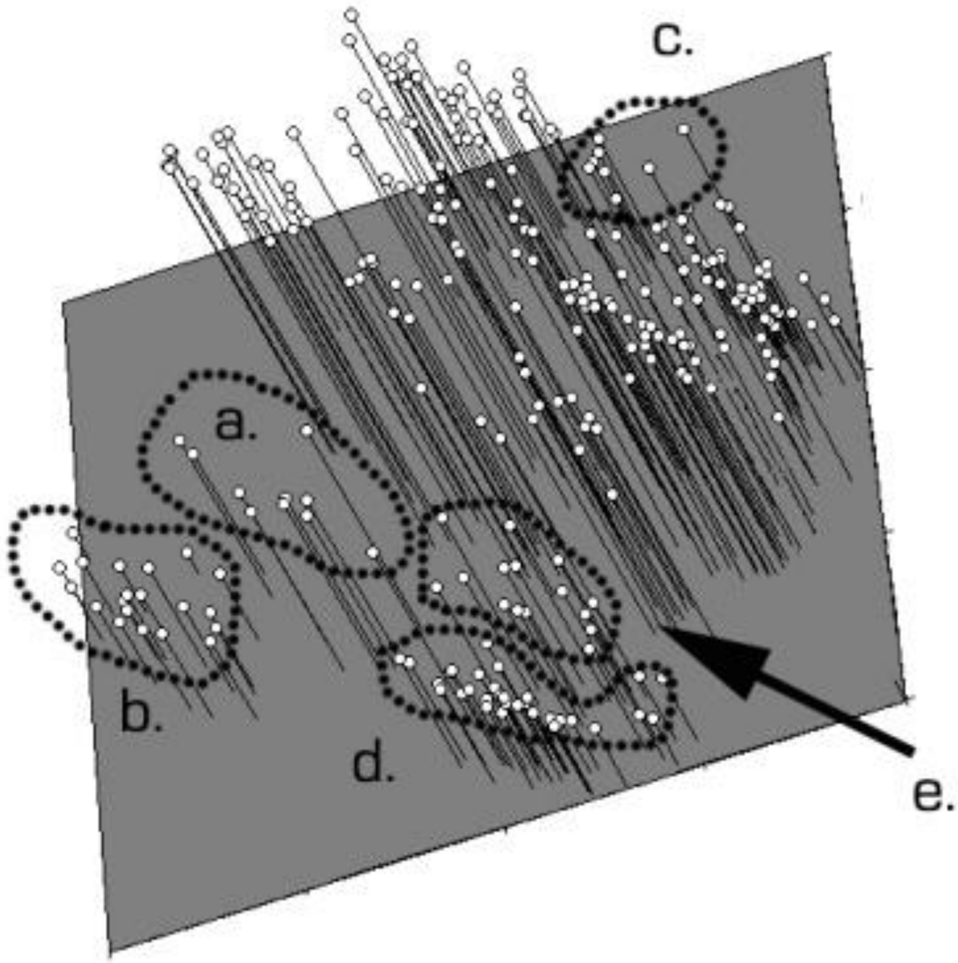

Figure 21. PCoA plot of the first three principal coordinates. The variability accounted for by each axis is 18.1% for the first, 12% for the second, and 5.2% for the third. a = *M. punctata* from Florida and southeast U.S., b = *M. humilis*, c = *M. stanfieldii*, d = *M. villicaulis ined.*

Descriptive statistics

Box plots showed 21 characters (with non-overlapping quartiles) that may be useful in differentiating the taxa in this section. Vegetative traits (figs 22, 23, 24) include internode length, internode width, petiole length, length of serrated margin, leaf tooth size, leaf length, leaf width, upper bract length, upper bract width. Inflorescence traits (figs. 25 - 28) include number of flowering branches, calyx length, calyx orifice pubescence length, calyx lobe width, lower corolla lip width, mid-limb length, mid-limb width, lateral-limb length, lateral-limb width, upper corolla lip length, upper corolla lip width, upper limb length. Box plots display the taxa in the following order: M. arkansana, var. correllii, M. fruticulosa, M. humilis, var. lasiodonta, M. maritima, M. occidentalis, var. punctata, Monarda n. sp. 2, M. stanfieldii, M. villicaulis, M. viridissima.

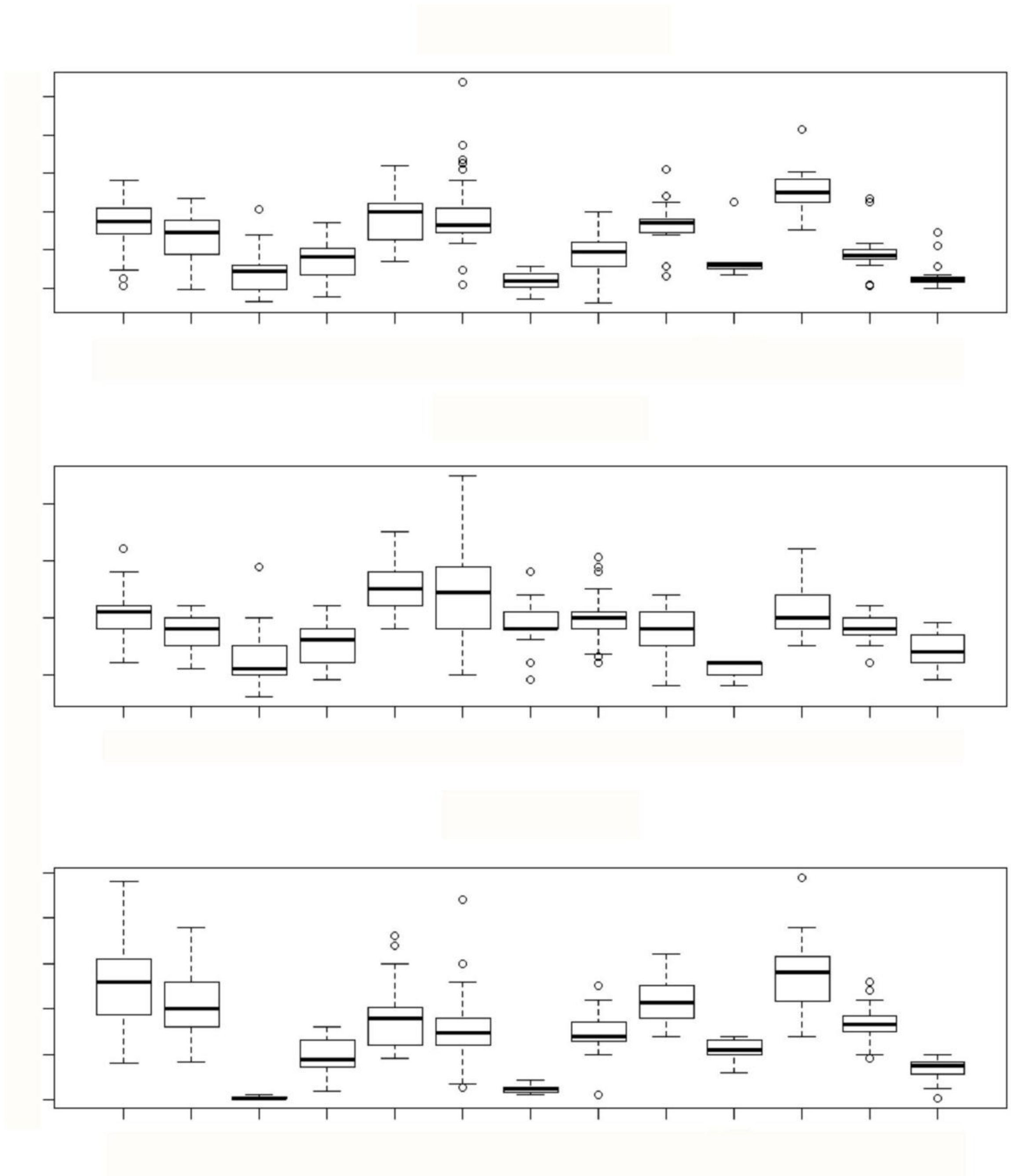

Figure 22. Box plots of Internode length (mm), Internode Width (cm), and Petiole Length (mm) of *Monarda* section *Cheilyctis*.

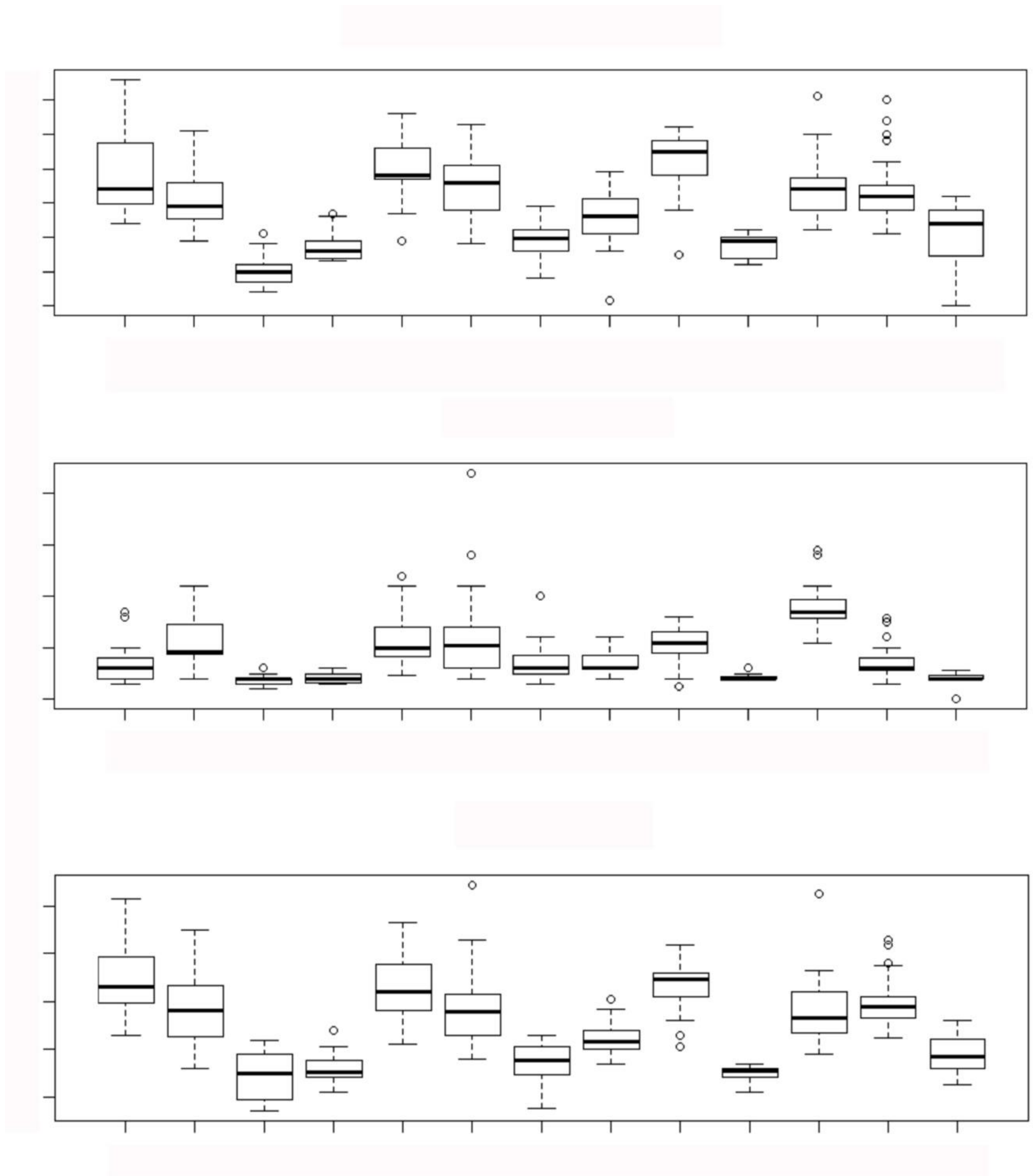

Figure 23. Box plots of Length of the Serrated Margin (mm), Leaf Tooth Size (mm), and Leaf Length (cm) of *Monarda* section *Cheilyctis*.

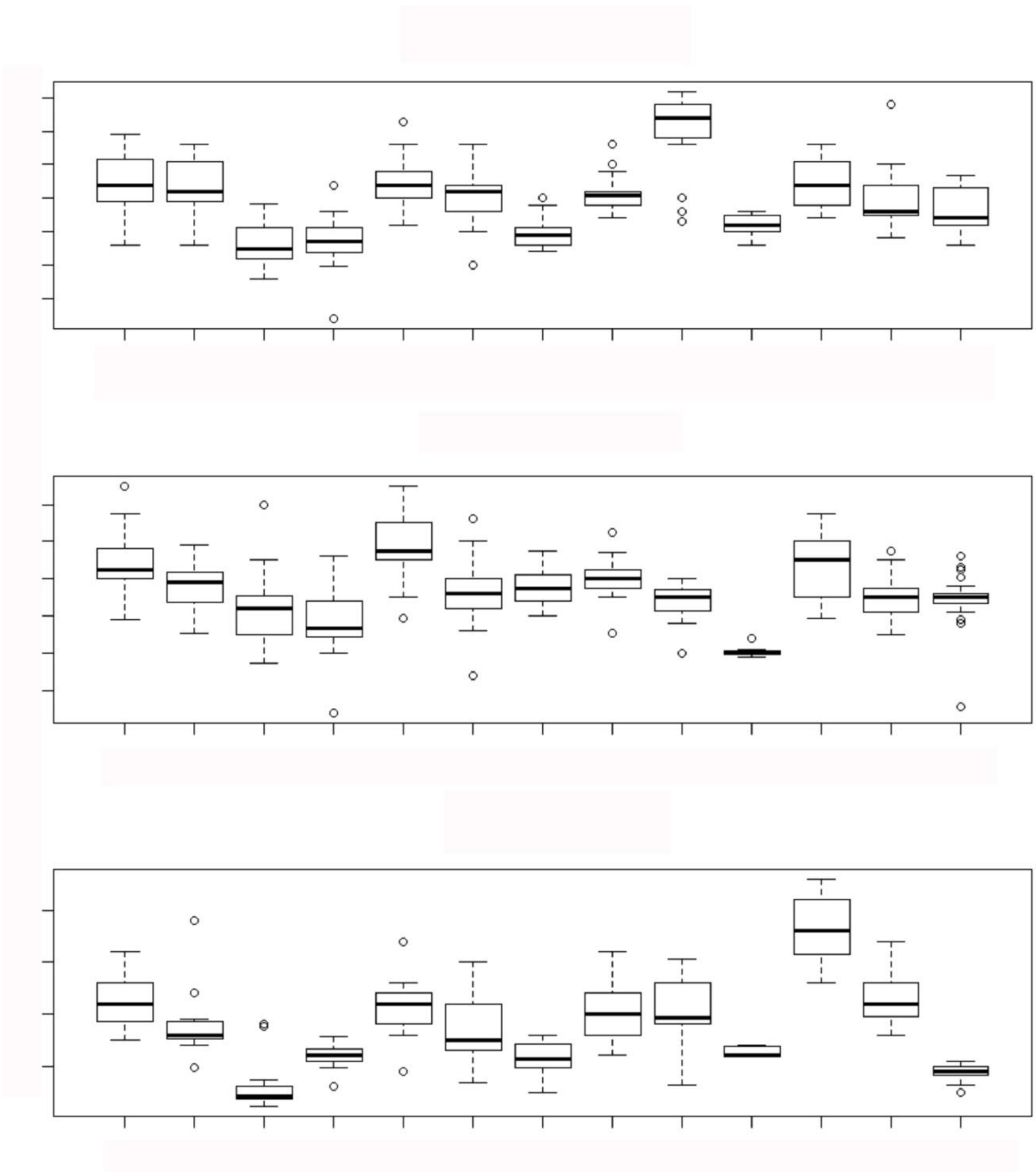

Figure 24. Box plots of Length of Upper Bract (cm), Width of Upper Bract (mm), and Leaf Width (cm) of *Monarda* section *Cheilyctis*.

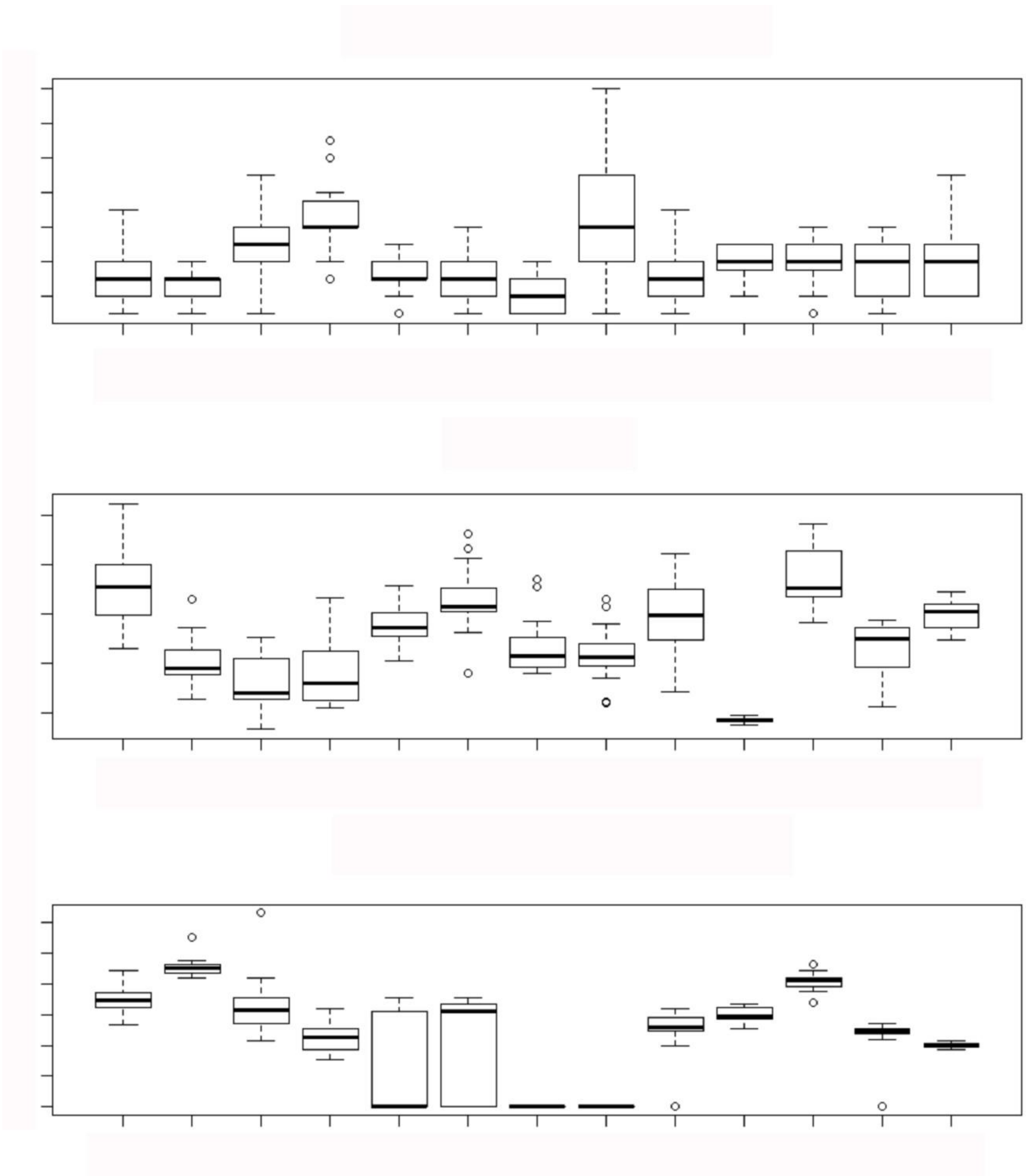

Figure 25. Box plots of Number of Flowering branches, Calyx Length (mm), and Calyx Orifice Pubescence Length (mm) of *Monarda* section *Cheilyctis*.

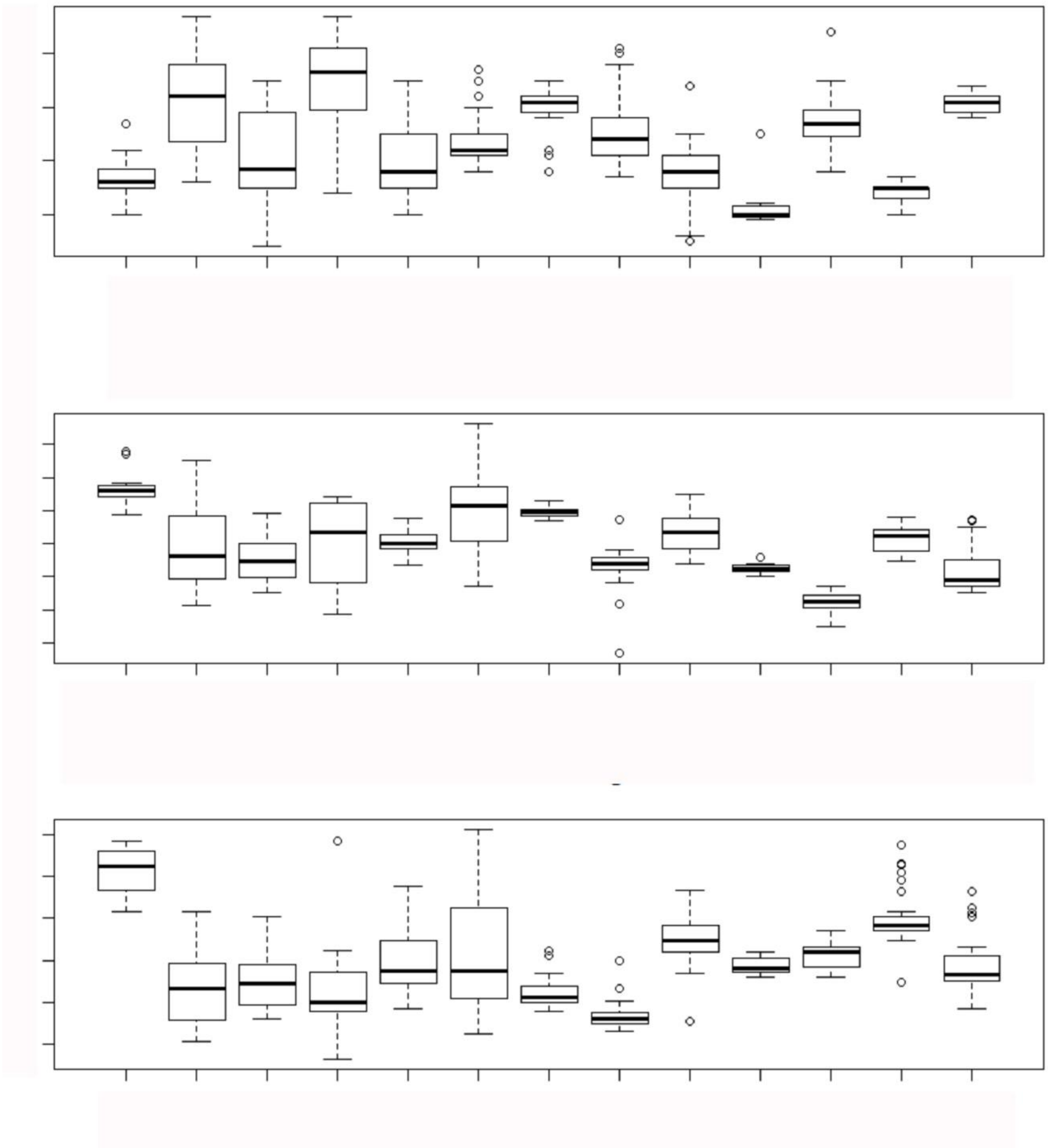

Figure 26. Box plots of Calyx Lobe Width (mm), Lower Corolla Lip Width (mm), and Mid-Lip Length of *Monarda* section *Cheilyctis*.

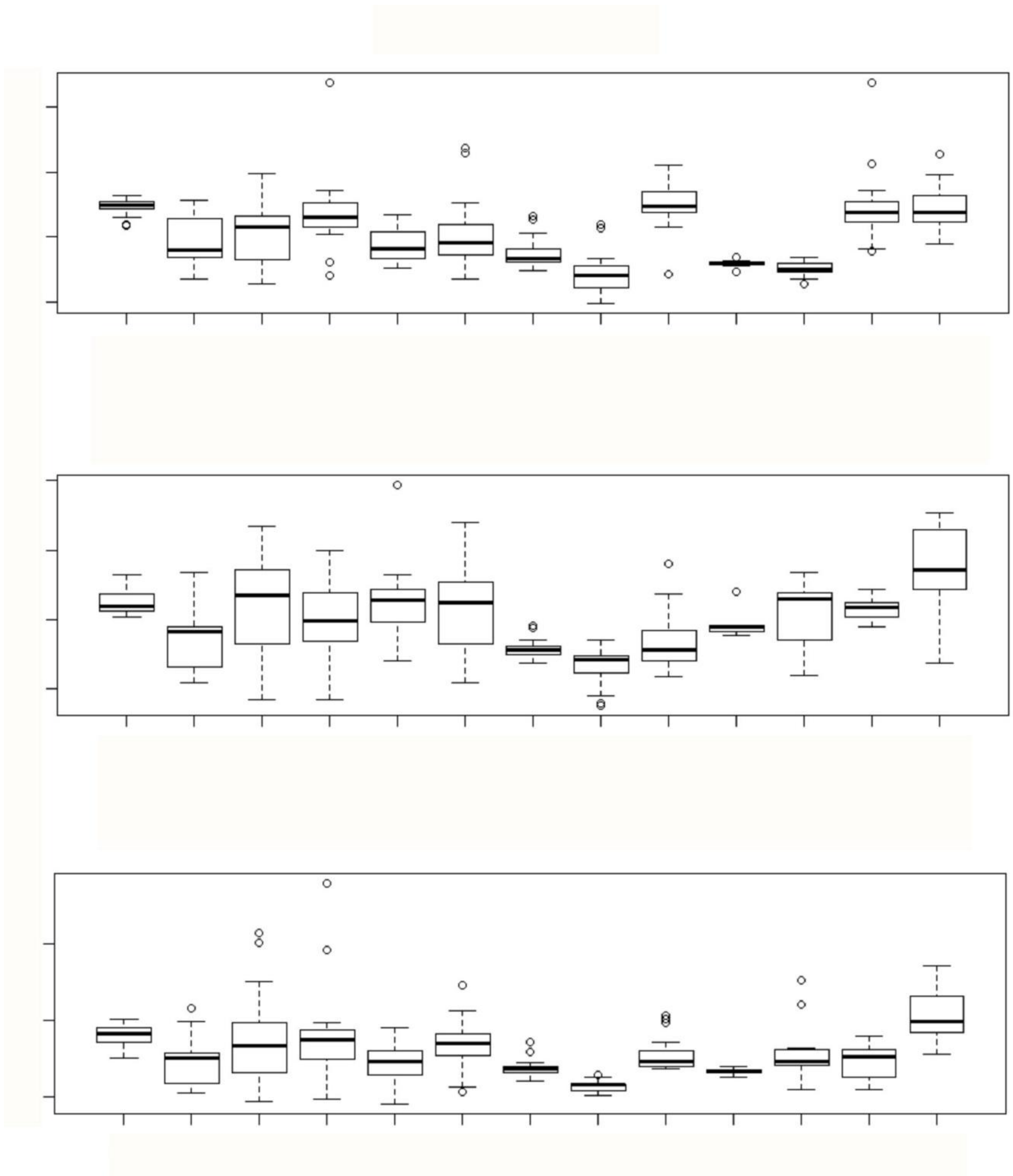

Figure 27. Box plots of Mid-Limb Width (mm), Lateral-Limb Length (mm), and Lateral-Limb Width (mm) of *Monarda* section *Cheilyctis*.

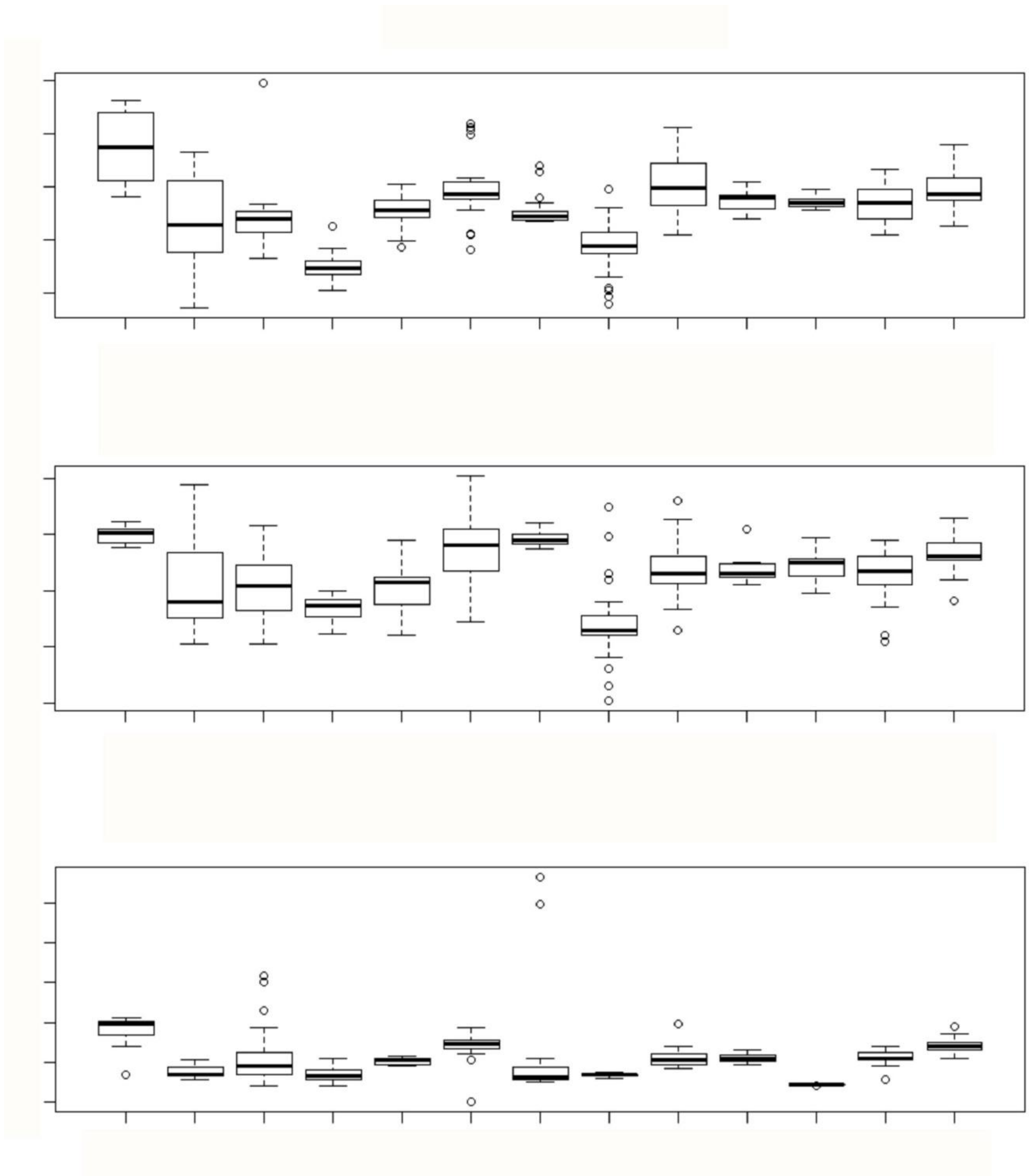

Figure 28. Box plots of Upper Corolla Lip Length (mm), Upper Corolla Lip Width (mm), and Upper Limb Length (mm) of *Monarda* section *Cheilyctis*.

Discussion

The following discussion is organized into two sections. The first section is a discussion, taxon by taxon, of the taxonomic conclusions made concerning my putative species circumscriptions (from the Methods section). Those will be addressed in the following order:

1) taxa that are supported by both UPGMA and PCOA,

2) taxa that are supported by one analysis but ambiguous or not supported in the other

3) taxa that receive no support from either analysis

The second section is a discussion of the contribution of morphological traits to the taxonomy of *Monarda* subgenus *Cheilyctis*. It covers characters that were shown in the box plot analyses and briefly summarizes the historical importance of those features as well as their utility in my current taxonomy for the subgenus.

Taxonomic conclusions

TAXA SUPPORTED BY BOTH UPGMA AND PCOA. Of the species presented in my putative taxonomy (Methods section), *M. austromontana* Epling, *M. clinopodioides*, *M. maritima*, *M. villicaulis ined*, *M.*

viridissima, *M. fruticulosa*, *Monarda n. sp.* 2, and *M. pectinata* have clear support by both UPGMA and PCoA. In both analyses these taxa cluster exclusively together in accordance with my hypothesis that they are indeed species. Of these, *M. clinopodioides*, *M. pectinata*, *M. maritima*, *M. viridissima*, and *M. fruticulosa* are all currently accepted species.

Monarda austromontana Epling and *M. villicaulis ined* were considered varieties of *M. citriodora* and *M. punctata*, respectively, and *Monarda n. sp.* 2 is a *spec. nov*. from Florida and the southeastern U.S. *Monarda austromontana* is most easily recognized by its reflexed lower bracts but also has the longest (> 1.2 mm) lateral limbs of section *Aristatae*. *Monarda villicaulis* is most easily recognized by the qualitative indumentum traits (Adaxial Surface >5, Abaxial surface >5, Inter-ridge Region >5) that give the species villous laminar and stem surfaces making the plants appear silvery. Furthermore, they are geographically isolated with a distribution in the northeastern regions of the US, extending only as far south and west as Missouri. *Monarda n. sp* 2 is best distinguished from the other taxa in this section by smaller (<4cm long, <1 cm wide) ovate leaves (Figs. 23, 24), thin and spindly stems (measured as internode width, Fig. 22) with occasional prostrate growth, and short calyces (Fig. 25) that make the flowers appear smaller than the other species in section *Cheilyctis*. It is found in central Florida and the southeastern U.S.

TAXA SUPPORTED BY UPGMA, AMBIGUOUS IN PCOA. *Monarda n. sp.* 1, *M. humilis*, *M. mexicana*, *M. stanfieldii*, and *M. occidentalis ined* also all cluster together (or have clear separation via a small similarity coefficient with any other OTU's as in the case of the single specimen of *Monarda n. sp.* 1) in the UPGMA but have a limited number of OTU's that are overlapping in the PCoA. Even considering this overlap in the PCoA analysis these five taxa warrant species status as they all have unique, identifying morphological features (discussed below).

Monarda n. sp. 1 is most distinct from the other members of *Monarda* section *Aristatae* by virtue of it being densely canescent on all vegetative surfaces. This gives the taxon a distinctly grey appearance. It also has the shortest calyces (<5 mm long) (Fig. 11) in the section and bears further differences from the taxon it overlaps (*M. austromontana* Epling) in bract shape and pigmentation characters. *Monarda humilis* has the shortest upper corolla lips of the section (Fig. 28), and is distinguished from the taxon it overlaps (*M. occidentalis ined*) by several additional features. It has smaller leaves and teeth (Fig. 23, 24), and a smaller length of the margin that is serrated (Fig. 23). It also has shorter upper bracts (Fig. 24), wider calyx lobes (Fig. 26) and wider mid (Fig. 26) and lateral (Fig. 27) limbs. *Monarda mexicana* has very finely serrulate leaf (Fig. 8) and bract (not shown) margins, the widest (> 15 mm) lower bracts in the subgenus (Fig. 22), and wide (>1.7 mm) calyx lobes (Fig. 26), and lower corolla lips (Fig. 26). *Monarda stanfieldii* has long petioles (Fig. 22), wide leaves with large dentate margins (Figs. 23, 24), and has flowers with long calyces (Fig. 25) and narrow lower corolla lips (Fig. 26). *Monarda occidentalis ined* is a more heavily branched species (as is *M. humilis* (Fig. 25)), lacking in calyx orifice hairs (Fig. 25), with smaller lower corolla lip limbs (Fig. 27) and narrow upper corolla lips (Fig. 28).

There are some additional features that are distinctive of *M. stanfieldii, M. occidentalis ined,* and *M. humilis* that proved to be too problematic to include in this investigation. The first is the uniquely dense calyx orifice hairs seen in *M. stanfieldii* which were excluded, along with all density measures of indument, due to difficulty of data collection. The second is the large number of flowers clustered in each verticilaster of *M. occidentalis ined*. I refrained from counting this for each OTU as the sampling would require the destruction of entire glomerules for each specimen included in the analysis. Finally, I avoided collecting data pertaining to color and pigmentation patterns between taxa, as age differences, drying methods, and other discrepancies between the handling of the herbarium specimens would lend to differential fading of the pigments. However, these traits are often invoked in separating the taxa in this section, and a good example is in separating *M. humilis* from its closest geographic neighbor, *M. occidentalis ined*. The former has purple floral bracts and white corollas with purple spots whereas the later has white floral bracts and yellow corollas with purple spots.

These three species also have somewhat distinct distributions. *M. occidentalis* has the largest geographic distribution, extending south from southern Kansas through western Oklahoma across western Texas and eastern New Mexico and down into northern Mexico. *M. stanfieldii* is found in central Texas, east of *M. occidentalis*, and *M. humilis* is found in New Mexico on the western margin of the distribution of *M. occidentalis*.

TAXA LACKING SUPPORT FROM EITHER ANALYSIS. Though individuals of *M. citriodora* var. *parva* clustered together in the UPGMA, the branch that separated them from *M. citriodora* var. *citriodora* was very shallow (larger coefficient of similarity between those groups of OTU's). In fact, there are some branches of *M. pectinata* and *M. austromontana* that are similarly long. Their positions in the PCoA analysis were quite close to them as well. Since there weren't any solid morphological traits that corroborate species recognition, the conservative conclusion is that they remain part of *M. citriodora*.

With the exception of the *M. punctata* var. *arkansana* in group 3 (Fig. 18, discussed in detail below), there are large clusters in both analyses formed of varieties of *M. punctata*. Because of this I maintain that those taxa indeed belong to the species *M. punctata* and stress that it is a highly variable species. To further highlight this variation I make note of eight additional specimens of *M. punctata* that came out in unexpected locations along the dendrogram. Four of them (lasio61, punc298, punc160, punc159) show up in group 3 (Fig. 18) with *M. arkansana ined*, and four (corr464, corr470, corr471, lasio70) show up in group 2 (Fig. 16) with *M. occidentalis ined*. One possible explanation for those specimens to come out with *M. occidentalis ined* is because they have abnormally large (compared to the other taxa of *M. punctata*) bract dimensions. Similarly, the specimens that come out with *M. arkansana ined* have larger leaf dimensions, which they have in common with *M. arkansana*. However, in the PCoA they are clustered with the rest of *M. punctata*, reinforcing their placement in that species.

Of additional interest in *M. punctata* (especially evident in the UPGMA) were the two groups of *M. punctata* var. *arkansana*. One group (Fig. 17) shared a branch with *M. punctata*, and the other (Fig. 18) shared one with *M. villicaulis.* Close inspection of the specimens and Scora's representative specimen list revealed that this pattern is an artifact of Scora being unfamiliar at the time of his publication with the variation in stem pubescence found in *M. punctata* var. *punctata* or of that taxon's wider geographic distribution. In his key (which was used in assigning the specimens in this study to taxon) he separates *M. punctata* var. *arkansana* from *M. punctata* var. *punctata* based on the former as having stems with many horizontal bristles, leaf blades from 60 - 80 mm long, and being from Arkansas, whereas he recognized the latter as having stems with few horizontal bristles, leaf blades from 40 - 50 mm long, and being from the Atlantic and Gulf seaboards. The *M. punctata* var. *arkansana* individuals that share the branch with the remaining varieties of *M. punctata* (Fig. 17) are in fact *M. punctata* var. *punctata* that are found in Arkansas, with stems having many horizontal bristles. In fact, Scora examined the specimens in 1984 and annotated them as such.

Based on the cluster analyses and some unexpected morphological distinctiveness identified by the boxplots, I have elected to elevate *M. punctata* var. *arkansana* to *M. arkansana ined*. The species has the longest upper corolla lips (Fig. 28) of section *Cheilyctis*, as well as the longest lower corolla mid limb (Fig. 27) and upper corolla limb (Fig. 28). It also is distinguished from *M. punctata*, expressly, by its larger leaves and more densely pubescent surfaces (though there are specimens of *M. punctata* var. *punctata* that are exceptions to this). Despite the differences between *M. arkansana* and the rest of section *Cheilyctis*, I would still like to stress that this is a tentative conclusion, because the levels of variation of these traits are quite high within *M. punctata*.

In summary of the changes to my proposed taxonomy, two new species (*Monarda n. sp*. 1, *Monarda n. sp.* 2) will be recognized and three new combinations (*M. arkansana ined, M. occidentalis ined,* and *M. villicaulis ined*). The following is my final taxonomic list of the species in *Monarda* subgenus *Cheilyctis*:

<u>Section Aristatae</u>

Monarda n. sp. 1

M. austromontana Epling

M. citriodora Cervantes ex Lagasca

M. clinopodioides Gray

M. pectinata Nuttall

M. mexicana Epling

Section Cheilyctis

Monarda n. sp. 2

M. arkansana ined

M. fruticulosa Epling

M. humilis (Torrey) Prather & J.A. Keith

M. maritima (Cory) B.L. Turner

M. occidentalis ined

M. punctata L.

M. stanfieldii Small

M. villicaulis ined

M. viridissima Correll

Contribution of Morphological Traits to the Taxonomy of Monarda subgenus Cheilyctis

The traits most commonly employed for the circumscription of the species of this subgenus have been vestiture, leaf shape and dimensions, calyx shape and dimensions, and corolla pigmentation. Though calyx orifice hair density and corolla pigmentation were not examined in this analysis, there were a number of the above characters that were found to be unique to a single taxon and helped in circumscribing my recognized taxa. Among these were stem and leaf pubescence as well as leaf dimensions.

Below is a brief review of how these characters were used in previous treatments as well as a discussion of new insights into these characters and their impact on the taxonomy of this group. I also address additional characters from this study that showed promise for taxonomic utility. These include petiole length, leaf tooth size, length of serrated margin, and bract dimensions.

Vestiture. Indumentum has played an important role in the taxonomy of this section from at least the inception of the first subspecies of *M. punctata, M. punctata.* subsp. *villicaulis* by Francis W. Pennell (Pennell 1919). Its utility stems from variation in hair type (bristly, canescent, ciliate, strigose, tomentose, villous, puberulent) density (dense, sparse, spreading) angle (down swept, horizontal, upswept) and placement (on stems, nodes, petioles, ab- and adaxial leaf surfaces, leaf margins, midveins, floral bracts, calyx lobes, calyx orifices), and has been invoked among various taxonomic keys for almost every taxon. Their treatment has been inconsistent, however, and there is some disagreement on aspects such as hair type and location as well as how often it occurs across a given taxon and their overall importance as identifying traits. Epling (1935), McClintock & Epling(1942), Scora (1967), and Prather & Keith (2003) agree that *M. fruticulosa* has a canescent indument, whereas Turner (1994) refers to it as densely strigose. *M. villicaulis ined* has spreading hairs throughout according to Pennell (1919), but has a thinly pubescent upper leaf surface and dense covering of thin hairs along the lower leaf surface by McClintock & Epling (1942), Epling (1935), and Scora (1967). *M. maritima* has pilose indument upon the stem and leaf surfaces according to Turner (1994) and Prather & Keith (2003) but the taxon, *sensu* Scora (1967), has bristles on the stems and petioles and elongated stiffish hairs on the abaxial leaf surface.

Leaf Dimensions. Most treatments of these taxa include circumscriptions based in part on leaf size and shape. McClintock & Epling (1942) treated *M. fruticulosa* as having narrow (not wider than 3 mm) linear leaves, and they treated the leaves of *M. punctata* var. *immaculata* as linear-lanceolate. Though Scora (1967) separated *M. punctata* vars. *fruticulosa* and *immaculata* from the other taxa in this section by their linear leaves, Turner, while not recognizing *M. punctata* var. *immaculata*, elevated *M. punctata* var. *fruticulosa* to *M.*

fruticulosa and also segregated it from the rest of the taxa based specifically on their narrow leaves. Leaf size is also a vital feature in the identification of other species in the subgenus as well. *M. microfolia* is readily identified by its small leaves, and *M. arkansana ined* by its larger leaves.

Calyx lobe dimensions. Calyx lobe shape differences have also been used frequently to differentiate taxa in this section. The most prominent differences in this trait come from comparing the two sections. In fact, a defining feature of *Monarda* section *Aristatae* is the presence of long aristate calyx lobes, (vs. the shorter wider lobes of *Monarda* section *Cheilyctis*). Even within the sections, however, there is notable variation in these traits. Both Scora (1967) and McClintock and Epling (1942) separate *M. punctata* var. *occidentalis* from the other varies by their widely deltoid calyx teeth. In his taxonomic keys, Turner (1994) distinguishes *M. punctata* var. *punctata* from *M. punctata* var. *correllii* by the narrowly deltoid calyx lobes of the former and the broadly deltoid calyx lobes of the later. He also uses the "broadly acute" calyx lobes of *M. punctata* var. *occidentalis* to distinguish it from *M. punctata* var. *intermedia*, which he indicates as having "narrowly acute" lobes. The current treatment recognizes two species based, at least in part, on calyx lobe shapes. The first is *M. occidentalis ined* (for reasons described above), the second is *M. mexicana* which demonstrates wider calyx lobes than any of the other species in *Monarda* section *Aristatae*.

Petiole length. *M. fruticulosa* is without (or with a very minute (<0.2 mm)) petioles and *M. maritima* has petioles from 0.5 to 2.1 mm. The rest of the taxa have longer petioles (> 3 mm).

Leaf tooth size. While a few taxa in *Monarda* section *Cheilyctis* (*M. fruticulosa*, *M. humilis*, *M. microfolia*, and *M. viridissima*) have teeth <0.3mm wide, most taxa in this section have teeth from 0.3 mm – 0.7 mm in width. *Monarda stanfieldii,* however, have the largest teeth from 0.8 - 1.3mm. *Monarda mexicana*, from *Monarda* section *Aristatae* has distinctly serrulate margins, unlike the larger teeth of the rest of that section.

Length of serrated margin. The only taxon with definable differences in length of serrated margin is *M. fruticulosa*. In this species the serrated region of the leaves are smaller (<20% vs. >30%) than in the other taxa of section *Cheilyctis*.

Bract dimensions. Inflorescence bracts have long been a main feature that taxonomists have used in developing a circumscriptive structure for the species in *Monarda* L. There is striking variability across the genus including shape, number, color, and degree of differentiation from the leaves.

In *Monarda* subgenus *Cheilyctis* there are two morphologically distinct types of bracts: the two basal, more foliar bracts, and the many upper bracts that are reduced in shape and different in color than the either the lower bracts that subtend them, or the true leaves of the plants. Between the sections one can compare the aristate tips of the upper bracts of *Monarda* section *Aristatae* with the acute to acuminate tips of the bracts of *Monarda* section *Cheilyctis*. There are also species that are noted for their bract color such as *M. humilis* and *M. occidentalis ined* (see taxonomic conclusions above) and those noted because of distinctive bract shapes, such as *M. mexicana* which has very wide lower bracts (also discussed above).

Chapter 3

MONOGRAPH OF *MONARDA*

SUBGENUS *CHEILYCTIS*

Introduction

Monarda subgenus *Cheilyctis* Rafinesque is comprised of 16 species distributed across the eastern and central United States and northern Mexico. In the U.S. it extends west into New Mexico and Colorado and in Mexico as far south as Hidalgo. Characteristically, they are herbaceous perennials and annuals that grow upright, branch at the base, and sometimes appear shrubby. Leaf arrangement is opposite and decussate. They have distinctly bilabiate flowers and a unique inflorescence comprised of sessile cymes (glomerules) that are subtended by two sets of bracts: a lower, petioled set and an upper, sessile set. The lower bracts are usually two in number and appear mostly green, whereas the upper set can occur as four to more than 40 in number and appear either green or highly colored. The species of subgenus *Cheilyctis* are distinguished from those of *M.* subgenus *Monarda* Scora by their taproots, strongly arching upper corolla lips, inserted stamens, and verticillastrate glomerules. Also, the species of *M.* subgenus *Cheilyctis* have a variable chromosome number (see below) whereas *M.* subgenus *Monarda* have n=18 chromosomes (or 16 in *M. media*).

The subgenus has two sections, *Cheilyctis* and *Aristatae*. The species in *Monarda* section *Cheilyctis* are distinguished morphologically from those in section *Aristatae* by differences in calyx lobe shape, calyx venation, and indumentum of the calyx opening (see morphology section for a discussion of these). The chromosome number of taxa in *Monarda* section *Cheilyctis* are n=11 (or 12 in *M. humilis* and *M. villicaulis*) while those in section *Aristatae* are n=9 (or 18 in *M. pectinata*).

The taxa of *Monarda* section *Cheilyctis* are distributed from central U.S. to the eastern seaboard, with the majority of the species occurring in the states of Arkansas, Oklahoma, and Texas. They are often found in sandy soils on plains, prairies, beaches and river banks. The taxa of *Monarda* section *Aristate* are distributed across the southwestern United States and northern Mexico, with *M. citriodora* extending east into Florida, and *M. pectinata* extending north into Nebraska, across Colorado, and west into Arizona.

The extent of the distributions of the species in this subgenus is highly variable. Some species, such as *M. punctata* and *M. citriodora* are found widespread across much of the distribution of the subgenus while others, such as *M. fruticulosa* and *M. stanfieldii*, are narrow endemics. This pattern is especially pronounced in section *Cheilyctis*. Several species, including *M. fruticulosa*, *M. maritima*, *M. stanfieldii*, and *M. viridissima* fit this distribution profile and are recognized (Keith 2003) as edaphic endemics.

Taxonomic history

The taxonomic rank of many of the species and varieties of this subgenus has been a continued matter of debate for over eight decades (Epling 1935; McClintock and Epling 1942; Scora 1967; Turner 1994; Prather and Keith 2003). *Monarda stanfieldii* was once considered a subspecies of *M. punctata* by Epling (1935), a variety of *M. punctata* by Scora (1967), and not until 1994 did it achieve its currently accepted status of species by Turner (1994). *Monarda punctata* var. *lasiodonta* was considered a synonym of *M. punctata* var. *occidentalis* by Epling (1935), but both were treated as distinct subspecies by Mclintock and Epling(1942) and varieties by Scora (1967). Though these are only two examples, the taxonomic literature concerning *Monarda* subgenus *Cheilyctis* is replete with many more of this nature. To date, the most comprehensive treatments of this group were two reviews of the entire genus by McClintock & Epling (1942) and Scora (1967) who recognized six and five species of *M.* subgenus *Cheilyctis*, respectively. The objective of this monograph is to provide a current, in-depth treatment of this subgenus, including taxonomic changes and novelties that have been published since Scora's 1967 monograph, as well as incorporate the extensive morphometric analyses performed as part of this dissertation (Chapter 2).

Morphology

Duration/Vegetative Habit. With one exception (*Monarda n. sp*. 1) all the species in section *Aristatae* are annuals. The majority of the species from section *Cheilyctis*, however, are perennial, the annual species being *M. humilis*, *M. occidentalis ined.*, *M. punctata (*which has some populations that are perennial), *M. stanfieldii*, and *M. villicaulis* (which may also have populations that are perennial). The perennial species can take on woody characteristics, and the more heavily branched taxa (*M. fruticulosa, M. maritima, M. occidentalis, M. stanfieldii*) can appear shrubby.

Roots. Both annual and perennial species (see above) have a short tap root with numerous fibrous secondary roots which comprise the majority of the root system. The roots vary in size among the species, with the perennial taxa usually demonstrating larger tap roots than those that are annual.

Stems. The stems are quadrangular and variously pubescent (see vestiture section) or glabrous. They have an upright growth pattern and may branch primarily at the base (*M. maritima*, *M. pectinata*), the middle region of the stem (*M. arkansana*, *Monarda n. sp.* 1, *Monarda n. sp.* 2, *M. stanfieldii*, and *M. villicaulis ined*), the apical region of the stem (*M. austromontana* and *M. citriodora*), or, most commonly, a combination of these. Each species may also develop short (< 1 cm), axillary, lateral shoots which bear leaves in tightly clustered fascicles.

Leaves. Species of subgenus *Cheilyctis* have leaves that are simple, with an opposite and decussate phyllotaxis, though leaves borne on the short axillary branches appear fascicular. Petiole length varies from sessile (*M. fruticulosa*) to 25 mm (*M. stanfieldii*). Leaf size and shape are useful characteristics for identifying taxa that have particularly small features (e.g. *M. fruticulosa* has small (10 - 40 mm long) linear leaves and *Monarda n. sp.* 2 has small (10 - 15 mm long) ovate to orbicular leaves. The remaining taxa have leaves that vary from lanceolate to ovate. Leaf margins are entire (in some *M. fruticulosa*) or serrate. The serrations do not always occur along the entire margin, and when present occur at the tip and extend from 15% (*M. fruticulosa*) to 100% (*M. arkansana ined.* and *M. punctata*) of the distance down the blade toward the base of the leaf. The widest part of the leaf occurs toward the middle of the leaf in some taxa and closer to the base of the leaf in others. The leaf bases range from acute to acuminate and are frequently ciliate.

Vestiture. The vestiture of subgenus *Cheilyctis* consists of sessile glands and uniseriate non-glandular trichomes of various sizes and appearance (Fig. 29). The glands are usually sessile and appear as punctate dots that are colored or translucent on the adaxial surface of the leaves and floral bracts and occasionally on the stems. The non-glandular trichomes range from short, rigid, unicellular hairs commonly found covering virtually all the plant surfaces of most species in this subgenus, to multicellular hairs (three to seven cells) that are clustered about the nodes, petioles, distal ridge of the upper corolla lobe, and on the margins of leaves, floral bracts, calyx opening (orifice), and calyx lobes. The multicellular trichomes can be curly or wavy forming a villous surface, or straight and flexible forming a pilose surface.

Inflorescence. The inflorescences in this subgenus are very distinctive, as they are composed of multiple, axillary verticillate glomerules. They are important in distinguishing subgenus *Cheilyctis* from subgenus *Monarda*, as the latter has glomerules that are solitary and terminal, though variation among the species of this section is limited.

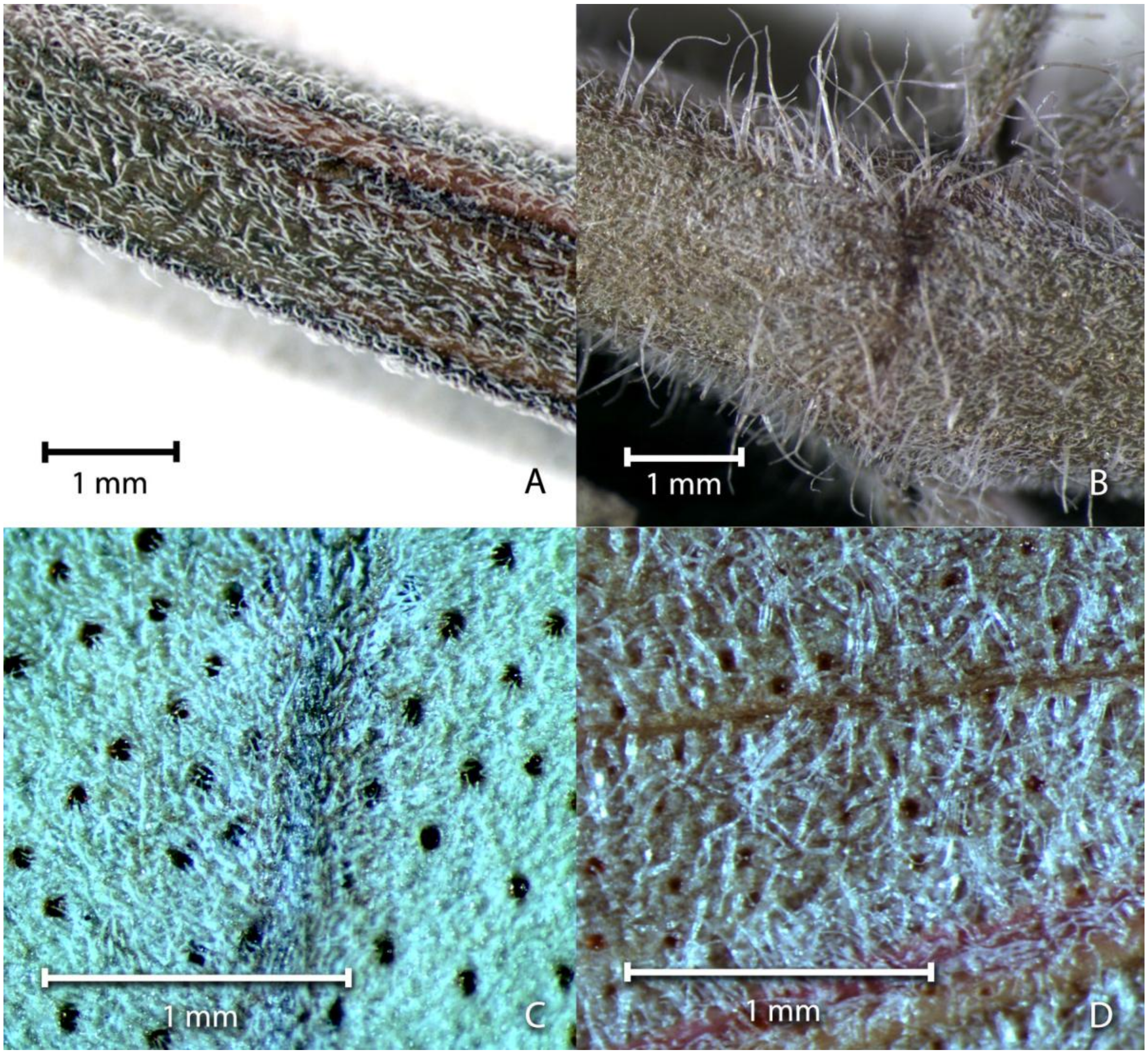

Figure 29. Trichome types. A. Unicellular hairs along the stem of *M. punctata* (*Correll 18925*, TEX). B. Multicellular hairs on the pilose nodal region of *M. maritima* (*Johnston 53254.22*, TEX). C. Glandular punctations on a canescent adaxial leaf surface of *M. fruticulosa* (*Garcia 110*, TEX). D. Villous abaxial leaf surface of *M. villicaulis ined.* (*Bourdo 306*, MSC). For interpretation of the references to color in this and all other figures, the reader is referred to the electronic version of this dissertation.

Inflorescence bracts. There are two main types of bracts that subtend the glomerules. The lowermost bracts are decussate to the distal most pair of leaves and are always two in number. They are usually green with a short petiole and often resemble the shape of the adjacent leaves, although they are usually reduced slightly in size, and can be variously pigmented. The blades vary from lanceolate to ovoid-lanceolate and their margins are entire or serrate. The widest part of the bract occurs toward the middle in some taxa and closer to the base in others. The uppermost bracts vary in number between four and 40. They vary in color from green to white to red and are sessile in either a single or several whorls. In section *Cheilyctis* the upper bracts are lanceolate with acute tips and are positioned in an upright to horizontal orientation. The bracts usually occur in a single whorl with <10 bracts per glomerule. In section *Aristatae* the upper bracts range from lanceolate to linear, are aristate, and have a horizontal to reflexed orientation. They usually occur in several whorls with >15 bracts per glomerule.

Calyx. The orifice can be glabrous or diffusely (as in most species of section *Cheilyctis*) to densely bearded (species in section *Aristatae* and *M. stanfieldii*) with flexuous to stiff white multicellular hairs. The lobes have varying shapes from deltoid to lanceolate and can be covered in hairs of varying length and density (Fig. 30). The calyx lobe tips also vary from acute (species in section *Cheilyctis*) to aristate (species in section *Aristatae*). Calyx indumentum and lobe shapes are commonly used in taxonomic keys (Scora 1967, Turner 1994, Prather 2003).

Corolla. The two petals that form the upper lip may or may not form a minute cleft at the distal end of the lip. The lower corolla lip, formed from the fusion of the remaining three petals, has three distinct lobes: a middle lobe and two shorter lateral lobes. Between species the lobes vary in length (0.2-2 mm) and shape (tapered to clubbed) and (especially the middle lobe) may be reflexed upward relative to the horizontal portion of the lower corolla lip. Corolla color can be white, crème, yellow, or a range from pink to red, and can have white, yellow, or maroon spots.

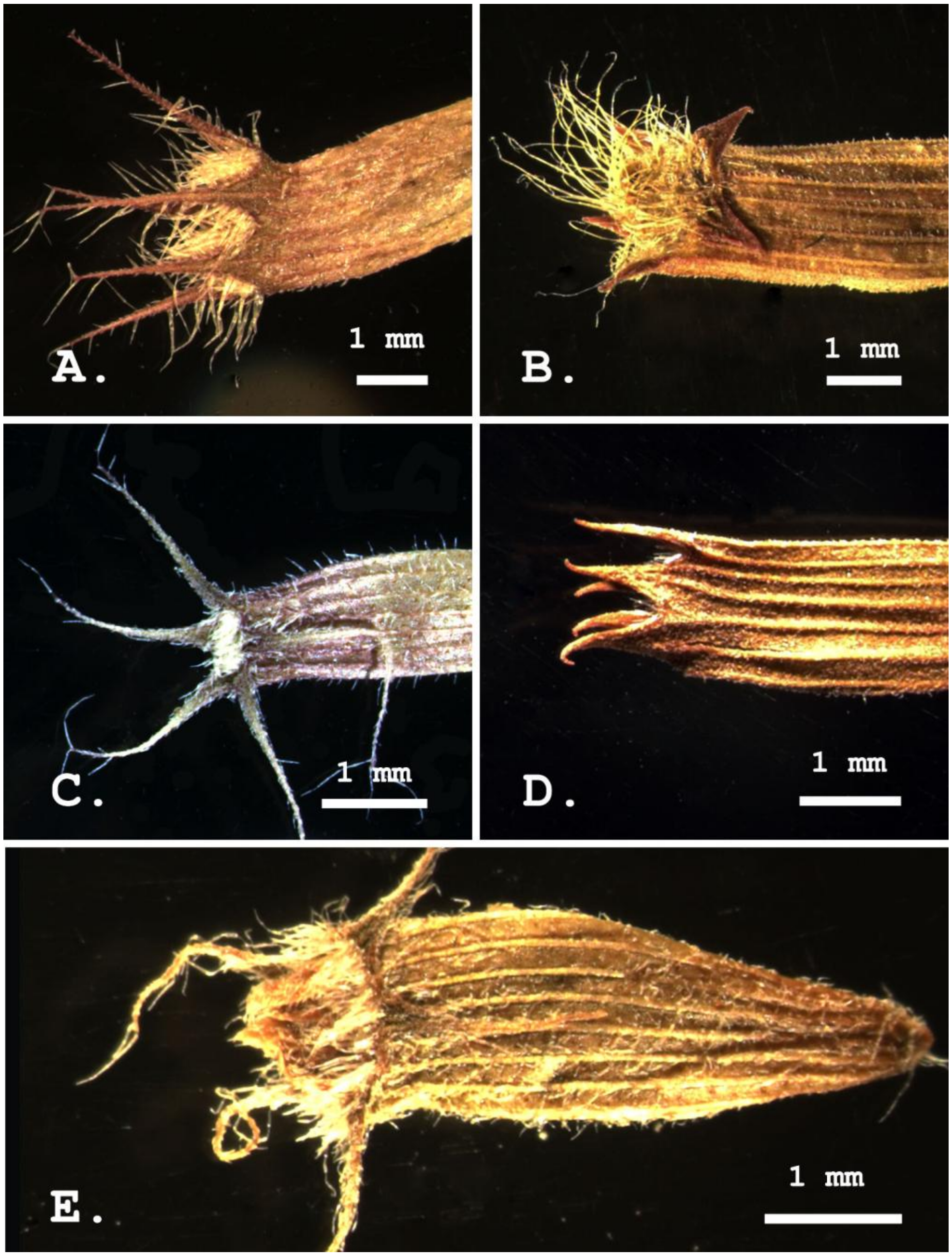

Figure 30. Calyx lobe shapes and vesture types. A. *M. clinopodioides* (*Lawson 40*, OKL) with aristate calyx lobes and long lobe margin hairs; B. *M. humilis* (*Higgins 7737*, NMC) with acute calyx lobes and glabrous margins; C. *M. austromontana* (*Maysilles 8272*, TEX) showing sparsely packed, short calyx lobe margin hairs; D. *M. maritima* (*Churchill 90-930*, MSC) with lanceolate calyx lobes; E. *M. citriodora* with orifice and calyx tube hairs.

Species Concept

Species discussed in this manuscript are defined according to the phenetic species concept (PSC)(Sokal and Crovello 1970, DeQueiroz 2007, McCauley 2007). They represent morphologically cohesive groups that are delineated by quantitative or qualitative gaps. Furthermore, intraspecific taxa are not formally treated (they are not given their own taxonomic descriptions, synonymies, etc.) in this monograph, as any significant morphological differences between them and other taxa would warrant species recognition. Instead, in the respective species descriptions I discuss any putative variation and specify the names and intraspecific ranks that are historically attached to the individuals that demonstrate that variation.

Phylogeny

A phylogenetic hypothesis for all 16 species of *Monarda* subgenus *Cheilyctis* is lacking. Prather et al (2002) presented an ITS phylogeny for the genus *Monarda* but included only six species from subgenus *Cheilyctis*. Likewise, for her master's thesis, Kieth (2003) examined patterns of speciation (using molecular phylogeny) in section *Cheilyctis*, but examined only six of the ten currently recognized species of that section. Therefore, a cladistics analysis was conducted to determine species relationships, provide an evolutionary framework for examining trait distributions, and identify autapomorphies for all currently recognized species of subgenus *Cheilyctis*.

Cladistic analysis of Monarda subgenus Cheilyctis

All 16 species of subgenus *Cheilyctis* were included in the analysis. The outgroups (*M. bradburiana* and *M. russeliana*) were selected based on their positions in the molecular phylogeny presented in Prather *et al*. (2002).

Forty-three qualitative morphological characters were identified and assigned discrete states (table 1, 2) based on direct observations of herbarium specimens (see table 2 for list) made during the morphometric analysis discussed in Chapter 2. PAUP 4.0b10 (Swofford 2002) was used to apply the parsimony optimality criterion. All characters were given equal weight and treated as unordered, and multistate taxa were treated as polymorphic. Gaps were treated as missing data. Only 34 characters were parsimony informative (nine were autapomorphic). The heuristic search option was performed and resulted in four equally most parsimonious trees of 114 steps, consistency indices (CI) of 0.711, and a retention indices (RI) of 0.708 (both CI and RI calculated excluding uninformative characters). Stability of the internal clades was tested with a bootstrap analysis of 1000 replicates. A representative cladogram (Fig. 31) and semi-strict consensus (Fig. 32) tree are presented. A semi-strict consensus tree was used to provide better resolution of section *Aristatae* because it incorporates topologies that are not contradicted by other equally parsimonious trees, though topological differences between the strict and semi-strict consensus trees are discussed below).

The semi-strict consensus tree reveals two basal clades which correspond to *Monarda* sections *Cheilyctis* and *Aristatae*. There is strong support (BS = 99%) for the monophyly of the subgenus. Within section *Aristatae* the only relationship that contains bootstrap support >60% is between *M. clinopodioides* and *M. pectinata* ("4" from Fig. 32; BS = 64%). The remaining clades have bootstrap values <50%. The *M. clinopodioides* clade is defined by pectinate calyx lobe hairs and villous petioles. Another clade consists of *M. austromontana* and *Monarda n. sp.* 1 ("5" from Fig. 32; BS = <50%)) which share the apomorphies of lower bracts reflexed and lower bracts lanceolate. *Monarda mexicana* is potentially sister to all the remaining species of the section. The only topological differences between the four parsimony-equal trees for section *Aristatae* are the relationships of *M. citriodora* to the above mentioned clades. In two of the trees it is sister to the *M. clinopodioides/M. pectinata* and *M. austromontana*/*Monarda n. sp.* 1 clades, and in the other two trees it is an unresolved polytomy with those two clades. Because of the latter, the difference between the semi-strict consensus and the strict consensus tree is the inclusion of a resolved *M. citriodora* in the semi-strict tree, instead of a polytomy in the strict consensus.

In section *Cheilyctis* three clades are consistently identified among the most-parsimonious trees. The first ("1" from Fig. 32; BS = 71%)) is a clade of species with linear to linear-lanceolate leaves from south-central to southern Texas consisting of *M. fruticulosa*, *M. maritima*, and *M. viridissima*. The second ("2" from Fig. 32; BS = 73%) is a clade of species with glabrous calyces consisting of *M. humilis*, *M. occidentalis*, and *M. stanfieldii*. *Monarda punctata* is sister to the third ("3" from Fig. 32; BS = 75%) clade, which consists of species with villous indumentum on at least the abaxial leaf surfaces. This clade consists of *M. arkansana, Monarda n. sp.* 2*,* and *M. villicaulis*. The only topological differences between the four parsimony-equal trees for section *Cheilyctis* are the relationships of *M. humilis*, *M. occidentals,* and *M. stanfieldii.* In two of the trees *M. stanfieldii* is sister to *M. humilis* and *M. occidentalis*, and in the other two trees *M. humilis* is sister to *M. occidentalis* and *M. stanfieldii*. For the representative tree I chose the phylogeny which depicts *M. occidentalis* as sister to *M. humilis,* but caution that their precise phylogenetic placement is not supported. Furthermore, the low bootstrap values (Fig. 32) for most of the nodes of the cladogram is a sign of concern, and is probably a result of the small data set relative to the number of taxa included in the analysis, as well as a moderate level of homoplasy.

It is noteworthy that this current morphological phylogeny is largely congruent with the phenetic dendrogram presented in the previous chapter. Though evolutionary relationships should not be inferred from the dendrogram, it depicts many of the same relationships as seen in the current phylogeny. The only notable difference is the placement of *Monarda n. sp.* 2 with *M. villicaulis* and *M. arkansana* in the phylogeny, where it shares a branch with *M. viridissima* in the phenogram.

The morphological phylogeny is also consistent with the subgenus *Cheilyctis* portion of the ITS phylogeny presented in Prather et al. (2002). Though they included only six species from this subgenus, their phylogeny depicts *M. clinopodioides* and *M. pectinata* as sister taxa, with *M. citriodora* as sister to that clade. The current phylogeny includes additional species, but the position of *M. citriodora* proximal to a clade containing *M. clinopodioides* and *M. pectinata* does not conflict with that presented by the ITS tree. In the current phylogeny a clade consisting of *M. austromontana* and *Monarda n. sp.* 1 (not included in Prather (2002)) is sister to the *M. clinopodioides* clade, with *M. citriodora* sister to a clade encompassing all the above-mentioned taxa. The relationship between *M. fruticulosa*, *M. viridissima*, and *M. punctata* follow this same pattern. Both the ITS and this morphological phylogeny depict *M. punctata* proximal to a clade containing *M. fruticulosa* and *M. viridissima*. Though Keith (2003) did produce multiple cladograms based on ADH1 and ADH2, ncpGS, her objectives weren't strictly consistent with those of the present phylogeny and thus the two should not be compared.

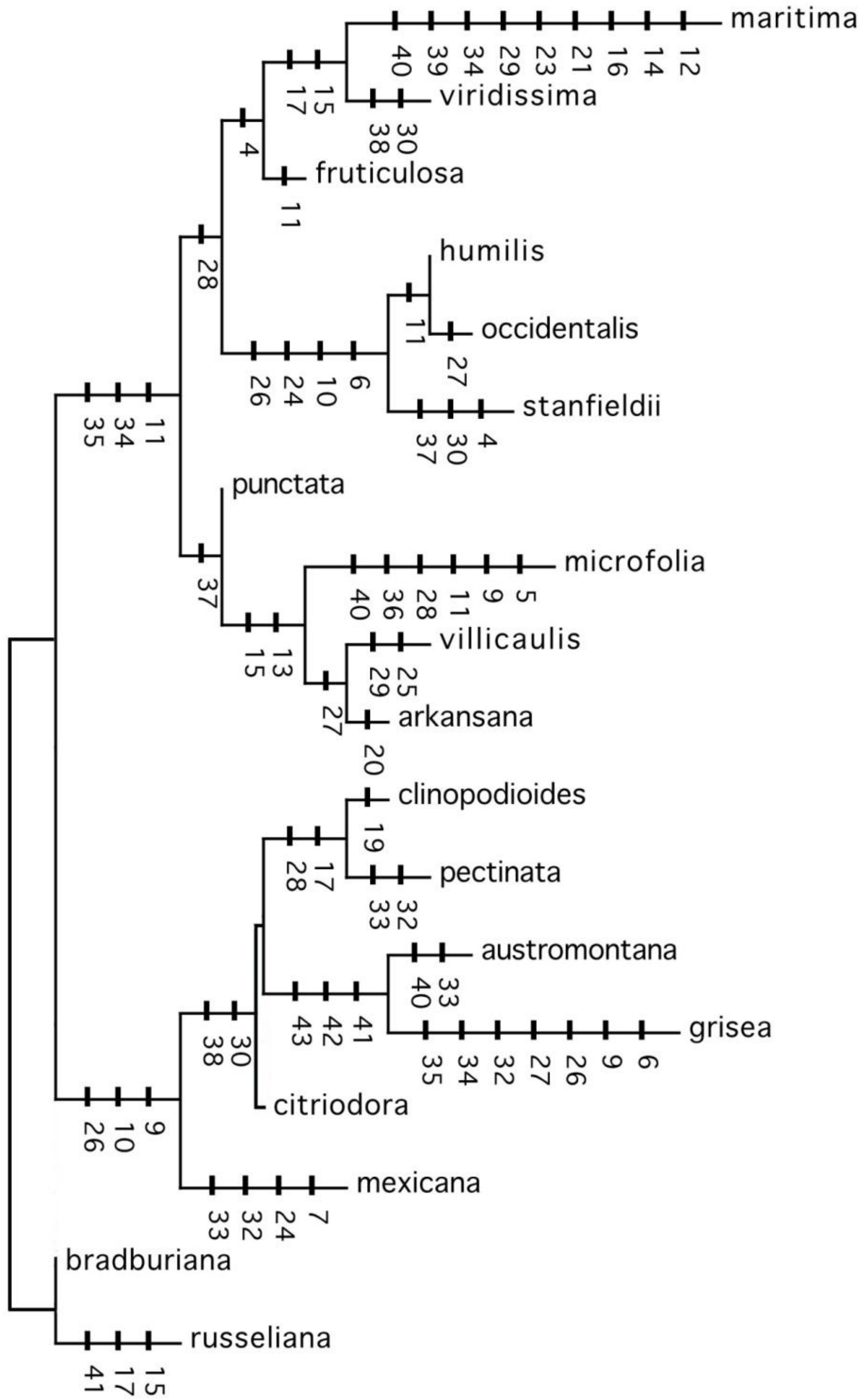

Figure 31. One of four equally most parsimonious cladograms for *Monarda* subgenus *Cheilyctis*.

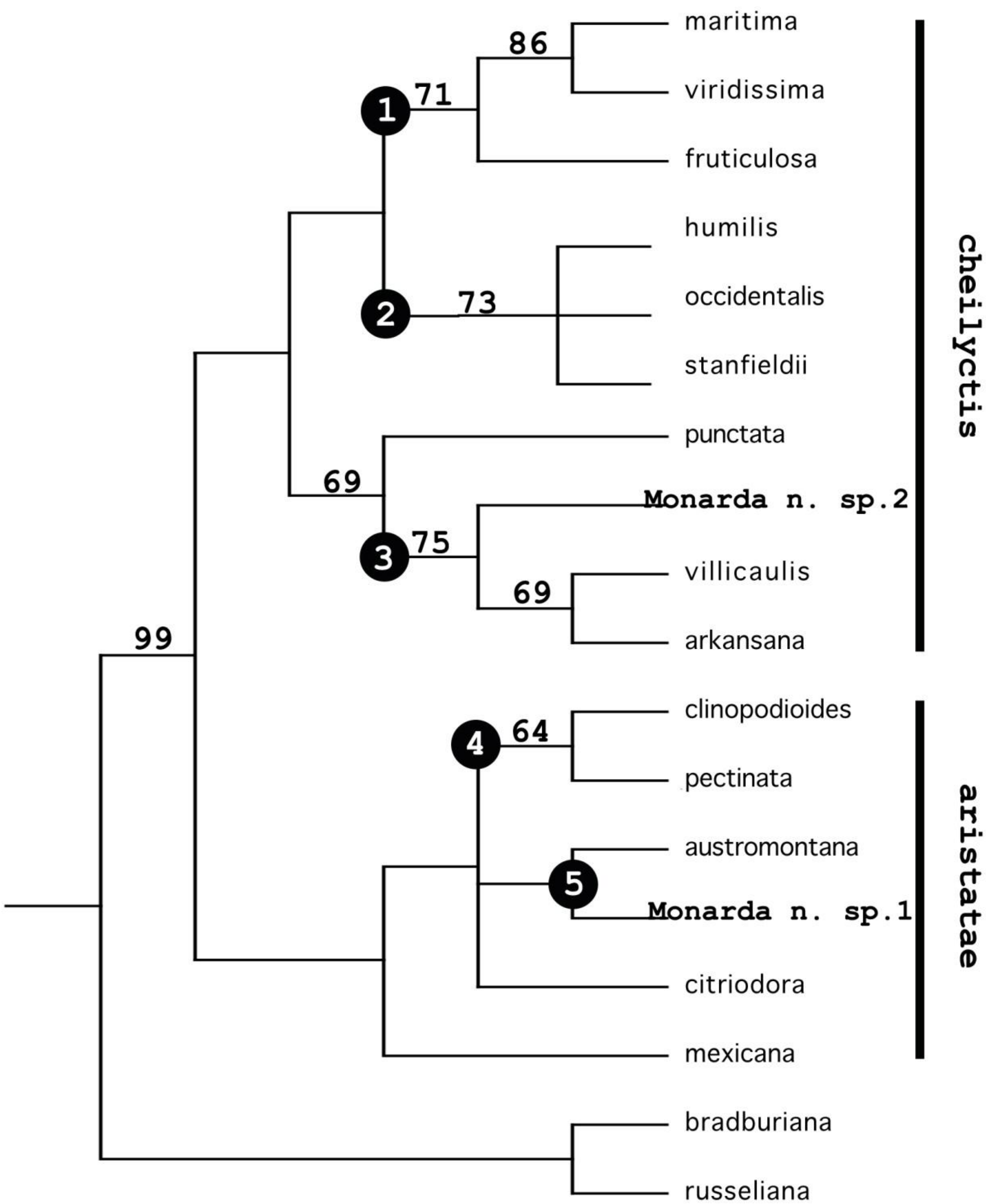

Figure 32. Strict consensus tree of *Monarda* subgenus *Cheilyctis* derived from four equally parsimonious cladograms (114 steps, CI = 0.711, RI = 0.708). Taxonomic sections are indicated by vertical bars, and numbers above branches indicate bootstrap values. Outgroups are *M. bradburiana* and *M. russeliana.*

Table 1. Characters used in the phylogenetic analysis of *Monarda* subgenus *Cheilyctis*.

1. Stamens exerted (0); stamens inserted (1)
2. Glomerules terminal (0); glomerules verticillastrate (1)
3. Corolla weakly arched (0); corolla strongly arched (1)
4. Leaf shape lanceolate (0); leaf shape linear (1); leaf shape linear-lanceolate (2); leaf shape ovate (3)
5. Leaf tip acuminate (0); leaf tip acute (1)
6. Leaf base round (0); leaf base acute (1); leaf base acuminate (2)
7. Leaf margin serrate (0); leaf margin subentire (1)
8. Leaf attachment petiolate (0); leaf attachment Subsessile (1); leaf attachment sessile (2)
9. Upper bract tip shape acuminate (0); upper bract tip shape acute (1); upper bract tip shape aristate (2)
10. Upper bract shape elliptical (0); upper bract shape lanceolate (1); upper bract shape oblong (2)
11. Calyx lobe shape aristate (0); calyx lobe shape acuminate (1); calyx lobe shape lanceolate (2); calyx lobe shape acute (3)
12. Abaxial leaf surface without minute (<3 cells) hairs (0); adaxial leaf surface with minute hairs (1)
13. Abaxial leaf surface without long (>5 cells) hairs (0); adaxial leaf surface villous with long hairs (1); adaxial leaf surface pilose with long hairs (2)
14. Midvein without minute (<3 cells) hairs (0); midvein with minute hairs (1)
15. Midvein without long (>5 cells) hairs (0); midvein villous with long hairs (1); midvein pilose with long hairs (2)
16. Petiole without minute (<3 cells) hairs (0); petiole with minute hairs (1)
17. Petiole without long (>5 cells) hairs (0); petiole villous with long hairs (1); petiole pilose with long hairs (2)
18. Interpetiolar plane without minute (<3 cells) hairs (0); interpetiolar plane with minute hairs (1)

Table 1 continued.

19. Interpetiolar plane without long (>5 cells) hairs (0); interpetiolar plane villous with long hairs (1); interpetiolar plane pilose with long hairs (2)
20. Nodal ridge without minute (<3 cells) hairs (0); nodal ridge with minute hairs (1)
21. Nodal ridge without long (>5 cells) hairs (0); nodal ridge villous with long hairs (1); nodal ridge pilose with long hairs (2)
22. Internode without minute (<3 cells) hairs (0); internode with minute hairs (1)
23. Internode without long (>5 cells) hairs (0); internode villous with long hairs (1); internode pilose with long hairs (2)
24. Calyx surface without minute (<3 cells) hairs (0); calyx surface with minute hairs (1)
25. Calyx surface without long (>5 cells) hairs (0); calyx surface with long hairs (1)
26. Plant perennial (0); plant annual (1)
27. Calyx lobe cilia absent (0); calyx lobe cilia short (<3 cells) (1); calyx lobe cilia long (>5 cells) (2)
28. Calyx lobe cilia density sparse(0); calyx lobe cilia density pectinate (1)
29. Calyx lobe face without long (>5 cells) hairs (0); calyx lobe face with long hairs (1)
30. Calyx orifice hair density sparse (<5 hairs) (0); calyx orifice hair density medium (>10 hairs <20); calyx orifice hair density dense (>40 hairs)
31. Lower bract color green (0); lower bract color white (1)
32. Upper bract color purple (0); upper bract color green (1); upper bract color white (2)
33. Lower bract margin serrate (0); lower bract margin entire (1); lower bract margin serrulate (2)
34. Upper bract cilia density sparse (<3 hairs)(0); upper bract cilia density dense (>6) hairs (1)
35. Upper bract cilia position basal only (0); upper bract cilia position along the entire margin (1)

Table 1 continued.

36. Upper bract margin entire (0); upper bract margin serrulate (1)
37. Upper corolla lip without spots (0); upper corolla lip with spots (1)
38. Lower corolla lip without spots (0); lower corolla lip with spots (1)
39. Corolla color white, purple, or pink (0); corolla color yellow (1)
40. Calyx color purple (0); calyx color green (1)
41. Upper corolla lip without long (>5 cells) hairs (0); upper corolla lip with long hairs (1)
42. Lower bracts strongly reflexed (0); lower bracts horizontal (1)
43. Lower bracts linear (0); lower bracts lanceolate (1)

Table 2. Data matrix of characters used in the phylogenetic analysis of *Monarda* subgenus *Cheilyctis* and two outgroups (*M. bradburiana* and *M. russeliana*). The character number matches those presented in table 1.

	1	2	3	4	5	6
M. maritima	1	1	1	2	0	2
M. viridissima	1	1	1	2	0	2
M. fruticulosa	1	1	1	1,2	0	2
M. humilis	1	1	1	0	0	1
M. occidentalis	1	1	1	0	0	1
M. stanfieldii	1	1	1	3	0	1
M. punctata	1	1	1	0	0,1	1,2
Monarda n. sp. 2	1	1	1	0	1	2
M. clinopodioides	1	1	1	0	1	2
M. citriodora	1	1	1	0	0	2
M. austromontana	1	1	1	0	0	2
M. pectinata	1	1	1	0	1	2
M. mexicana	1	1	1	0	0	2
Monarda n. sp. 1	1	1	1	0	1	1
M. bradburiana	0	0	0	0	1	0
M. russeliana	0	0	0	0	1	0

Table 2 continued.

	7	8	9	10	11	12
M. maritima	0	1	0	0	2	0
M. viridissima	0	1	0	1	2	1
M. fruticulosa	0	2	0	0	1	1
M. humilis	0	0	0	1	3	1
M. occidentalis	0	0	0	1	3	1
M. stanfieldii	0	0	0	1	2	1
M. punctata	0	0	0	0	2	1
Monarda n. sp. 2	0	0	1	0	1	1
M. clinopodioides	0	0	2	1	0	1
M. citriodora	0	0	2	3	0	1
M. austromontana	0	0	2	1	0	1
M. pectinata	0	0	2	1	0	1
M. mexicana	1	0	2	1	0	1
Monarda n. sp. 1	0	0	0	1	0	1
M. bradburiana	0	0	0	0	0	1
M. russeliana	0	0	0	0	0	1

Table 2 continued.

	13	14	15	16	17	18
M. maritima	1	0	1	0	1	1
M. viridissima	1,0	1	1	1	1	1
M. fruticulosa	0	1	0	1	0	1
M. humilis	0	1	0	1	0	1
M. occidentalis	0	1	0	1	0	1
M. stanfieldii	0	1	0	1	0	1
M. punctata	1,0	1	1,0	1	1,0	1
Monarda n. sp. 2	1	1	1	1	1	1
M. clinopodioides	0	1	0	1	1	1
M. citriodora	0	1	0	1	0	1
M. austromontana	0	1	0	1	0	1
M. pectinata	0	1	0	1	1	1
M. mexicana	0	1	0	1	0	1
Monarda n. sp. 1	0	1	0	1	0	1
M. bradburiana	0	1	0	1	0	0
M. russeliana	0	1	1	1	1	0

Table 2 continued.

	19	20	21	22	23	24
M. maritima	1	1	1	1	1	1
M. viridissima	1,0	1	0	0,1	0	1
M. fruticulosa	0	1	0	1	0	1
M. humilis	0	1	0	1	0	0
M. occidentalis	0	1	0	1	0	0
M. stanfieldii	0	1	0	1	0	0
M. punctata	1,0	1	1,0	1	1,0	1,0
Monarda n. sp. 2	1	1	1	1	1	1
M. clinopodioides	1	1	0	1	0	1
M. citriodora	0	1	0	1	0	1
M. austromontana	0	1	0	1	0	1
M. pectinata	0	1	0	1	0	1
M. mexicana	0	1	0	1	0	0
Monarda n. sp. 1	0	1	0	1	0	1
M. bradburiana	1	1	0	0	0	1
M. russeliana	1	1	0	0	0	1

Table 2 continued.

	25	26	27	28	29	30
M. maritima	0	0	2	1	1	1
M. viridissima	0	0	2	1	0	0
M. fruticulosa	0	0	2	1	0	1
M. humilis	0	1	2	1	0	1
M. occidentalis	0	1	1	1	0	1
M. stanfieldii	0	1	2	1	0	2
M. punctata	0	0,1	0,2	0	0	1
Monarda n. sp. 2	0	0	2	1	0	1
M. clinopodioides	0	1	2	1	0	2
M. citriodora	0	1	2	0	0	2
M. austromontana	0	1	2	0	0	2
M. pectinata	0	1	2	1	0	2
M. mexicana	0	1	2	0	0	1
Monarda n. sp. 1	0	0	1	0	0	2
M. bradburiana	0	0	2	0	0	1
M. russeliana	0	0	2	0	0	1

Table 2 continued.

	31	32	33	34	35	36
M. maritima	0	0	0	1	0	0
M. viridissima	0	0	0	0	0	0
M. fruticulosa	0	0,2	0	0	0	0
M. humilis	0	0	0	0	0	0
M. occidentalis	0	2	0	0	0	0
M. stanfieldii	0,1	1,2	0	0	0	0
M. punctata	0	0	0	0	0	0,1
Monarda n. sp. 2	0,1	0	0	0	0	1
M. clinopodioides	0	0	0	1	1	0
M. citriodora	0	0	0	1	1	0
M. austromontana	0	0	2	1	1	0
M. pectinata	0	1	1	1	1	0
M. mexicana	0	1	1	1	1	0
Monarda n. sp. 1	0	1	0	0	0	0
M. bradburiana	?	0	?	1	1	0
M. russeliana	?	0	?	1	1	0

Table 2 continued.

	37	38	39	40	41	42
M. maritima	0	1	0	1	1	1
M. viridissima	0	0	1	0	1	1
M. fruticulosa	0	1	1	0	1	1
M. humilis	0	1	1	0	1	1
M. occidentalis	0	1	1	0	1	1
M. stanfieldii	1	1	1	0	1	1
M. punctata	1	1	0,1	0	1	1
Monarda n. sp. 2	1	1	1	1	1	1
M. clinopodioides	0	0	1	0	1	1
M. citriodora	0	0	1	0	1	1
M. austromontana	0	0	1	1	0	0
M. pectinata	0	0	1	0	1	1
M. mexicana	0	1	1	0	1	1
Monarda n. sp. 1	0	0	1	0	0	0
M. bradburiana	0	1	1	0	1	?
M. russeliana	0	1	1	0	0	?

Table 2 continued.

	43
M. maritima	0
M. viridissima	0
M. fruticulosa	0
M. humilis	0
M. occidentalis	0
M. stanfieldii	0
M. punctata	0
Monarda n. sp. 2	0
M. clinopodioides	0
M. citriodora	0
M. austromontana	1
M. pectinata	0
M. mexicana	0
Monarda n. sp. 1	1
M. bradburiana	?
M. russeliana	?

Key to the species of *Monarda* subgenus *Cheilyctis*

1a. Calyx lobe tips attenuate to aristate,

2a. Lowest inflorescence bracts > 12 mm wide; pollen Yellow; leaf margins serrulate.........**4. Monarda mexicana**

2b. Lowest inflorescence bracts < 8 mm wide; pollen white; leaf margins serrate

3a. Stems and leaves canescent; floral bracts immediately subtending the calyces with acuminate tips, green................................**6. Monarda n. sp. 1**

3b. Stems and leaves distinctly green; floral bracts immediately subtending the calyces with narrowly cuspidate to aristate tips, greenish-purple to red.

4a. Floral bracts of many widths, ciliate along the entire margin, strongly reflexed, especially the lowest set; lateral limb of lower corolla lip > 1.5 mm long ....**1. M. austromontana**

4b. Floral bracts of consistent width (may be linear-lanceolate or elliptic, but not both), ciliate along the base to mid-margin, horizontally spreading or weakly reflexed; lateral limb of lower corolla lip <1.4 mm long

5a. Floral bracts immediately subtending the calyces > 4 mm wide, abruptly narrowing to a cuspidate tip; stems, bracts, and calyx tubes purple pigmented

....................................**2. M. citriodora**

5b. Floral bracts immediately subtending the calyces ≤ 4 mm wide, gradually narrowing to a cuspidate tip; stems, bracts, and calyx tubes green (rarely sparsely pigmented with purple).....**5. M. pectinata**

1b. Calyx lobe tips acute to acuminate

7a. Leaves linear or linear-lanceolate

8a. Fruticose; leaves linear, ≤ 3 mm wide; stems and leaves canescent; petiole absent or minute, < 1 mm long ....**8. M. fruticulosa**

8b. Suffruticose; leaves linear-lanceolate to lanceolate, > 4 mm wide; stems and leaves green; petiole > 1 mm long

9a. Stems, petioles, and leaves densely pilose, calyx orifice glabrous; southern coastal Texas ....**10. M. maritima**

9b. Stems, petioles, and leaves puberulent, calyx orifice pubescent; south central Texas......**15. M. viridissima**

7b. Leaves lanceolate or ovate

10a. Calyx orifice densely bearded by a cone of white trichomes; leaves broadly lanceolate ....**13. M. stanfieldii**

10b. Calyx orifice glabrous or ciliate, not densely bearded; leaves lanceolate to ovate

11a. Calyx teeth broadly acute; calyx tube glabrous or with minute hairs on (but not between) the veins; flowers lavender, white, or cream

12a. Floral bracts purple to pink; corollas lavender to purple; calyx orifice pubescent ....**9. M. humilis**

12b. Floral bracts white to green; corollas white to Cream; calyx orifice glabrous ....**11. M. occidentalis *ined.***

11b. Calyx teeth narrowly acute; calyx tube with scattered hairs between (and on) the veins; flowers yellow

13a. Midvein and laminar portion of lower leaf with short, single-celled hairs or glabrous ....**12. M. punctata**

13b. Midvein and/or laminar portion of lower leaf with longer, villous, multicellular hairs

14a. Leaves 2.2 – 3.5 cm long; upper bract tip acute; calyx lobe tips acuminate ....**16. Monarda n. sp. 2**

14b. Leaves 3.2 – 10cm long; upper bract tip acuminate; calyx lobes lanceolate

15a. Lower leaf surface pubescent throughout; calyx lobe face pubescent; lower corolla lip < 2.8 mm wide..**14. M. villicaulis *ined.***

15b. Lower leaf surface pubescent primarily on and around midvein; calyx lobe face glabrous; lower corolla lip > 3.2 mm wide ....**7. M. arkansana *ined.***

Taxonomy

Monarda L. Sp. Pl. 1: 22. 1753.

Annual, perennial, or biennial herbs, shrubs, or subshrubs to 120 cm tall; upright, simple or branching from the base, middle of stem, or inflorescence. Vegetative parts aromatic from essential oils carvacrol, monardol, thymol; glabrous or variously pubescent with single and multicellular hairs. Leaves linear to ovate, sessile to petiolate, margins dentate, serrate, serrulate or entire. Inflorescence a solitary terminal glomerule or multiple verticillate glomerules, flowers few to many, subtended by one or two sets of foliar bracts. Flowers bilabiate; lower lip three lobed, the middle lobe longer than the two lateral lobes; upper lip of two equal-sized lobes. Stamens 2 (occasionally two additional aborted stamens), inserted or exerted.

Monarda subgenus Cheilyctis Scora, Univ. of Cal. Publ. Botany. 41: - 71. 1967. *Monarda* section Cheilyctis Rafinesque, Med. Fl. 2: 37. 1830. *Monarda* section *Coryanthus* Nuttall, Trans. Am. Philos. Soc.5:186. 1837. –Type species: *Monarda punctata*.

Herbs, shrubs, and subshrubs with taproots. Inflorescence of verticillate glomerules. Flowers with arched upper corolla lips and inserted stamens. N = 9, 11, 12 or 18.

Monarda section Aristatae Epling, Univ. Calif. Publ. Botany 20: 186. 1942. *Monarda* subsection *Aristatae* Epling, Madroño 3: 26. 1935. –Type species: *Monarda citriodora.*

Annual **h**erbs. Floral bract tips aristate. Calyx lobe tips aristate. Pollen white. N = 9 or 18.

1. Monarda austromontana Epling, Madroño 3: 29. 1935. *Monarda citriodora* Cerv. *ex* Lag. subsp. *austromontana* (Epling) Scora, Madroño 18: 120. 1965. *Monarda citriodora* Cerv. *ex* Lag. var. *austromontana* (Epling) B.L. Turner, Phytologia 77(1): 56. 1994.--TYPE: MEXICO. Chihuahua: on La Bufa Mountain near Cusihuiriachic, 1887, *Pringle 1355* (holotype: US!; isotype: NY (digital image)!, F (digital image)!, CAS (digital image)!, US (digital image)!).

Habit annual, subshrub to 70 cm tall; upright, branching from the inflorescence and middle of stem. Stem indumentum variable; internode with short hairs, node with short hairs, nodal plane with short hairs. Penultimate vegetative internode 31 - 65 mm long, 0.9 – 2.5 mm wide. Leaves 32 - 72 mm long, 4.1 - 12 mm wide; petiole 0.8 - 10 mm long; serrations 0.34 mm wide; leaf shape lanceolate, base acuminate; margins serrate from apex to 80% length of laminar tissue, apex acuminate; petiole indumentum of long hairs; abaxial surface hirsute with medium-long hairs around the midvein; adaxial surface glabrous; margin ciliate toward the base of the leaf; both leaf surfaces green. Basal inflorescence internode to 60 mm long, 2 mm wide; pubescent. Lower floral bracts 40-110 mm long, 1.2 - 5 mm wide; sessile; lower bract shape linear-lanceolate, base attenuate, margins serrate; apex acuminate; abaxial surface puberulent; adaxial surface puberulent; margin ciliate toward the base of the bract; abaxial surface green, adaxial surface green. Upper floral bracts 8.5 – 15 mm long, 3 - 6 mm wide; upper bract shape linear to linear-lanceolate, base cuneate, margins serrated; apex aristate; abaxial surface pubescent; adaxial surface pubescent; margins ciliate; abaxial surface green; adaxial surface purple (rarely green). Calyx tube 6.4 – 7.2 mm long, 1.71 – 2.65 mm wide, with minute and pilose hairs on outer surface. Calyx lobes 2 – 5.6 mm long, 0.06 – 0.07 mm wide, aristate, with hairs along the margins. Calyx orifice densely hirsute with stiff white hairs. Lower corolla lip 5.5 - 9.2 (10) mm long, 2.1 – 3.2 mm wide; mid limb to 4.5 mm long, 2.7 mm wide, expanding toward the tip; lateral limbs to 1.7 mm long, 1.6 mm wide. Upper corolla lip 4.7 – 7.5 mm long, 2.6 – 3.8 mm wide, lobes to 0.65 mm long and 0.83 mm wide, corolla violet to white. Stamens to 1.7 cm in length, anthers 0.8 long, 0.3 wide, pollen white. Pistil to 17 mm long. N = 9 (Scora 1967).

Phenology. Flowering specimens have been collected from July through December.

Distribution. In open and rocky areas of the Sierra Madre of Western Mexico and U.S.

M. austromontana is most similar morphologically to *Monarda n. sp.* 1 and *M. citriodora*. It can be distinguished from the former by its lack of canescence and longer (> 3 cm) lower bracts and the latter by strongly reflexed (vs. horizontally spreading) lower bracts. Bracts shape is also useful in distinguishing *M. austromontana* from *M. citriodora.* In *M. austromontana* the bracts gradually taper to an aristate tip (vs. abruptly tapering as in *M. citriodora*), and *M. austromontana* inflorescences can bear both broadly elliptic and linear lanceolate bracts on the same inflorescence, whereas the upper bracts of *M. citriodora* are of a consistent width.

Figure 33. Herbarium specimen of *M. austromontana*. *Van Devender 96-378* (ARIZ).

Representative specimens examined: MEXICO. CHIHUAHUA. Proximidades al campo 1, ejido El Largo, Municipio de Madera, *Benitez 1984* (MEXU); Aroyo de las Varitas, ejido El Largo, municipio de Madera, *Bolanos 1448* (MEXU); in open, partialy grazed area near the airstrip, southeast of Creel, *Bye 2684* (MEXU); Bocoyna, ejido San Ignacio Arareco, east of Gonogochic, *Bye 8725* (MEXU); NW of Creel, in open rocky area S of the railroad tracks, *Bye 1795* (MEXU); Mesa de Horcones, *Laferriere 2017* (TEX); Nabogame, Mpio. Temosachi, *Jenkins 89-308* (TEX); road to Basaseachic trhough Tomochic, 2.2 km W of Rio Tomochic bridge, at end of pavement just after crossing a small crek on another bridge, *Lane 2767* (TEX); Culebra mountains, *Martin s.n.* (ARIZ); 2 km southeast of Cocheno, *LeSueur 887* (TEX); Municipio Ocampo, Parque Nacional de Cascada Basaseachic, *Spellenberg 9243* (MEXU); Mpio de Casas Grandes, *Tenorio 1773* (MEXU); 42 km WNW of Colonia Juarez in "Canyon de la Piedra cantil", upper part of the Tinaja, *Wilson 8457* (TEX); DURANGO. in Mimbres Canyon, 26 miles west of Durango, route 40, *Correll 20146* (LL); Memelichic, meadow east of town, *Jenkins 89-297* (ARIZ); Quebrada de San Juan, 26 road miles north of railroad at Coyotes, on road to San Luis, *Maysilles 8272* (TEX); 2 miles east of Llano Grande 16 miles east of El Salto, 160 meters northeast of KM 1039, *Scora*

2716 (TEX); Sierra Madre Occidental, 5.1 rd. mi. by hwy. 40 SW of El Salto at Aroyo De Agua, *Worthington 8910* (TEX); SINALOA. Pmio Badiraguato a 15 km al N. de Surutato rumbo a Sta. Rita, *Vega 2541* (MEXU); SONORA. Yecora, *Neff 8-17-91-13* (MEXU, TEX); El Tigre Canyon and Mountain above El Tigre Mine, east of Esqueda and Lago Angostura, *Turner 2098* (ARIZ); Mesa el Campanero, Arroyo Largo, upper tributary of Barranca El Salto, *Van Devender 96-378* (ARIZ); U.S.A. ARIZONA. **Navajo**: Alongsie Fish Hatchery road near junction with Diamond Creek road; Fort Apache Indian Reservation, *Granfelt 6-224* (ARIZ).

2. Monarda citriodora Cervantes *ex* Lagasca Gen. Sp. Nov. 2. 1816. --TYPE: MEXICO. Based on specimens grown from seed sent from Cervantes from unpublished locality and date(lectotype: BM; lsolectotype: G-DC).

Monarda citriodora Cervantes *ex* Lag. var. *parva* Scora, Madroño 18: 120. 1965.—TYPE: U.S.A. Texas: San Patricio Co., near Sinton, *Rowell 4977* (holotype: WWF).

Monarda citriodora Cervantes *ex* Lag. var. *attenuata* Scora, Madroño 18: 121. 1965.—TYPE: MEXICO. Coahuila: near

Musquiz, 1963, *Scora 2340* (holotype: MICH; isotype: UCR).

Monarda dispersa Small, Fl. S.E. U.S. 138. 1903.--TYPE: U.S.A. Missouri: Eagle Rock, no date, *Bush* 122 (holotype: NY (digital image)!).

Monarda aristata Nutt., Trans. Amer. Phil Cos. 5: 186. 1837. --Type: based on a collection from "Arkansa," no date, *Nuttall s.n.* (holotype: BM).

Habit annual, subshrub to 75 cm tall; upright, branching heavily from the inflorescence and rarely from the base or middle of stem. Stem indumentum variable; internode with short hairs densely packed, node with short hairs, nodal plane with short hairs. Penultimate vegetative internode (20) 40 – 80 (150) mm long, 0.8 - 3.5 mm wide. Leaves 30 - 80 mm long, 3 - 9 mm wide; petiole 3 – 12 mm long; serrations 0.2mm wide; leaf shape lanceolate, base acuminate; margins serrate from apex to 95% length of laminar tissue, apex acuminate; petiole indumentum of long hairs; abaxial surface hirsute with medium-long hairs around the midvein; adaxial surface glabrous; margin ciliate toward the base of the leaf; both leaf surfaces green. Basal inflorescence internode to 40 mm long, 0.7-1.1 mm wide; glabrous to pubescent with minute downward curled hairs. Lower floral bracts 12 - 37 mm long, 2.2 - 9 mm wide; sessile; lower bract shape lanceolate, base attenuate, margins serrate; apex acuminate; abaxial surface glabrous; adaxial surface glabrous; margin ciliate toward the base of the bract; abaxial surface green, adaxial surface green. Upper floral bracts 9 – 21 mm long, 3.2 – 7.1 mm wide; upper bract shape oblanceolate, base cuneate, margins serrate to entire; apex aristate; abaxial surface puberulent; adaxial surface puberulent; margins ciliate; abaxial surface green; adaxial surface purple (rarely green). Calyx tube 7.2 – 8.4 mm long, 1.4 – 2.4 mm wide, with hairs of various sizes on outer surface. Calyx lobes 1.2 – 4.6 mm long, 0.1 – 0.2 mm wide, aristate, with long hairs along the margins. Calyx orifice densely hirsute with stiff white hairs. Lower corolla lip 3.2 – 9.8 mm long, 1.7 – 3.5 mm wide; mid limb to 3.2 mm long, 2.1 mm wide, expanding toward the tip; lateral limbs to 1.8 mm long, 0.8 mm wide. Upper corolla lip 6.8 – 9.2 mm long, 2.7 – 7.1 mm wide, lobes to 0.8 mm long and 0.8 mm wide, corolla violet to white. Stamens to 18 mm in length, anthers 0.8 long, 0.3 wide, pollen white. Pistil to 18 mm long. N = 9 (Scora 1967).

Phenology. Flowering material has been collected from April through September.

Distribution. Widespread from eastern Mexico to much of the southeastern and eastern United States extending as far north as Illinois.

M. citriodora is morphologically most similar to the western species *M. austromontana* and *M. clinopodioides*. It is distinguished from the latter by a larger growth habit and more frequent branching pattern as well as the shape of the upper bract tips. *Monarda citriodora* bract tips taper dramatically to an aristate bristle, whereas *M. clinopodioides* bracts have a much more gradual tapering. Features that distinguish *M. citriodora* from *M. austromontana* are covered in the *M. austromontana* discussion above.

M. citriodora exhibits substantial levels of morphological variability and most authors have assigned varietal names to illustrate that variation. Populations, typically from northern Mexico, that have more attenuate bract tips and darker green foliage have been assigned to *M. citriodora* var. *attenuata*, and populations in south eastern Texas with shorter calyx (5 – 7 mm vs. 7 – 15 mm long) and corolla tubes (8 – 11 mm vs. 11 – 18mm long) belong to *M. citriodora* var. *parva*.

Figure 34. Herbarium specimen of *M. citriodora. Massey 2070* (OKL).

Representative specimens examined: U.S.A. OKLAHOMA. **Atoka**: 0.4 miles N. of Chockie, *Johnson 254* (OKL); 3 miles E. of Atoka on Hwy. 7 E, *Massey 2070* (OKL); **Bryan**: Durant; US 75, 1 miles north of RT. 78, *Semple 566* (OKL); **Carter**: Criner Hills, 1.5 miles northeast of Brock, *Goodman 7849* (OKL); **Choctaw**: Hwy 109 near junction with Hwy 70, S of railroad tracks and about 1 mile SW of Fort Towson, *Dorr 238*1 (TEX);**Marshall**: 5 miles south of Madill at crossing of routes 99 and 32, *Ettner* 77-1 (OKL); pasture along Buncombe Creek, 1.5 miles NW of Shay, *Williams 33*1 (OKL); **Mayes**: Pin Oak Acres 5 miles E, 1 and 3/4 mile N of Mazie; Sec. 15, T19N, R19E; Atoka fm, *First* 7 (OKL); **Murray**: on SH 77D east of I-35 north of Turner Falls, *Folley 564* (OKL); **Roger Mills**: Antelope Hills, 4.5 miles northeast of Durham, T. 17N., R 25W., Sect. 22, *Goodman 8384* (OKL); **Rogers**: 7.5 miles N Sageeyah Siding; S12 T23N R16E, *Vanderpool 759* (OKL); **Woods**: about 13 miles northwest of Alva; near Greenleaf Creek, *Nighswonger 3143* (OKL); TEXAS. **Brazos**: College Station, *Thalis 30* (TEX); **Burnet**: grasslands in Inks Lake State Park, along Clear Creek, *Correll 25295* (LL); **Calahan**: along Tex. 36, about 14 miles southeast of Abilene, *Henderson 63-938* (TEX); **Collin**: in field along Shelley road, between Renner and Plano, *Correll 18997* (LL); **Dallas**: Stults Prairie, southwest corner of Coit

Road and Belt Line Road, *Correll 16806* (TEX); **Goliad**: hwy 249 4 miles east of junction F.R. 81, *Semple 578* (MO); **Harris**: 1.5 miles north of F.M. Road 1959 north of Webster, *Correll 32917* (LL); **Leon**: Blackland prairie on upper Cretaceious marls on top of the Marquez salt dome, *Tharp 54996* (TEX); **Liberty**: off highway 146, ca. 1.6 miles north of Moss Hill, *Lundell 15083* (LL);**Nueces**: Chapman Ranch Road, *Segers s.n.* (RM); **San Patricio**: Welder Wild Life Foundation, *Scora* 2222 (TEX); 0.5 mile west of Ingleside on T. 361, *Semple 599* (MO); five miles west of Aransas Pass in black clay along roadside, *Webster 7075* (TEX); **San Saba**: 10 miles southwest of San Saba, *Howell* 2 (LL); **Somervell**: 2 miles west of Glen Rose, *Correll 19007* (LL); **Starr**: about 4.1 airmiles W of junction F.M. 650 and S Rt. 83, WNW of Roma; Lower Rio Grande Valley NWR, Fronton Tract, *Carr 13595* (TEX); **Valverde**: depression 3 miles southeast of Del Rio, route 277, *Correll 19448* (TEX); **Walker**: Huntsville, *Albers 35013* (TEX).

3. Monarda clinopodioides A. Gray, Syn. Fl. N. Amer. 2(1): 375. 1878.--TYPE: U.S.A. Texas: Dallas Co., near Dallas, June 1874, *J. Reverchon 446* (lectotype: GH, isotype: GH).

Habit annual, herb to 45 (75) cm tall; upright, branching mainly from base, occasionally from the middle of stem. Stem indumentum variable; internodes puberulent with minute downward-curled hairs, especially in the lower parts; node with short hairs, nodal plane with long hairs. Penultimate vegetative internode 23 - 72 mm long, 1.2 – 2.6 mm wide. Leaves 38 - 52 mm long, 5.2 - 12 mm wide; petiole 1.8 – 6.5 mm long; serrations 0.4 mm wide; leaf shape lanceolate , base acuminate; margins serrate from apex to 80% length of laminar tissue, apex acute; petiole indumentum of long hairs; abaxial surface puberulent; adaxial surface glabrous; margin ciliate toward the base; both leaf surfaces green. Basal inflorescence internode 5 - 10 mm long, 0.8 - 1.2 mm wide; puberulent. Lower floral bracts 20 - 50 mm long, 4 - 8 mm wide; sessile; lower bract shape lanceolate, base acuminate, margins serrate; apex attenuate to aristate; abaxial surface puberulent; adaxial surface puberulent; margin ciliate to 70% length of bract; abaxial surface green, adaxial surface green. Upper floral bracts 10 - 20 mm long, 4 –5 mm wide; upper bract shape lanceolate, base cuneate, margins ciliate; apex aristate; abaxial surface puberulent; adaxial surface puberulent; margins entire; abaxial surface green; adaxial surface green to purple. Calyx tube 6 – 8.5 mm long, 1.2 – 1.8 mm wide, with minute scattered hairs on outer surface. Calyx lobes 3 – 4.8 mm long, 0.1 – 0.3 mm wide, narrowly triangular with aristate tips, ciliate with multicellular trichomes. Calyx orifice densely hirsute with stiff white hairs. Lower corolla lip 5.2 - 8 mm long, 1.5 - 2.5 mm wide; mid limb to 3.3 mm long, 2.2 mm wide, expanding toward the tip; lateral limbs to 1.3 mm long, 1.2 mm wide. Upper corolla lip 5.2 – 6.2 mm long, 2.2 – 3.5 mm wide, lobes to 1 mm long and 0.8 mm wide, corolla white to pink with violet pigmentation. Stamens to 2.5 cm in length, anthers 0.8 long, 0.3 wide, pollen white. Pistil to 25 mm long. N = 9 (Scora 1967).

Phenology. Flowering material has been collected from April through June.

Distribution. Southern Kansas south through much of Oklahoma and central to south-central Texas.

Monarda clinopodioides is most closely related (see phylogeny), and morphologically similar, to *M. pectinata*. Both have reduced branching and upper floral bracts that gradually taper to an apical bristle. The two can be distinguished from each other because *M. clinopodioides* most commonly has purple bracts, calyx lobes and (rarely white) corollas, whereas *M. pectinata* have green bracts and calyx lobes and yellow corollas. *Monarda clinopodioides* is also typically taller, growing 30 - 60 cm in height, than *M. pectinata*, though there is a degree of overlap with the latter growing 20 – 40 cm high.

Figure 35. Herbarium specimen of *M. clinopodioides*. *Dubrule 307* (TAMU).

Representative specimens examined: U.S.A. OKLAHOMA. **Alfalfa**: near end of active runway; UTM: (05 779 40 673), *Proctor KEG0328* (OKL); **Beaver**: rt 23, 7 miles south of Beaver, *Huff 1391* (OKL); **Comanche**: 1 km W of Pratt Hill on Deer Creek Rd.; ec 23, T3N, R13W, *Thompson S0486* (OKL); 1 km E of SW corner of Quanah Range; Sec 13, T2N, R15W, *Thompson S0520* (OKL); 0.5 km E of SW corner of Quanah Range; Sec 14, T2N, R15W, *Thompson S0527* (OKL); **Custer**: 1 mile E, 05 miles S of SE edge of Arapaho, *Sanders 132* (OKL); **Dewey**: 5 miles S of Seiling, *Landon 172* (RM); **Jefferson**: 13 miles east of Ryan along HW 32, 5-10 miles north of the Red River, *Crook 953* (OKL); **McClain**: Johnson's Pasture; 4 miles west of Jct. of I35 on HW 9; south side of road, *Lawson 40* (OKL); **Tillman**: 7 miles north of Chatanooga, *Crook 1009* (OKL); **Woods**: about six miles northwest of Alva; sandy grassland on bluf above Salt Fork River, *Nighswonger 672* (OKL); northwest of Alva about 6.5 miles; roadside on bluffs south of river, *Nighswonger 1221* (OKL); 2 miles east of junction US 64 and Ok. 14; east of Alva o US 64, then 7 miles N and 0.6 miles E. south of road, *Pearce 57* (OKL); TEXAS. **Bastrop**: both sides of New Road, 0.3 mi N of East Loop Road, ca 3.8 airmiles SE of jct. US Rt. 290 and F.M. 696; Camp Swift Training Site (Texas National Guard); Elgin East Quadrangle, 30.268890, -97.263889, *Carter 13788* (TEX); 100

meters north of Dan Sawicki Bog (north of Bastrop), *Kutac s.n.* (TEX); **Brazos**: about 0.5 miles east of highway 6, along the OSR, *Ajilvshi 8400* (TAMU); **Burleson**: one mile north of Lyons on highway 60, *Simpson 139* (TAMU); **Dewitt**: *Albers 45Ph025* (TEX); **Fannin**: about 1 mile north of Monkstown, Route 79, *Correll 27489* (LL); **Fayette**: along West Point-Muldoon road, *Tharp 51-535* (TEX); **Freestone**: in sandy woods 1 mile southeast of Streetman, *Correll 16407* (LL); **Hamilton**: in caliche soil abt 2 miles N of Hamilton, off of hwy 281, *Correll 32847* (LL); **Henderson**: sandy post oak area about 5 miles southeast of Eustace, *Correll 23400* (LL); **Hopkins**: in oak flatwoods about 2 miles west of Sulphur Springs, *Correll 16741* (LL); **Lampasas**: 12 miles W. Lampasas city limits sign on FM 580, *Dubrule 307* (TAMU); **Lee**: Giddings, *Albers 48019* (TEX); **Robertson**: sandy soil in highway 1940 right of way, 5 miles W of OSR New Baden, *Carter 91* (TAMU); NE 1/4 Calver Quad., U.S.G.S 192; 2.5 miles SE of Calvert along Tx. Hwy. 6, Mud Creek marsh, *Starbuck 1926* (TAMU); **Wichita**: prairie hilside within 100 yards of shore of New City (Iowa Park) Lake, 3.5 miles W of Iowa Park, *Mahler 1135* (TEX).

4. Monarda mexicana Epling Madroño 3: 26. 1935.--TYPE: MEXICO.

Durango: no locality, no date, *P.I. Garcia 399* (holotype:

US!).

Annual herb to 50 cm tall; upright, rarely branching. Stem indumentum variable; internode puberulent with short downward curled hairs and few long hairs, node with short hairs, nodal plane with short hairs. Penultimate vegetative internode 3 – 4 mm long, 0.8 - 1.2 mm wide. Leaves 45 - 60 mm long, 8 - 12 mm wide; petiole 3 – 8 mm long; leaf shape lanceolate, base acuminate; margins subentire , ciliate toward base, apex acute; petiole indumentum of short; abaxial surface puberulent with occasional longer hairs around the midvein; adaxial surface glabrous; margin ciliate toward the base of the leaf; both leaf surfaces green. Basal inflorescence internode 5 – 10 mm long, 0.6 - 0.8 mm wide; hirsute. Lower floral bracts 35 - 45 mm long, 16 - 23 mm wide; sessile; lower bract shape ovate-lanceolate, base attenuate, margins entire; apex acute; abaxial surface glabrate, with occasional long hairs; adaxial surface glabrous; margin ciliate toward the base of the bract; abaxial surface green, adaxial surface green or green with purple at base of bract. Upper floral bracts 9 – 12 mm long, 3 – 5 mm wide; upper bract shape lanceolate, base cuneate, margins entire, ciliate; apex acuminate; abaxial surface glabrate; adaxial surface glabrate; abaxial surface green; adaxial surface green to violet. Calyx tube 5.8 – 6.2 mm long, 1.8 – 2.1 mm wide, glabrous. Calyx lobes 1.2 – 1.5 mm long, 0.1 – 0.2 mm wide, narrowly triangular, ciliate along the entire margin. Calyx orifice hirsute with flexible white hairs. Lower corolla lip 5.6 – 7.4 mm long, 3.5 – 4.2 mm wide; mid limb to 2.2 mm long, 1 mm wide, toward the tip; lateral limbs up to 1.1 long, 0.9 wide. Upper corolla lip to 7.8 – 9.2 mm long, 3.2 - 4 mm wide, lobes up to 0.2 mm long and 0.16 mm wide, corolla white to violet. Stamens to 18 mm in length, anthers 1.2 mm long, 0.3 mm wide, pollen white. Pistil to 18 mm long. N = 9 (Scora 1967).

Phenology. Flowering material has been collected from August.

Distribution. Collections of this species are very limited in number, but all have been collected in the state of Durango, Mexico. The highest geographic resolution for the location of this species was obtained from an herbarium label of collections

Figure 36. Herbarium specimen of *M. mexicana*. *Maysilles* 7771 (TEX).

(475 and 476) of James Maysilles: between El Salto and Pueblo Nuevo, Durango.

M. mexicana is most likely sister to all the remaining species of *Monarda* section *Aristatae* (see Phylogeny section). It is distinguished most notably by its very wide lower bracts which have entire margins, and by its leaves which have subentire margins. It also has glabrous calyx tubes (which, among section *Aristatae*, is unique to this species) and green upper bracts.

Turner (1994) treats *M. mexicana* as a variety (var. *austromontana*) of *M. citriodora*. This was based primarily on the broad calyx lobes exhibited by this species and other individuals of *M. citriodora* (sensu Turner 1994) he is familiar with in the region. However, while certainly recognizing the large morphological variation inherent in Mexican species of this section, it is the author's opinion that *M. mexicana* is a separate species based on additional characters auxiliary to the calyx lobe shape discussed above (see chapter 2).

Representative specimens examined: <u>MEXICO.</u> DURANGO. *Garcia 399 (photograph)*(MICH); from El Salto, south along lumber road toward Pueblo Nuevo (about 60 air miles southwest of C. Durango) *Maysilles* 7771 (MICH, TEX).

5. **Monarda pectinata** Nutt., J. Acad. Phil., ser. 2, 1: 182. 1847.--TYPE: U.S.A. New Mexico: Santa Fe Co., near Santa Fe, no date, *Gambel s.n.* (holotype: K, according to McClintock and Epling (1942) and Scora (1967)).

Habit annual, herb to 30 (55) cm tall; upright, branching primarily from base of stem. Stem indumentum variable; internodes puberulent with minute downward-curled hairs, especially in the lower parts; node and nodal plane with short hairs. Penultimate vegetative internode 20 – 70 (86) mm long, 1 – 3.5 mm wide. Leaves 3.2 – 6.5 mm long, 5.5 - 12 mm wide; petiole 2.2 – 5 mm long; serrations 0.1 mm wide; leaf shape lanceolate, base acuminate; margins serrate from apex to 80% length of laminar tissue, apex obtuse; petiole indumentum of long hairs; abaxial surface puberulent with small hairs across entire surface; adaxial surface glabrous; margin ciliate toward the base; both leaf surfaces green. Basal inflorescence internode 10 – 50 mm long, 0.6 – 1.2 mm wide; puberulent. Lower floral bracts 21 - 60 mm long, 4 -8 mm wide; sessile; lower bract shape lanceolate, base acuminate margins serrate; apex acuminate; abaxial surface puberulent; adaxial surface glabrous; margin serrate and ciliate ; abaxial surface green, adaxial surface green. Upper floral bracts 8 – 23 mm long, 2.6 – 3.8 mm wide; upper bract shape lanceolate, base cuneate, margins serrate; apex aristate; abaxial surface puberulent; adaxial surface glabrous; margins ciliate; abaxial surface green; adaxial surface green occasionally with purple margins or green-purple throughout. Calyx tube 6.1 - 10 mm long, 1.5 – 2.5 mm wide, with minute scattered hairs on outer surface. Calyx lobes 2.5 – 3.5 mm long, 0.1 mm wide, aristate, margins ciliate. Calyx orifice densely hirsute with stiff white hairs. Lower corolla lip to 8 (9.5) mm long, 3 mm wide; mid limb to 3.5 mm long, 1.75 mm wide, expanding toward the tip; lateral limbs to 1 mm long, 1 mm wide. Upper corolla lip 5 – 8 (11) mm long, 2 - 3.8 mm wide, lobes to 0.6 mm long and 0.4 mm wide, corolla white to pink. Stamens to 26 mm in length, anthers to 1.2 mm long, 0.8 wide, pollen white. Pistil to 26 mm long. N = 18 (Scora 1967).

Phenology. Flowering material has been collected from May through October.

Distribution. Western Texas and the panhandle of Oklahoma extending west through Arizona and Colorado and north through Nebraska.

M. pectinata is most closely related (and morphologically similar) to *M. clinopodioides*. The features distinguishing the

Figure 37. Herbarium specimen of *M. pectinata*. *Ballinger s.n.* (TEX)

two species can be found in the discussion under *M. clinopodioides*. The two species are largely allopatric, but populations of *M. pectinata* from western Texas occur within 250 miles of the central Texas populations of *M. clinopodioides*

Representative specimens examined: U.S.A. COLORADO. **Boulder**: Boulder, *Daniels* 13 (MSC); **Larimer**: Fort Collins, *Lawsen 384* (MSC); un-named mountain 0.5 miles NW of Cherokee Park rd, T10N R71W S10, *Neely 3566* (RM); **Park**: along route 24, 1 mile west of Wilkerson Pass, Lake George, *Churchil 74821*3*8* (MSC); NEBRASKA. **Banner**: pipo woodland near C-7 about 8 miles SE of Harrisburg, *Long s.n.* (RM); **Dawes**: in the sand hills near Ft. Robinson, *Porter 9356* (RM); **Devel**: Rush Creek, *Tracy 799*1 (MSC); **Garden**: along dirt road in Crescent Lake National Wildlife Refuge; ca. 1 to 5 miles S of lakeside, *Theiret 59653* (KNK); **Thomas**: Nebraska National forest, Halsey, *Haynes 969*2 (KNK); NEW MEXICO **Catron**: middle fork of Gila, *Wooton s.n.* (NMC); near Gallo Spring in western Catron Co., *Wooton s.n.* (NMC); **Cibola**: Craters, *Wooton s.n.* (NMC); **Harding**: route 39, 10 miles east of town, *Higgins 6948* (MSC); TEXAS. **Andrews**: North Andrews City, *Ballinger s.n.* (TEX); **Bailey**: in deep sandy loam of woody pasture 4 miles north of Maple, *Rosson 956* (MSC); **Dawson**: 11.6 miles west of Lamesa, *Shinners 3006*1 (TEX); **Garza**: barditch highway 380, 16 air miles east of Post, *Hutchins* 11*33* (TEX); **Hockley**: *Rachaner* 132 (TEX);

Jefferson: grassy roadside in Limpia Canyon, 9-10 miles above Ft. Davis, *Correll 18391* (TEX); near base of north slope of Mt. Livermore, *Correll 33768* (TEX); Davis Mountains; Madeira Canyon, *Kugel 2098* (MSC); Davis Mountains, highway 118, Scenic Drive, 7 miles from cut-off to McDonald Observatory, *Lundell 14224* (TEX); Davis Mts., Hw 166, SW slope of Sawtooth Mt., protected arroyo, under oak tres, *Sanders 75084* (TEX); Musquiz Canyon; Davis Mountains; 8 miles south of Ft. Davis, *Warnock 5672* (TEX); **Lubbock**: *Demaree 7554* (TEX); **Midland**: rte 349, 5 miles north of Midland, *Correll 22048* (TEX); Midland Draw, 10 miles east-southeast of Midland, *LeSassier 225* (TEX).

6. Monarda n. sp. 1, *sp. nov.*--TYPE: MEXICO. Chihuahua: Cuauhtemoc-La Junta, 2000 m, 25 July 1994, *C. Yen & E. Estrada 2681* (holotype: CAS!; isotype: CAS!).

Habit perennial, herb to 50 cm tall; upright, branching from the middle of stem. Stem indumentum variable; internodes canescent with minute downward-curled hairs. Nodes with short hairs, nodal plane with long hairs. Penultimate vegetative internode 25 - 35 mm long, 2.5 - 3.5 mm wide. Leaves 30 - 45 mm long, 5 - 11 mm wide; petiole 0.5 - 4 mm long; serrations 0.3 mm wide; leaf shape lanceolate, base acute; margins serrate from apex to 75% length of laminar tissue, apex acute; petiole canescent with occasional long hairs; abaxial surface canescent with occasional long hairs around the midvein; adaxial surface canescent; margin ciliate toward the base of the leaf. Basal inflorescence internode 25 - 45 mm long, 1.5 - 2.5 mm wide; puberulent. Lower floral bracts 15 - 33 mm long, 8 - 12 mm wide; sessile; lower bract shape linear to lanceolate, base attenuate, margins entire; apex acuminate; abaxial surface canesent; adaxial surface canescent; margin ciliate toward the base of the bract; both surfaces canescent. Upper floral bracts 4 - 8 mm long, 0.8 - 3 mm wide; upper bract shape lanceolate, base cuneate, margins entire; apex acuminate; abaxial surface canescent; adaxial surface canesent; margins ciliate. Calyx tube 2.5 - 5.5 mm long, 1 - 2 mm wide, puberulent. Calyx lobes 1.8 - 2.6 mm long, 0.1 mm wide, aristate, margins ciliate. Calyx orifice densely hirsute with stiff white hairs. Lower corolla lip 4.5 - 5.2 mm long, 2.1 - 2.8 mm wide; mid limb up to 1.6 mm long, 1.4 mm wide, expanding toward the tip; lateral limbs to 1 mm long, 0.8mm wide. Upper corolla lip 4.5 - 5.5 mm long, 2.8 - 3.2 mm wide, lobes to 0.1 mm long and 0.15 mm wide, corolla white. Stamens to 10 mm in length, anthers 1.5 - 2.5 mm long, 0.4-0.7 mm wide, pollen white. Pistil 8 mm long.

Phenology. Flowering specimens have been collected in July.

Distribution. Sierra Madre mountains in the state of Chihuahua, Mexico.

Monarda n.sp.1 is most closely related, and morphologically similar, to *M. austromontana*. The former can easily be distinguished from the latter by their canescent vesture which gives the stems and leaves a grey appearance. The species is known from only a single collection.

Representative specimens examined: Mexico. CHIHUAHUA: *Yen 268*1 (CAS); between Cuauhtémoc and La Junta.

Figure 38. Herbarium specimen of *Monarda n. sp.* 1. *Yen 268*1 (CAS).

Monarda section Cheilyctis Epling, Univ. Calif. Publ. Botany 20: 186. 1942. *Monarda* subsection *Cheilyctis* Epling, Madroño 3: 22. 1935.

Annual or perennial **h**erbs. Floral bract tips acute to acuminate. Calyx lobe tips acute to acuminate. Pollen yellow. N = 11 or 12.

7. Monarda arkansana *ined.*, *comb nov*. *M. punctata* var. *arkansana* (McClintock and Epling) Shinners, Field and Lab. 21(2): 90. 1953. *M. punctata* ssp. arkansana McClintock and Epling, Univ. Calif. Publ. Botany 20: 182. 1942. —TYPE: U.S.A. Arkansas: Hot Springs County, near Magnet Cove, no date, *Demaree 15590* (holotype: LA).

Habit annual or perennial, subshrub to 65 cm tall; upright, branching heavily from the middle of stem. Stem indumentum variable; internode with long villous hairs, node with long villous hairs, nodal plane with long villous hairs. Penultimate vegetative internode 21 – 76 mm long, 1.2 – 3.2 mm wide. Leaves

46 – 86 (100) mm long, 8 – 18 mm wide; petiole (4) 6.5 – 17 (24) mm long; serrations 0.2 mm wide; leaf shape lanceolate to oblanceolate, base attenuate; margins serrate from apex to 15% length of laminar tissue, apex acute to acuminate; petiole indumentum of long hairs; abaxial surface villous along the midvein; adaxial surface glabrous; margin ciliate toward the base of the leaf; both leaf surfaces green. Inflorescence internode 5 - 18 mm long, 0.6 - 0.8 mm wide; villous or glabrous. Lower floral bracts 30 - 65 mm long, 5.2 – 12 mm wide; sessile; lower bract shape lanceolate, base attenuate, margins entire; apex acuminate; adaxial surface glabrous; adaxial surface villous; margin ciliate toward the base of the bract; abaxial surface green, adaxial surface green. Upper floral bracts 13 – 30 mm long, 5 – 13 mm wide; upper bract shape oblanceolate, base cuneate, margins serrated; apex acuminate; abaxial surface villous; adaxial surface glabrous; margins glabrous; abaxial surface green; adaxial surface red to green. Calyx tube 6.2 – 9.4 mm long, 1.1 - 2 mm wide, with minute scattered hairs on outer surface. Calyx lobes 1.0 - 1.6 mm long, 0.2 - 0.4 mm wide, lanceolate, with minute hairs along the margins. Calyx orifice ciliate with flexible white hairs. Lower corolla lip 4.1 – 7 mm long, 3 – 4.1 mm wide; mid limb to 3.5 mm long, 1.3 mm wide, expanding toward the tip; lateral limbs to 1.3 mm long, 1 mm wide. Upper corolla lip 7.8 – 12 mm

long, 3.8 – 4.2 mm wide, lobes to 0.4 mm long and 0.3 mm wide, corolla yellow in color with violet pigmentation. Stamens to 22 mm in length, anthers 0.8 mm long, 0.2 wide, pollen yellow. Pistil to 21 mm long. N = 11 (Scora 1967).

Phenology. Flowering material has been collected from July through October.

Distribution. Central and southern Arkansas extending south into northeastern Texas and northeastern Louisiana.

Representative specimens examined: U.S.A. ARKANSAS, **Desha**: access road to Dam #2 on Ark. River, *Locke 2784* (UARK); **Garland**: Hot Springs, *Demaree 410* (UARK); Hot Springs National Park, Sugar Loaf Mt., *Demaree 15840* (UARK); Hot Springs, *Foreman s.n.* (US); Hot Springs, *Letterman s.n.* (US); 1 M west of Three Frks Walnut Creek on 270 north of Crystall Springs, *Scora 1056* (US); **Hempstead**: McNab, *Palmer 12665* (US); **Hot Springs**: SW 1/4, Sec. 2, T 5S, R 22W, Point Cedar Quadrangle, *Roberts 471* (UARK); **Jefferson**:within 1/4 mi. of 3006 West Orlando Drive in SW Pine Bluff, *Locke 26* (UARK); **Miller**: Texarkana, *Buchhohy 335* (UARK); **Polk**: vicinity of Grannis; 25 mi. S. of Mena, *Moore 400459* (UARK); Bog Springs; Whiskey Peak vicinity, *Moore 410-213* (UARK); Big Fork, *Moore s.n.* (UARK); **Saline**: Bryant, *Moore 400401* (UARK); **Sebastion**: Fort Smith, *Bigelow s.n.* (US); **Union**: east of El Dorado (Champagnole Rd.), *Moore 68341* (UARK); along

Figure 39. Herbarium specimen of *M. arkansana*. *Moore 400459* (UARK).

US route 167, 5 km N of AR route 7 junction S of town. Sec. 10, T 18S, R 15W, *Thomas 111098* (MSC); beside U.S. 167 south of El Dorado and 3 miles north of Ark. 7 junction; Sec. 10, T18S, R15W, *Thomas 111098* (UARK).

8. Monarda fruticulosa Epling, Madrono 3: 26. 1935. *Monarda punctata* L. var. *fruticulosa* (Epling) Scora, Uni. Calif. Publ. Bot. 41: 46. 1967.--TYPE: U.S.A. Texas: Duval Co., near Pena Station, September 1884, *Harvard s.n.* (holotype: US!).

Perennial herb to 1 m tall; upright, branching from the middle or base of stem. Stem indumentum variable; internodes canescent with minute downward-curled hairs; node with short hairs, nodal plane with occasional longer hairs. Penultimate vegetative internode 10 – 60 mm long, 0.6 - 3 mm wide. Leaves 10 - 40 mm long, 1 - 4 mm wide; sessile or with minute (0.5 mm) petiole; serrations 0.2 mm wide; leaf shape linear, base acuminate; margins serrate from apex to 15% length of laminar tissue, apex acute; petiole indumentum of long hairs; abaxial surface canescent; adaxial surface canescent; margin occasionally ciliate toward the base of the leaf. Basal inflorescence internode 10 – 30 mm long, 0.6 - 1.5 mm wide; caulescent. Lower floral bracts 10 – 40 (56) mm long, 2-5 (7) mm wide; sessile; lower bract shape linear, base attenuate, margins serrate; apex acute; abaxial surface canescent; adaxial surface canescent; margin ciliate toward the base; adaxial surface yellow to white. Upper floral bracts 8 - 20 mm long, 3 – 12 mm wide; upper bract shape elliptic, base cuneate, margins entire or minutely serrated; apex acuminate; abaxial surface canescent; adaxial surface canescent; margins entire or occasionally cilate; adaxial surface white to pink. Calyx tube 4 – 6.5 mm long, 1 - 2 mm wide, with long villous trichomes on outer surface. Calyx lobes 1 – 2 mm long, 0.1 – 0.4 mm wide, narrowly triangular, with long villous trichomes along the margins. Calyx orifice hirsute with flexible white hairs. Lower corolla lip 2 – 5.5 mm long, 1.5 - 3 mm wide; mid limb to 2.6 mm long, 1.5 mm wide, expanding toward the tip; lateral limbs to 2 mm long, 1.3 mm wide. Upper corolla lip 5 -7 (12) mm long, 2 – 3 (4.2) mm wide, lobes to 0.6 mm long and 0.5 mm wide, corolla white to pink with lower corolla lip with occasional maroon pigmentation. Stamens to 1.6 mm in length, anthers to 0.8 mm long, 0.4 mm wide, pollen yellow. Pistil to 16 mm. N = 11 (Scora 1967)

Phenology. Flowering material has been collected from March through December.

Distribution. Southern Texas in sandy roadsides and pastures.

M. fruticulosa is part of the narrow leaf clade (see phylogeny). It is most closely related to *M. maritima*, *Monarda n. sp.* 2, and *M. viridissima*, and though they all have narrow leaves, *M. fruticulosa* is the only species whose leaves are truly linear. It also has acuminate calyx lobes, but its most distinguishing feature is the canescence that covers all of its vegetative surfaces.

Figure 40. Herbarium specimen of *M. fruticulosa*. *Runyon 399*1 (RM).

Representative specimens examined. U.S.A. TEXAS. **Brooks:** north of Encino, *C.L. Lundell & 8850* (TEX); State Highway 285, twenty miles east of Hebronville, *Garcia* 110 (TEX); 22 mi. W of Falfurias, *Muller 8053* (TEX); ca 18 mi S of Falfurrias on Scot & Hoper Ranch, *O'Brian* 1163 (RM); San Manuel to Encino, *Runyon* 2628 (TEX); 6.05 M north of Encino on highway 281, south of Falfurias, *Scora 2223* (US); North of Encino on Highway 281, south of Falfurias, *Scora 2224* (US); **Cameron:** vicinity of Brownsville, *Shiller* 178 (US); **Hidalgo:** 8 miles north of San Manuel, *Lundell* 12792 (TEX); 8 miles north of San Manuel, *Lundell* 12796 (US); **Jim Hogg:** E side of F. M. 1017, 3.0 roadmiles S of jct. with smaller road at Agua Nueva. Agua Nueva SE Quadrangle, 26.513800, -98.364600, *Carr* 13206 (TEX); ten miles south of Hebbronville on road No. 1017, *Johnston 541835* (TEX); 1 mile north of Agua Nueva, *Salinas* 180 (TEX); **Kenedy:** 10 miles south of Sarita, *Correll* 26913 (LL); King Ranch, roadside 5.5 mi. S. rest stop S. of Sarita, *Dubrule 804* (TAMU); Sarita, *Fisher* 41125 (RM, US); Saltillo Pasture, Norias Division of King Ranch, *Johnston 53254*.21 (TEX); Las Norias, *Runyon 399*1 (RM, TEX); on highway between Las Norias and Armsrong, *Runyon 4333* (US, TEX); Kennedy Ranch, *Tharp 42-40* (TEX); **Zapata:** about 11 miles northeast of San Ygnacio, *Corell 35452* (GH, LL); San Ignacio, *Gamboa 158* (TEX).

9. Monarda humilis (Torrey) Prather & J. A. Keith, Novon 13: 1. 2003. *Monarda punctata* var. *humilis* Torrey, Report of an Expedition down to the Zuni and Colorado Rivers 166. 1853. --TYPE: U.S.A. New Mexico: no date, *[S.W.] Woodhouse s.n.* (holotype: GH).

Habit annual, herb to 50 m tall; upright, branching (occasionally from the base) from the middle of stem. Stem indumentum puberulent with small downward curling hairs on the internodes, nodes and nodal plane, often red (especially toward top of plant). Penultimate vegetative internode 20 – 50 mm long, 0.8 - 1.2 mm wide. Leaves 20 - 50 mm long, 3 - 8 mm wide; petiole 1 – 8 mm long; serrations 0.3 mm wide; leaf shape lanceolate, base acute; margins serrate from apex to 25% length of laminar tissue, apex acute; petiole indumentum of short hairs but occasionally with longer ciliate hairs; abaxial surface puberulent occasionally with medium hairs around the midvein; adaxial surface puberulent; margin ciliate toward the base; both leaf surfaces green. Basal inflorescence internode 5 - 7mm long, 0.6-0.8 mm wide, puberulent. Lower floral bracts 20 - 40 mm long, 4 - 10 mm wide, petiolate; lower bract shape lanceolate, base acute, margins serrate; apex acute; abaxial surface puberulent; adaxial surface puberulent; margin ciliate toward the base; abaxial surface green, adaxial surface green. Upper floral bracts 1.9 – 25 mm long, 1 –9 mm wide; upper bract shape lanceolate, base cuneate, margins serrate; apex acuminate; abaxial surface puberulent; adaxial surface puberulent; margins entire; abaxial surface green; adaxial surface purple to green. Calyx tube 4 – 7.5 mm long, 1 – 2.5 mm wide, glabrous or with small trichomes along the veins. Calyx lobes 0.5 - 1 mm long, 0.4 – 0.9 mm wide, with long flexuous hairs on the margins. Calyx orifice hirsute with long flexuous hairs. Lower corolla lip 2 - 4 mm long, 1 – 3.5 mm wide; mid limb to 2 (3) mm long, 1.4 (2) mm wide, expanding toward the tip; lateral limbs to 1.4 mm long, 1.5 mm wide. Upper corolla lip 4 – 5.5 (6.5) mm long, 2 - 3 mm wide, lobes to 0.3 mm long and 0.3 mm wide, corolla white with maroon margin and spots. Stamens to 15 mm in length, anthers to 1.7 mm long, 1.5 mm wide, pollen yellow. Pistil to 15 mm long. N = 12 (Ward and Spellenberg 1984)

Phenology. Flowering material has been collected from June through September.

Distribution. Central and western New Mexico

M. humilis is most closely related, and most morphologically similar to *M. occidentalis* and *M. stanfieldii* and is part of the glabrous calyx clade (see Phylogeny section). It is found in sandy regions of western and central New Mexico which is west of the distribution range of *M. occidentalis*. It is distinguished from these two species by its smaller stature and purple pigmentation that is found on the upper bracts, calyx, and corolla, but also occasionally along the stems. *Monarda humilis* has violet flowers with maroon spots instead of the yellow or white flowers (which may also have maroon spots) commonly associated with the rest of the clade.

Figure 41. Herbarium specimen of *M. humilis*. *Goodrow 522* (UNM).

Representative specimens examined: U.S.A. NEW MEXICO. **Catron:** North Cebollita Mesa T8N R9W, Sec. 8, *McIntosh* 1*006* (UNM); **Cibola**: T7N, R10W, Sec. 8, *DeBruin 448* (UNM); Inscription Rock, *Wooton s.n.* (US); Mts. West of Grant's Station, *Wooton s.n.* (NMC); Inscription Rock, *Wooton s.n.* (US); **McKinley**: T10N R18W Sec. 18 Zumi Indian Reservaion. 1.5 mi. e of Blackrock, 0.5 mi. NE of Blackrock Reservoir, *Brandt* 1*094* (UNM); **Rio Arriba**: West of San Larenzo, *Wooton s.n.* (NMC, US); **Sandoval**: Santo Domingo Pueblo, *Abbott s.n.* (UNM); **Socorro**: S20, T3S, R4W, *Goodrow 522* (UNM); plains east of Datil on hwy 60, *Higgins 7737* (NMC); 10 mi. S of Claunch on St. 55., *Pase 3566* (NMC); near Cibola. Between Datil and Magdalena on roadside highway 60, *Tafoya* 1*3*1 (UNM); **Torrance**: Cibola N.F. Gallinas Mtns. Fm Rd. 458, *Pase 36*21 (NMC); **Valencia**: El Morro Nat'l Monument, *Carlson SC4* (UNM).

10. Monarda maritima (Cory) B.L. Turner, Phytologia. 77(1): 72. 1994. *Monarda punctata* L. var. *maritima* Cory, Field & Lab. 17: 52. 1949.--TYPE: U.S.A. Texas: San Patricio Co., 4mi W of Aransas Pass, 14 October 1951, *F.B. Jones 648* (holotype: SMU).

Habit perennial, herb to 110 cm tall; upright, branching heavily from the base of stem. Stem indumentum densely pubescent; internodes hirsute with 1 - 3 mm long spreading hairs; node with long hairs, nodal plane with long hairs. Penultimate vegetative internode (14) 20 -30 (35) mm long, 0.9 - 3 mm wide. Leaves 15 - 60 mm long, 4 - 10 mm wide; petiole 0.5 – 2 mm long; serrations to 1 mm wide; leaf shape linear to lanceolate, base acuminate; margins serrate from apex to 75% length of laminar tissue, apex acute; petiole indumentum of long hairs; abaxial surface hirsute with long hairs around the midvein; adaxial surface glabrous or with occasional spreading hairs; margin ciliate toward the base of the leaf; both leaf surfaces green. Basal inflorescence internode 5 – 10 mm long, 0.6 - 0.8 mm wide; hirsute. Lower floral bracts 15 - 60 mm long, 3 - 11 mm wide; sessile to minutely petioled; lower bract shape linear to lanceolate, base attenuate, margins distinctly toothed; apex acute; abaxial surface hirsute; adaxial surface glabrous or with occasional spreading hairs; margin ciliate toward the base of the bract; both surfaces green to red to white. Upper floral bracts 12 – 22 mm long, 6 – 9.5 mm wide; upper bract shape lanceolate, base cuneate, margins serrated; apex acute; abaxial surface hirsute; adaxial surface glabrous or with occasional hairs; margins ciliate; abaxial surface green; adaxial surface yellow to white to red. Calyx tube (6) 8 - 10 mm long, 1 - 1.8 mm wide, with minute scattered hairs on outer surface. Calyx lobes 1 – 2.5 mm long, 0.25 - 0.5 mm wide, narrowly triangular, with no hairs along the margins. Calyx orifice glabrous or with few hairs. Lower corolla lip 8 - 10 mm long, 2 – 4 mm wide; mid limb to 2.5 mm long, 1 mm wide, expanding toward the tip; lateral limbs to 1.2 mm long, 1 mm wide. Upper corolla lip 8 - 10 mm long, 3 – 5 mm wide, lobes to 1 mm long and 0.4 mm wide, corolla white with some pink along the edges. Stamens to 15 mm in length, anthers 1.5 – 2.5 mm long, 0.4 – 0.8 mm wide, pollen white. Pistil to 9 mm long. N = 11 (Scora 1967).

Phenology. Flowering material has been collected from July through December.

Disribution. South eastern coastal Texas.

Monarda maritima is a south-eastern Texas species in the narrow-leafed clade (see Phylogeny section) and is most closely related to *M. fruticulosa, Monarda n. sp.* 2*, and M. viridissima*. It can easily be distinguished from these by a covering of pilose hairs on almost all the vegetative surfaces. Geographically, *M. fruticulosa* is the closest neighbor in this clade (150 miles separate them at their closest point), but it has linear leaves and is covered by smaller silvery hairs that gives it a distinct canescence.

Figure 42. Herbarium specimen of *M. maritima*. *Johnston 53254.22* (TEX).

Representative specimens examined: U.S.A. TEXAS. **Aransas**: 14 km from Fulton, *Churchill 90-930* (MSC); Goose Island State Park, *Johnston 53254.27* (TEX); Lamar, situated on the edge of Copano Bay, *Palmer 1081* (US); Lamar, *Palmer 1081* (US); Copano Bay, *Tharp 1553* (US); **Kleberg**: near Mortila Camphouse, Laureles Division of King Ranch, *Johnston 53254.22* (TEX); Laureles Division of King Ranch, near Mortilla Camphouse, *Johnston 53254.23* (TEX); eastern Laureles Division of King Ranch, *Johnston 53254.24* (TEX); eastern Laureles Division of King Ranch, *Johnston 53254.24* (RM); **Refugio**: Goose Island State park, *Scora 2170* (US); Goose Island State park, *Scora 2170* (GH, TEX); Austwel, *Tharp 5553* (US).

11. Monarda occidentalis *ined*., *comb nov*. *M. punctata* subsp. *occidentalis* Epling, Madrono 3: 23. 1935. *M. punctata* var. *occidentalis* (Epling) Palmer and Steyermark, Ann. Missouri Botan. Gardens 22: 634. 1935.--TYPE: U.S.A. Oklahoma: Woods Co., near Alva, *Stevens 3072* (holotype: NY (digital image)!; isotype: GH).

Habit annual, herb to 50 cm tall; upright, branching heavily from the middle to upper part of the stem. Stem indumentum of short hairs; internodes puberulent with minute downward-curled hairs; node with short hairs, nodal plane with short hairs. Penultimate vegetative internode 12 – 60 mm long, 1 - 3 mm wide. Leaves 30 - 60 mm long, 6 - 20 mm wide; petiole 5 – 15 mm long; serrations to 0.8 mm wide; leaf shape lanceolate, base acute; margins serrate from apex to 20% - 90% length of laminar tissue, apex acute; petiole indumentum of long hairs; abaxial surface puberulent with short hairs and occasionally longer hairs around the midvein; adaxial surface puberulent; margin ciliate toward the base of the leaf; both leaf surfaces green. Basal inflorescence internode 8 – 25 mm long, 0.6 - 0.8 mm wide; puberulent. Lower floral bracts 25 - 70 mm long, 8 – 25 mm wide; sessile, or nearly so; lower bract shape lanceolate, base acute, margins serrate; apex acuminate; abaxial surface puberulent; adaxial surface puberulent; margin ciliate toward the base of the bract; abaxial surface green, adaxial surface green to white (or white with green tips or margins). Upper floral bracts 17.5 - 30 mm long, 6 - 11 mm wide; upper bract shape lanceolate, base cuneate, margins entire; apex acuminate; abaxial surface puberulent; adaxial surface puberulent; margins occasionally ciliate; abaxial surface green; adaxial surface yellow to white. Calyx tube 5 – 7.5 mm long, 1 – 2.5 mm wide, with minute scattered hairs on outer surface. Calyx lobes 0.5 – 1.2 mm long, 0.4 – 1.0 mm wide, broadly deltoid, ciliate. Calyx orifice hirsute. Lower corolla lip 4 – 6.5 mm long, 0.8 - 3 mm wide; mid limb to 2 mm long, 1.5 mm wide, expanding toward the tip; lateral limbs to 0.8 mm long, 0.6 mm wide. Upper corolla lip 3 – 8 mm long, 2 - 4 mm wide, lobes to 0.15 mm long and 0.22 mm wide, corolla white to pink, occasionally with maroon spots. Stamens to 15 mm in length, anthers 0.4 – 0.9 mm long, 0.2 -0.4 mm wide, pollen yellow. Pistil to 17 mm long. N = 11 (Scora 1967).

Phenology. Flowering material has been collected from July through December.

Distribution. Western Texas, Oklahoma, and southwestern Kansas.

M. occidentalis is part of the glabrous calyx clade (see phylogeny). Its closest and most morphologically similar relatives are *M. stanfieldii* and *M. humilis.* It can be distinguished from these by its large globose glomerules, short calyx lobe cilia, and white to cream colored corollas. Furthermore, it is separated from *M. stanfieldii* by its broadly deltoid calyx lobes and from *M. humilis* by its green (vs. purple) calyces.

Figure 43. Herbarium specimen of *M. occidentalis*. *Correll 33017* (TEX).

Representative specimens. U.S.A. NEW MEXICO. **Valencia:** ElMorro National Monument, *Vogt 7* (ARIZ); OKLAHOMA. **Beaver:** 2 mi. S. of Gate along roadside, *Laverty 7343* (OKL); **Beckham:** north fork of Red River at State Highway 30, 6 miles N. of Erick, *Goodman 8090* (OKL); **Harmon:** Hwy 30 N of Salt Fork of Red River, *Wagner 3615* (MO); **Harper:** About 5.5 miles west and 7 miles south of Buffalo, *Bellah 76* (OKL); NNE of Buffalo about 12 miles: one mile from Kansas line, *Nighswonger 1925* (OKL); **Jackson:** N boundary, 200 E of active runway.UTM: (0475238382). T3N R20W Sec. 35, *McCarthy ALT0280* (OKL); **Kingfisher:** Kingfisher, *Carletan 183* (MSC); **Marshall:** in vicinity of University of Oklahoma Biological Station, *Barclay 851* (US); **Roger Mills:** Antelope Hils, 4.5 miles northeast of Durham, T. 17N, R 25W, Sect 22., *Goodman 8379* (OKL); **Woods:** north of the Cimarron River ca. 15 miles south of Alva on SH 14 and two miles west on a ranch road, *Folley Nr. 580* (OKL); about 5 miles N and 61/2 miles W of Freedom. Roadside of U.S. Hwy. # 64, *Nighswonger 3270* (OKL); **Woodward:** 5 miles E of Mooreland, 36.439136, -99.114304, *Springer 374* (OKL); Wolf Creek, 1 mile south-east of Ft. Supply, *Waterfall 14926* (US); TEXAS. **Andrews:** central part of county, *Scudday* (LL); **Childress:** on sand hills on south side of Prairie Dog Town fork of the Red River, 10 miles north of Childress, *Correll 16859* (TEX); **Crane:** along Ranch Rd. 1601 about 14 miles south of Penwell. (Ector Co.), *Correll 33017* (LL); five to eight miles north of Imperial, *Warnock 15444* (LL); **Hemphill**: Canadian, *Palmer 14116* (US); **Hutchinson**: Maverick Village, Fritch, *Drake 108* (TEX); **Lynn**: O'Donnell, *Reed 3437* (US); **Stonewall**: along U.S. #380, about 1/2 mile west of Swenson, 33.206935, -100.346355, *Henderson 63-834* (TEX); **Ward**: 4 miles northeast of Monahans, *Cory 51996* (US); highway 4 miles east of Monahans, *Warnock 7878* (LL); **Winkler**: 3 mi. N.E. of Wink on 115. 100 yds from side of road, *Stuessy* 157 (TEX).

12. Monarda punctata L., Sp. Pl. 1: 22. 1753.--TYPE: U.S.A. no locality, no date, no collector name (holotype: L, according to Epling (1935)).

Monarda punctata L. var. *lasiodonta* A. Gray, Syn. Fl. N. Amer. 2(1): 375. 1878. *Monarda lasiodonta* (A. Gray) Small, Fl. S.E. U.S. 1038, 1337. 1903.—TYPE: U.S.A. Texas: no locality, 1834-1935, *Drummond s.n.* (lectotype: GH (selected by Scora (1967)).

Monarda punctata L. subsp. *immaculata* Pennell, Bull. Torrey Bot. Club 46: 187. 1919. *Monarda punctata* L. var.

immaculata (Pennell) Scora, Univ. Calif. Publ. Bot. 41: 47. 1967.—TYPE: U.S.A. Texas: Victoria Co., Aloe, 8 September 1913, *Pennell 5494* (holotype: PH; isotype: NY (digital image)!)

Monarda punctata L. var. *intermedia* (McClintock & Epling) Waterfall, Rhodora 52: 38. 1950. *Monarda punctata* L. subsp. *intermedia* McClintock & Epling, Univ. Calif. Publ. Bot. 20: 184. 1942—TYPE: U.S.A. Texas: Van Zandt Co., near Wills Point, Little 14456 (holotype: UCLA).

Monarda punctata L. var. *correllii* B.L. Turner, Phytologia 77(1): 56. 1994.—TYPE: U.S.A. Texas: Webb Co., red sandy soils along highway 83, 13 mi NW of Webb, 16 July 1957, *Correll & Johnston 18109* (holotype: LL!).

Habit annual and perennial, herb to 85 cm tall; upright, branching from the base or the middle of the stem. Stem indumentum variable; internodes puberulent with minute downward-curled hairs and occasionally with longer spreading trichomes; node with short hairs, nodal plane with long hairs. Penultimate vegetative internode 20 – 70 mm long, 0.8 – 3.2 mm wide. Leaves 30 - 100 mm long, 8 – 20 mm wide; petiole 3 – 24 mm long; serrations to 0.4 mm wide; leaf shape lanceolate to ovate, base acute to acuminate; margins serrate from apex to 20% length of laminar tissue, apex acute; petiole ciliate; abaxial surface puberulent or with medium-long hairs around the midvein, occasionally with scattered longer hairs; adaxial surface glabrous; margin ciliate toward the base; both leaf surfaces green. Basal inflorescence internode 5 - 12 mm long, 0.6 - 0.8 mm wide; glabrous or puberulent. Lower floral bracts (25) 30 - 80 mm long, 2 - 13 mm wide; sessile; lower bract shape lanceolate, base attenuate, margins serrate; apex acute; abaxial surface puberulent; adaxial surface glabrous; margin ciliate toward the base; abaxial surface green, adaxial surface green. Upper floral bracts 10 - 36 mm long, 2.8 – 13 mm wide; upper bract shape elliptic, base cuneate, margins entire; apex acuminate; abaxial surface glabrous; adaxial surface glabrous or puberulent; margins glabrous or ciliate; abaxial surface green; adaxial surface purple. Calyx tube 5 – 9.4 mm long, 1 - 3 mm wide, with minute scattered hairs on outer surface. Calyx lobes 0.6 – 1.9 mm long, 0.2 – 0.5 mm wide, narrowly triangular, margins glabrous or ciliate. Calyx orifice glabrous or hirsute. Lower corolla lip (2.5) 6 - 10 mm long, 1.2 – 4.5 mm wide; mid limb to 3.6 mm long, 1.7 mm wide, expanding toward the tip;

lateral limbs to 2 mm long, 1.3 mm wide. Upper corolla lip (3.5) 6 - 11 mm long, 2 - 5 mm wide, lobes to 0.4 mm long and 0.5 wide, corolla yellow to cream with deep maroon pigmentation. Stamens to 12 mm in length, anthers to 1.8 mm long, 0.8 wide, pollen yellow. Pistil to 12 mm long. N = 11 (Scora 1967).

Figure 44. Herbarium specimen of *M. punctata*. *Marsh 121* (TEX).

Phenology. Flowering material has been collected from March through November.

Distribution. *M. punctata* has a wide distribution, extending from northern Mexico southern and eastern United States as far north as Canada.

Monarda punctata is probably sister to species in the villous leafed clade(see phylogeny discussion), which, collectively is sister to the remaining species in *Monarda* section *Cheilyctis*. It is distinguished from the that clade by the lack of villous indumentum on the adaxial and abaxial (for M. villicaulis) surfaces of the leaves, except for the midveins and petioles, for which it may have longer hairs.

Monarda punctata exhibits high levels of intraspecific variation. The most notable differences are in vegetative pubescence and leaf size, and, though much of the variation is continuous, most treatments for this species have included intraspecific rankings. Populations with villous hair on the midveins of the adaxial leaf surfaces are treated as *M. punctata* var. *lasiodonta*, and populations where the indumentum is strictly short (0.1 -0.2 mm) appressed hairs (not villous at all) are *M. punctata* var. *intermedia*. The previous two varieties are typically found in eastern and central Texas (former) and central and south central Texas (latter). *Monarda* *punctata* var. *correllii* is comprised of populations in south western Texas that exhibit weakly nervate leaves and more widely deltoid calyx lobes, approaching those of *M. occidentalis*. Populations with narrower (<1.2 cm wide) leaves from south eastern Texas are commonly referred to as *M. punctata* var. *immaculata*.

Representative specimens examined: Mexico. TAMAULIPAS. *Rodriguez 84* (TEX); 10 miles southeast of Nuevo Laredo, U.S.A. ARKANSAS. **Garland**: *Locke 2784* (UARK); access road to Dam #2 on Ark. River, *Demaree 410* (UARK); Hot Springs, *Demaree 15840* (UARK); Hot Springs National Park, Sugar Loaf Mt., *Foreman s.n.* (US); Hot Springs, *Letterman s.n.* (US); Hot Springs, *Scora 1056* (US); 1 M west of Three Frks Walnut Creek on 270 north of Crystall Springs, **Hempstead**: *Palmer 12665* (US); McNab, **Hot Springs**: *Roberts 471* (UARK); SW1/4, Sec. 2, T 5S, R 22W, Point Cedar Quadrangle, **Jefferson**: *Locke 26* (UARK); within 1/4 mi. of 3006 West Orlando Drive in SW Pine Bluff, **Miller**: *Buchhohy 335* (UARK); Texarkana, **Polk**: *Moore 400459* (UARK); vicinity of Grannis; 25 mi. S. of Mena, *Moore 410-213* (UARK); Bog Springs; Whiskey Peak vicinity, *Moore s.n.* (UARK); Big Fork, **Saline**: *Moore 400401* (UARK); Bryant, **Sebastion**: *Bigelow s.n.* (US); Fort Smith, **Union**: *Moore 68341* (UARK); east of El Dorado (Champagnole Rd.), *Thomas 111098* (UARK); beside U.S. 167 south of El Dorado and 3 miles north of Ark. 7 junction; Sec. 10, T18S, R15W, *Thomas 111098* (MSC); along US route 167, 5 km N of AR route 7 junction S of town. Sec. 10, T 18S, R 15W, FLORIDA. **Bay**: *Perkins 479* (FLAS); near shores of St. Andrew Sound on e. end of Rafield Peninsula, just s. of 90 degre turn in road to Field Tech Unit, ca. 12 1/2 mile east of the East Bay Bridge, east end of Tyndall AF Base, S17, T6S, R12W, **Escambia**: *Morgan 7296* (RM); highway 125, 5 miles west of Pensacola, **Indian River**: *D'Arcy 2779* (FLAS); roadside hammock, Cardinal Drive, near Humiston Beach, Vero Beach, **St. Johns**: *Herring 75* (FLAS); T6S, R30E, S32; 2.8 miles north of Villano Beach on west side of SR A1A. Along roadside on secondary dunes, TEXAS, **Aransas**: *Correll 18925* (TEX); in open live-oak woods just south of bridge across Copano Bay, **Atascosa**: *Fryxell 1276* (LL); 2 miles S of Poteet, **Bexar**: *Parks Rx 3132* (TEX); east Bexar county, **Bowie**: *Heller 4173* (US); near Texarkana, **Brazoria**: *Fleetwood 9154* (TEX); Brazoria National Wildlife Refuge, Angleton, **Cameron**: *Rudd 3940* (TEX); east of Rio Hondo, **Chambers**: *Tharp s.n.* (TEX); Patton, **Dimmit**: *Correll 16025* (LL); 13.5 miles west of Carrizo Springs, **Frio**: *Higdon 53-57* (TEX); northern edge of county, *Tharp s.n.* (TEX), **Goliad**: *Albers 46040* (TEX); Ander, **Harris**: *Boon 175* (TEX); 6 miles N of Humble, *Boon 388* (TEX); three miles north of Humble on north side of San Jacinto River, *Traverse 169* (MSC); highway U.S. 59 abou 0.3 miles south of bridge over San Jacinto River, 23 miles north of Houston, east side of highway, **La Salle**: *Ramirez 8*2 (TEX); U.S. hwy. 81, 3 miles south of Cotulla, **McMullen**: *Albers 49035* (TEX); San Miguel River, **Webb**: *Bruni 24* (LL); Farm Road 1472, 15 miles northwest of Laredo, *Garcia 25* (TEX); Laredo Junior College, Laredo, **York**: *Kirkman 5*71 (FLAS); at edge of Patrol Road in old field of Cheatham Annex Naval Supply Center; P.O. Wiliamsburg, WASHINGTONG D.C.: *Steele s.n.* (MSC).

13. Monarda stanfieldii Small, Fl. S.E. U.S. 1038. 1903.

Monarda punctata subsp. *stanfieldii* (Small) Epling, Madroño 3: 25. 1935. *Monarda punctata* var. *stanfieldii* (Small) Cory, Rhodora 38: 407. 1936.--TYPE: U.S.A. Texas: Hayes County, near San Marcos and vicinity, no date, *S.W. Stanfield s.n.* (holotype: NY (digital image)!).

Habit annual, subshrub to 75 cm tall; upright, branching heavily from the middle of stem. Stem indumentum variable; internode with short and long hairs densely packed, node with short hairs, nodal plane with long hairs. Penultimate vegetative internode 18 – 24 mm long, 0.8 - 1.2 mm wide. Leaves 45 - 60 mm long, 15 - 25 mm wide; petiole 2 - 4mm long; serrations 2 mm wide; leaf shape lanceolate to oblanceolate, base attenuate; margins serrate from apex to 25% length of laminar tissue, apex acute to acuminate; petiole indumentum of long hairs; abaxial surface hirsute with medium-long hairs around the midvein; adaxial surface glabrous; margin ciliate toward the base of the leaf; both leaf surfaces green. Basal inflorescence internode 5 - 7 mm long, 0.6 - 0.8 mm wide; glabrous. Lower floral bracts 40 - 75 mm long, 8 - 12 mm wide; sessile; lower bract shape linear to lanceolate, base attenuate, margins entire; apex acuminate; abaxial surface glabrous; adaxial surface glabrous; margin ciliate toward the base of the bract; abaxial surface green, adaxial surface yellow to white. Upper floral bracts 17.5 - 25 mm long, 6 - 11 mm wide; upper bract shape oblanceolate, base cuneate, margins serrated; apex acuminate; abaxial surface glabrous; adaxial surface glabrous; margins glabrous; abaxial surface green; adaxial surface yellow to white. Calyx tube 6.2 - 8.4 mm long, 1.2 - 1.9 mm wide, with minute scattered hairs on outer surface. Calyx lobes 1.2 - 1.6 mm long, 0.3 - 0.5 mm wide, narrowly triangular, with no hairs along the margins. Calyx orifice densely hirsute with stiff white hairs. Lower corolla lip 3.0 - 3.4 mm long, 1.2 - 1.9 mm wide; mid limb up to 2.4 mm long, 0.9 mm wide, not expanding toward the tip; lateral limbs up to 1.4 mm long, 0.8 mm wide. Upper corolla lip 7.0 - 8.0 mm long, 2.8 - 3.6 mm wide, lobes to

0.1 mm long and 0.15 mm wide, corolla yellow with deep maroon pigmentation. Stamens to 15 mm in length, anthers to 1.7 mm long, 1.5 mm wide, pollen yellow. Pistil to 15 mm long. N = 11 (Scora 1967).

Phenology. Flowering material has been collected from May through July.

Disribution. Central Texas in granitic sands.

Monarda stanfieldii is limited in distribution to granitic sandy soils in three counties (Burnet, Llano, and Travis) in central Texas. It is probably most closely related, and morphologically most similar, to *M. humilis* and *M. occidentals* but can be distinguished easily from them *M. stanfieldii*'s yellow flowers and the presence of very densely packed white hairs around the opening (orifice) of the calyx tubes. Though other species of *Monarda* section *Cheilyctis* do have orifice hairs, the hairs of *M. stanfieldii* are so distinctive that the feature is obvious even as seen from a short distance. *Monarda stanfieldii* is found in sympatry with *M. punctata*, but there are no signs of introgression (at least the author has not seen any specimens that appear intermediate to these two species).

Figure 45. Herbarium specimen of *Monarda stanfieldii*. *Lundell 9029* (TEX).

Representative specimens examined. U.S.A. TEXAS. **Burnet**: Inks Dam area: 0.25 mi S of Hwy 29 on 4142. NE side of road., 30.754408, -98.375621, *Sammons s.n.* (MSC); **Llano**: Near Inks Dam, 30.729772, -98.381892, *Lundell 9029* (MICH); Near Inks Dam, 30.729772, -98.381892, *Albers s.n.* (TEX); Sandy banks of Llano river, *Albers, 49070* (CAS); Granite mountain near Llano, *Wolff 3859* (MSC); Granite outcrop on north-west corner of the intersection of U.S. Highway 261 and RM 1431 at Buchanan Dam., 30.761020, -98.460810, *Walters 593* (TAMU); **Travis**: Austin Dam, 30.292920, -97.787504, *Tharp s.n.* (MICH); Lake Austin Dam, 30.292800, -97.787504, *Tharp s.n.* (TEX); Austin, *Tharp s.n.* (MICH); Austin, *Tharp s.n.* (MICH); Austin, *Tharp s.n.* (TEX); Austin Dam, 30.292890, -97.787504, *Albers s.n.* (TEX); Off highway 71, on sand hill bove Perdnales River, 30.389931, -98.085587, *Lundell 15109* (MICH); off highway 71, on sand hill bove Perdnales River, 30.389931, -98.085587, *Lundell 15109* (US); In Zilker Park near Austin, 30.267804, -97.768057, *Barkley 46262* (TEX).

14. Monarda villicaulis *ined., comb nov. M. punctata* var. *villicaulis* (Pennell) Shinners, Field and Lab. 21(2): 90.

1953. *M. punctata* ssp. *villicaulis* Pennell, Bull. Torrey Botan. Club 46: 186. 1919.--TYPE: U.S.A. Indiana: near Clarks, no date, *Pennell 6412* (holotype: NY (digital image)!).

Habit annual or perennial, subshrub to 60 cm tall; upright, branching heavily from the middle of stem. Stem indumentum variable; internode with long villous hairs densely packed, node with long villous hairs, nodal plane with long villous hairs. Penultimate vegetative internode 20 – 45 mm long, 1.2 – 2.2 mm wide. Leaves 45 – 75 (90) mm long, 8 – 18 mm wide; petiole (4.5) 6.5 – 10 (12) mm long; serrations 0.2 mm wide; leaf shape lanceolate to oblanceolate, base attenuate; margins serrate from apex to 15% length of laminar tissue, apex acute to acuminate; petiole indumentum of long hairs; abaxial surface villous throughout; adaxial surface villous; margin ciliate toward the base of the leaf; both leaf surfaces green. Inflorescence internode 5-18 mm long, 0.6-0.8 mm wide; villous. Lower floral bracts 32 - 56 mm long, 4.5 – 8.5 mm wide; sessile; lower bract shape lanceolate, base attenuate, margins entire; apex acuminate; abaxial surface villous; adaxial surface villous; margin ciliate toward the base of the bract; abaxial surface green, adaxial surface green to white. Upper floral bracts 14 – 25 mm long, 5 – 9.5 mm wide; upper bract shape oblanceolate, base cuneate, margins serrated; apex acuminate; abaxial surface villous; adaxial surface villous; margins glabrous; abaxial surface green; adaxial surface green to white. Calyx tube 5.1 – 6.9 mm long, 1.1 - 2 mm wide, with minute scattered hairs on outer surface. Calyx lobes 0.9 - 1.37 mm long, 0.2 - 0.3 mm wide, lanceolate, with minute hairs along the margins. Calyx orifice ciliate with flexible white hairs. Lower corolla lip 4.8 – 7.9 mm long, 2.2 - 3 mm wide; mid limb to 3.3 mm long, 1.3 mm wide, expanding toward the tip; lateral limbs to 1.1 mm long, 0.85 mm wide. Upper corolla lip 6.2 – 8.7 mm long, 2.2 – 4 mm wide, lobes to 0.3 mm long and 0.3 mm wide, corolla yellow in color with violet pigmentation. Stamens to 22 mm in length, anthers 0.8 mm long, 0.2 wide, pollen yellow. Pistil to 21 mm long. N = 12 (Scora 1967).

Phenology. Flowering material has been collected from July through September.

Distribution. Northeastern U.S. extending west as far as Indiana and as far south as Missouri.

Representative specimens examined: U.S.A. INDIANA. **La Porte**: Dingler's Pond, just outside (E) of Michigan City, 41.692120, -86.965038, *Miller 1828* (MO); **Porter**: Indiana Dunes State Park,

Figure 46. Herbarium specimen of *M. villicaulis*. *Hestbeck 10* (MSC).

Miller 542 (MSC); MARYLAND. **Worcester**: Asateague Island; at roadside in sand at bend in road just NW of Northeach parking lots; North Beach; National Seashore, *Hill 15468* (US); MICHIGAN **Allegan**: Between Mt. Baldhead and Lake Michigan near Saugutuck, *Gilly 7172* (MSC); 4 Miles W of Saugatuck, Oval Beach. Secondary Dune., *Hestbeck 10* (MSC); **Barry**: Rutland Twp, sandy slope near Otis Lake, *Churchill s.n.* (MSC); Bull's Prairie, *Drew M264* (MSC); Yankee Springs State Game Area; Sec. 28, R 10 W, T 3 N., Gun Lake Road, opposite ranger station, *Eickwort 68* (MSC); T. 3N., R. 9W., Sec. 31., *Nielsen s.n.* (MSC); **Berrien**: Chikaming Twp. W1/2 NW Sec. 21-T7S-R20W., *Atwood 406* (MSC); **Kalkaska**: T25N R8W Sec. 19, *Ryel L120* (MSC); **Kent**: Cascade Twp., T6N, R10W, Sec. 22; 2 miles south east of Cascade, *Gilly 1078* (MSC); Rogue River State Game Area, Oak Grove, *Hoffman 310* (MSC); Plainsfield Twp. T8N, R11W, sec. 26, *Parmelee 819* (MSC); Hogadane Creek, Grand Rapids, *Shadick s.n.* (MSC); Hogadone Creek, Grand rapids, *Skeels s.n.* (MSC); **Mecosta**: Austin Twp: T14N, R9W, Sec. 13., *Parmelee 1015* (MSC); section 23, Dalton Twsp, *Bourdo 306* (MSC); **Muskegon**: section 23, DaltonTwp, Muskegon (Bourdo Farm), *Bourdo 20042* (MSC); Whitehall, *CP 302* (MSC); near North Muskegon. T. 10N. R. 17W., Sec. 21.; dunes near Coast Guard Station at end of highway 213, *Gillis 5415* (MSC); **Newago**: Big Prairie Desert, *Drew M270* (MSC); **Oceana**: Upper Silver Lake among jack pines, *Bourdo 30340* (MSC); T. 13N., R. 18W., Sec. 6. dunes between Stony Lake and Lake Michigan. Top of Vesper Dune, *Gilis 5889* (MSC); **Ottawa**: T6NR15W, Sec 16, SE-1/4. Lat - 42 deg 54' N on - 86 deg 12' W; campbell site, Field Unit CMP - 12, *Goff 1002* (MSC); **St. Clair**: near Algonac, *Dodge 509* (MSC); **Van Buren**: *Drew M171* (MSC); Keeler, *Pepoon s.n.* (MSC); **Washtenaw**: on Hogback road, *Scora 498* (US).

15. Monarda viridissima Correll, Wrightia 9: 76. 1968.--TYPE: U.S.A. Texas: Bastrop Co., 2 mi E of Bastrop along route 21, 10 September 1968, *D.S. Correll 36368* (holotype: TEX!; isotypes: GH, TEX!, UC, US!).

Habit perennial herb to 60 cm tall; upright, branching from middle and base of stem. Stem indumentum variable; internodes puberulent with minute downward-curled hairs, occasionally with spreading hairs in the upper parts; node with short hairs, nodal plane occasionally with longer hairs. Penultimate vegetative internode 20 – 50 mm long, 0.9 - 2 mm wide. Leaves 25 - 52 mm long, 4 - 7 mm wide; petiole 1 – 5 mm long; serrations 0.3 mm wide; leaf shape linear-lanceolate, base acuminate; margins serrate from apex to 20% length of laminar tissue, apex acute to acuminate; petiole indumentum of long hairs; abaxial surface puberulent with occasional longer hairs around the midvein; adaxial surface puberulent; margin ciliate toward the base; both leaf surfaces green. Basal inflorescence internode 20 – 40 mm long, 0.6 - 0.8 mm wide; puberulent. Lower floral bracts 20 - 45 mm long, 3 - 7 mm wide; sessile; lower bract shape linear-lanceolate, base attenuate, margins serrate, apex acuminate; abaxial surface puberulent; adaxial surface puberulent; margin ciliate toward the base; abaxial surface green, adaxial surface green to purple. Upper floral bracts 13 - 25 mm long, 1.2 – 9 mm wide; upper bract shape lanceolate, base cuneate, margins serrate; apex acuminate to aristate; abaxial surface puberulent; adaxial surface puberulent; margins entire; abaxial surface green; adaxial surface pink to purple. Calyx tube 6.4 – 7.5 mm long, 1.4 – 1.8 mm wide, with minute scattered hairs on outer surface. Calyx lobes 1.1 - 1.6 mm long, 0.3 - 0.5 mm wide, narrowly triangular, rarely ciliate. Calyx orifice with short flexible white hairs. Lower corolla lip 2.6 - 6 mm long, 1.6 - 3 mm wide; mid limb to 3 mm long, 1.8 mm wide, expanding toward the tip; lateral limbs to 1.8 mm long, 1 mm wide. Upper corolla lip 6.5 – 9.8 mm long, 2.7 – 4.2 mm wide, lobes to 0.3 mm long and 0.3 mm wide, corolla white in color with violet pigmentation. Stamens to 24 mm in length, anthers 0.8 mm long, 0.2 wide, pollen yellow. Pistil to 23 mm long. N = 11 (Scora 1967).

Phenology. Flower material has been collected from June through November.

Distribution. Central south Texas in sandy oak woods and roadsides.

M. viridissima is in the narrow leaf clade (see phylogeny) and is most closely related (and most morphological similar) to *M. fruticulosa*, *M. maritima*, and *Monarda n. sp.* 2. It has longer and more linear-shaped leaves than *Monarda n. sp.* 2, and is distinguished from *M. fruticulosa* and *M. maritima* by the presence of short spreading hairs at right angles to the stem instead of appressed silvery hairs in the former and spreading pilose hairs in the latter. It also lacks maroon spots on the lower corolla lip.

Figure 47. Herbarium specimen of *M. viridissima*. *Correll 19593* (GH).

Representative specimens examined: U.S.A. TEXAS. **Bastrop**: *Albers 45062* (TEX); near McDade, *Albers 46363* (TEX); along highway east of Elgin, *Albers 45-130* (TEX); in woods about 2 miles east of Elgin, *Correll 19593* (GH); 2 miles east of Elgin in sandy oak woods, *Correll 19593* (TEX); in sandy oak woods near Bastrop, *Correll 20400* (TEX); Pine hills east of Edward's saw mill, *Duval s.n.* (TEX); near the Pleistocene Gravel overlay at the edge of the Lost Pines, *Rodgers 46529* (MSC); near Paige in sand east of Edwards' Sawmill in Pine Hills, *Small 223* (TEX); adjacent highway 290 near McDade, *Sperry s.n.* (TAMU); in deep sand of the Carrizo in open woods near the Pleistocene Gravel overlay at the edge of the Lost Pines, *Tharp 46529* (TEX); **Caldwell**: *McBryde s.n.* (TEX); east of McMahon, *Tharp 52-532* (TEX); **Gonzales**: Waelder, *Hopkins s.n.* (US); Waelder, *Hopkins s.n.* (US); Palmetto State Park, *Tharp s.n.* (TEX); **Hays**: woods between Colorado and San Marcos, *Wright 108* (US); **Lavaca**: E of Hallettsville on FM 3283 (County road 124) between Vienna and Subline (ca. 5 miles N of Vienna), *Fryxell 4965* (MSC, TEX); **Milam**: ca. 2 mi N. Gause, open sandy area SE Sugarloaf, W. Long Mt. above Beaver Branch, *Dubrule 1399* (TAMU); 3 miles north and west of Milano, *Wolff 4843* (MSC); **Washington**: *Albers 46127* (TEX); **Wilson**: Sutherland Springs, *Parks 3135* (TEX); Lavernia, *Parks 27802* (TEX).

16. Monarda n. sp. 2, *sp. nov.*--TYPE: U.S.A. Florida: Columbia County, Four and 0.5 miles NW of Fort White off of U.S. 27 in Ichetucknee Springs State Park, 10 August 1991, *Herring 349* (holotype: FLAS!).

Habit perennial, herb to 80 cm tall; upright, branching heavily from the middle of stem. Stem indumentum variable; internodes puberulent with minute downward-curled hairs and spreading longer hairs; node with short hairs, nodal plane with long hairs. Penultimate vegetative internode 27 – 65 mm long, 0.8 - 1.2 mm wide. Leaves 22 - 34 mm long, 5 - 7 mm wide; petiole 3 – 7 mm long; serrations 0.3 mm wide; leaf shape ovate, base acuminate; margins serrate from apex to 10% length of laminar tissue, apex acute; petiole indumentum of long hairs; abaxial surface hirsute with medium-long hairs around the midvein; adaxial surface glabrous; margin ciliate toward the base; both leaf surfaces green. Basal inflorescence internode 15 – 25 mm long, 0.6 - 0.8 mm wide; puberulent with occasional spreading longer hairs. Lower floral bracts 13 - 30 mm long, 3 - 5 mm wide; sessile; lower bract shape ovate to lanceolate, base attenuate, margins serrate; apex acute; abaxial surface hirsute with medium-long hairs around midvein; adaxial surface glabrous; margin ciliate toward the base; abaxial surface green, adaxial surface green to pink. Upper floral bracts 13 – 18 mm long, 3.8 - 4.8 mm wide; upper bract shape elliptic, base cuneate, margins serrate; apex acute; abaxial surface glabrous; adaxial surface glabrous; margins entire; abaxial surface green; adaxial surface purple. Calyx tube 4.5 – 5 mm long, 1.5 – 1.8 mm wide, with minute scattered hairs on outer surface. Calyx lobes 0.9 – 1.3 mm long, 0.2 – 0.4 mm wide, narrowly triangular, with ciliate margins. Calyx orifice hirsute with flexible white hairs. Lower corolla lip 4.8 - 6 mm long, 2.0 – 2.5 mm wide; mid limb to 2.1 mm long, 0.9 mm wide, expanding toward the tip; lateral limbs to 1.2 mm long, 0.7 mm wide. Upper corolla lip 6.8 – 8.2 mm long, 3.1 – 4.1 mm wide, lobes to 2.6 mm long and 0.31 mm wide, corolla cream to yellow with purple pigmentation. Stamens to 28 mm in length, anthers 0.8 mm long, 0.5 mm wide, pollen yellow. Pistil to 28 mm long.

Phenology. Flowering material has been collected from August through October.

Distribution. Eastern U.S. from Florida to South Carolina.

Monarda n. sp. 2 belongs to the narrow-leafed clade and is morphologically most similar to the widespread species, *M. punctata*. It can be distinguished from other species in the section by its smaller leaves (largest are <3 cm long and 1 cm wide) and narrow stems lending it a spindly stature. It has serrulate upper bracts which are pink to purple in color and pale yellow flowers. Deep maroon spots are present only on the lower corolla lip.

Figure 48. Herbarium specimen of *Monarda n. sp. 2*. *Herring 349* (FLAS).

Representative specimens examined: U.S.A. FLORIDA. **Citrus**: along Fla. 490A, Homosasa Springs, *Genelle* 1621 (FLAS); **Columbia**: T6S, R15E, S13 four and 0.5 miles NW of Fort White of of US 27 in Ichetucknee Springs State Park. Ca. 0.9 mile NE of South Enrance on SE side of tram road in NE portion of section 1D, *Herring 349* (FLAS); **Hernando**: along FL 476 just w. of the Withlacoochee River, Nobleton, *Baltzell* 1314 (FLAS); along FL 46 near Hernando-Sumter County Line at Nobleton, *Baltzell 5424* (FLAS); **McIntosh**: near south end of Sapelo Island, *Dunun 20462* (US); **St. John's**: Fruit Cove Rd., 2 mi. s. of Julington Creek, *D'Arcy* 1244 (FLAS); SOUTH CAROLINA. **Horry**: Savanah, 3.8 mi S. of Socaste (3 mi. S. of jct. of 544 & 707 on 544 & 8 mi. E on unnumbered dirt road), *Massey 3387* (NCU).

CHAPTER 4

OVERVIEW OF ONLINE MONOGRAPH

Online Monograph

To supplement the growing collection of online resources that expedite plant systematics research such as Index Herbariorum (The New York Botanical Garden 2007), IPNI (The International Plant Names Index 2004), or web-accessible herbaria, a number of other online resources have been developed. Among these are online floras such as eFloras (Brach and Song 2006), The Atlas of Florida Vascular Plants (Wunderlin and Hansen 2008), South Carolina Plant Atlas (Mouseau 2009) and other, more taxon-specific resources such as the Tall Fescue monograph (Aiken, Alderan et al. 2003). Furthermore, large websites, such as Encyclopedia of Life (Wilson 2003) and Discover Life (The Polistes Corporation 2011) are being developed to host such resources.

Keeping with this trend, in addition to the traditional monograph presented above, I have also developed content to be hosted by Discover Life (www.discoverlife.org), a website created to document and track natural history, particularly for species in the U.S. It has a large partnership base that includes institutions such as the Academy of Natural Sciences, California Academy of Sciences, the Field Museum of Natural History, Missouri Botanical Garden, Smithsonian Institution, USGS, and the US National Park Service as well as numerous universities and their herbaria. This component of the work will represent an attempt to combine modern modes of information distribution with traditional botanical monography. The online representation of the paper monograph will contain similar content to its printed counterpart, but will be constructed to provide quick access to features in which the user may be interested. It will also provide services unavailable to a print-bound publication and allow future expansion of the monograph to keep the work current and growing. Below I discuss some of these and how the online monograph will improve information access for the reader.

Introductory page(s)

This contains a formal introduction to *Monarda* subgenus *Cheilyctis* as well as an introduction to the use of the website. It also functions as a "table of contents" whereby it provides links to the remaining chapters and services. It functions as the site hub for readers who are interested in working through the monograph in a traditional manner or for the readers that want to navigate elsewhere based on their specific interests.

Data

As there are abundant amounts of morphological data presented in the monograph, the online monograph organizes these into accessible linked pages where appropriate in the literature. Raw data as well as matrices are made available.

For the online monograph I will contribute:

- CSV file of morphometric data
- CSV file of phylogenetic data
- Paup file of character-coded phylogenetic data matrix

Specimen Database

A feature of considerable utility is the database of *Monarda* subspecies *Cheilyctis* specimens used in writing the monograph. From here readers are able to query any information commonly found on herbarium specimen labels, from collection records to phenological patterns. The database will be a work in progress so that with additional collections, the database will continue to expand and display the most current distribution information available. These data are assimilated into the mapping features of Discover Life (see below).

For the online monograph I will contribute:

- 27 records of *M. austromontana ined*
- 28 records of *M. citriodora*
- 30 records of *M. clinopodioides*
- 30 records of *M. fruticulosa*
- 15 records of *M. humilis*
- 20 records of *M. maritima*
- 25 records of *M. occidentalis ined*
- 28 records of *M. pectinata*
- 105 records of *M. punctata*
- 20 records of *M. stanfieldii*
- 30 records of *M. villicaulis ined*
- 25 records of *M. viridissima*
- 2 records of Monarda n. sp. 1
- 7 records of Monarda n. sp. 2

Habitat information

Whereas the cost of including abundant images, diagrams, maps, and informal notes on habitats keep them all too infrequent in printed journals, the online framework delivers admission to more content of this type which authors may conservatively exclude from their publications. The online monograph provides additional images of habitats and associated species where available. In addition, it includes notes that are used to broadly characterize the habitats of select taxa. These notes have utility in that they may offer insights into future avenues of research, but are not robust enough for inferring or making deterministic conclusions about how the taxa interact with or have been influenced by their environments. These habitat characterizations include notes on meteorological averages, species compositions, and floral visitor observations collected during standardized field observations made by the author.

For the online monograph I will contribute photographic images of live specimens of:

- M. austromontana ined
- M. citriora (with supplementary habitat image)
- M. clinopodioides (with supplementary habitat image)
- M. fruticulosa (with supplementary habitat image)
- M. maritima (with supplementary habitat image)
- M. occidentalis ined (with supplementary habitat image)
- M. pectinata
- M. punctata (with supplementary habitat image)
- M. stanfieldii (with supplementary habitat image)
- M. villicaulis ined (with supplementary habitat image)

- M. viridissima (with supplementary habitat image)

Habitat characterizations of:

- M. citriodora
- M. clinopodioides
- M. occidentalis
- M. stanfieldii
- M. villicaulis
- M. viridissima

Interactive range mapping

The online monograph presents a cost effective method of disseminating more habitat images, but it also provides zoomable range maps, a resource that is entirely unavailable in a printed monograph. The data for the maps are supplied from georeferenced herbarium specimens and each mapped location links to the label information of that particular specimen collection point. Specimens were georeferenced using the GEOLocate (Rios and Bart 2010) desktop application. For this process, herbarium locality information (including details such as street intersections and natural landmarks such as lakes and rivers) that is input into the client is used to generate GPS coordinates and polygonal error descriptions. Another valuable feature is that the mapping software used by Discover Life can pool additional locality information from other data sources and add it to the growing database of distribution information for these taxa. Examples of other sources are other herbaria contributing to the website and other biologists that take gps-linked photographs in the field.

For the online monograph I will contribute georeferenced data (including estimate of error) for the specimens listed in "Specimen Database" section above.

Interactive keys

The online monograph provides the traditional published keys in an easily printable format as well as access to an interactive key system which increases the ease of identification to persons not familiar with the keying process as well as for those attempting identification with limited plant material. Interactive keys are increasingly commonplace (Watson and Dalwitz 1992; Sanders and Lee 2003; Weiblen and Deacon 2003), and with the free distribution of Delta system (Description Language for Taxonomy) software, they are becoming easy to construct (Dallwitz 2005; Askevold O'Brien, C). The Delta system is a suite of programs that were designed to aid taxonomic investigation and publication by manipulating large data sets and having a computer present the information in a useful context. Among many of its uses is its ability to facilitate the construction of interactive keys.

Instead of relying on only one or a few traits at a time, interactive keys are designed to start with any number of morphological characters which are presented to (and may be recognized by) the user. The choices are usually accompanied by diagrams or images that clearly illustrate the character states. The user simply selects any of the character states presented which match their specimen of interest and species not matching those traits are eliminated from the pool of possibilities. In this way, taxa may be narrowed down until the point at which identification is reached. The user can focus on the traits that are easier to recognize in the beginning and rely on the difficult traits only if necessary. Also, if there is a trait that is unique to the species, and the user identifies it first, then the identification will be complete in only one step, a vast improvement over the traditional, and often lengthy dichotomous keys which require the user to make decisions based on traits in the order determined by the author. At the end of each species "trail" the reader will be able to directly view the species description, specimen images, images of living plants, specimen data, locality data, and range maps.

For the online monograph I will contribute:

- list of plant character states that uniquely identify Monarda subgenus Cheilyctis from all other plant species
- images of above-mentioned character states that the user can recognize when observing a specimen of Monarda subgenus Cheilyctis
- list of plant character states that uniquely identify each species of Monarda subgenus Cheilyctis
- images of above-mentioned character states that the user can recognize when observing a specimen of one of the species of Monarda subgenus Cheilyctis
- data matrix of character state values of all species in Monarda subgenus Cheilyctis for all previously mentioned characters.

These items will be incorporated into the database Discover Life uses for their interactive key project.

APPENDICES

APPENDIX A

Morphometric data for *Monarda* section *Cheilyctis*. Character numbers correspond to those presented in the Materials and Methods section

Table 3. Morphometric data for Monarda Section Cheilycits

				1	2	3
ark76	*Thomas*	*111098*	MSC	7.5	1.2	8.62
ark77	*Moore*	*s.n.*	UARK	6.1	2.2	10.3
ark81	*Thomas*	*111098*	UARK	6.25	2.2	9.6
ark83	*Locke*	*2784*	UARK	2.5	3.2	4.6
ark84	*Moore*	*400459*	UARK	7.6	2.5	5.9
ark85	*Scora*	*1056*	US	3.5	2	5.6
ark287	*Moore*	*68341*	UARK	2.9	2.8	5.2
ark288	*Roberts*	*471*	UARK	5.5	2.2	6.4
ark289	*Bigelow*	*s.n.*	US	6	2	8.2
ark290	*Palmer*	*12665*	US	5.2	1.4	6.5
ark291	*Locke*	*26*	UARK	5.5	1.8	6.8
ark408	*Moore*	*410-213*	UARK	5.7	1.2	5.98
ark409	*Buchhohy*	*335*	UARK	2.1	1.8	4.8
ark410	*Demaree*	*410*	UARK	5.1	2.1	7.1
ark411	*Moore*	*400401*	UARK	4.6	1.8	6.3
ark413	*Foreman*	*s.n.*	US	6.4	2.1	6.6
ark414	*Letterman*	*s.n.*	US	7	2.8	7.5
ark415	*Demaree*	*15840*	UARK	5.78	1.9	7.2
corr460	*Fryxell*	*1276*	LL	6.7	1.9	9
corr461	*Parks*	*Rx 3132*	TEX	5.2	1.8	5.2
corr462	*Garcia*	*25*	TEX	5.2	2.2	5.6
corr463	*Bruni*	*24*	LL	4.1	2.1	4.2
corr464	*Higdon*	*53-57*	TEX	3.4	1.5	5.8
corr465	*Tharp*	*s.n.*	TEX	3.1	1.1	3.2
corr466	*Albers*	*46040*	TEX	4.2	1.6	4.1
corr468	*Albers*	*49035*	TEX	5.9	1.9	5.7
corr470	*Correll*	*16025*	LL	4.9	2.1	7.5
corr471	*Ramirez*	*82*	TEX	6.5	1.5	7.85
Frut236	*Runyon*	*3991*	RM	1.69	1.2	2.5

Table 3 (Cont'd)

Frut237	*Gamboa*	*158*	TEX	2.9	1	2.5
Frut238	*Scora*	*2224*	US	2.9	2.9	4.3
Frut239	*Scora*	*2223*	US	3.3	1.9	4.2
Frut240	*Lundell*	*12792*	TEX	4.7	1.5	3.6
Frut241	*Runyon*	*3991*	TEX	4.1	1.8	3.8
Frut242	*Runyon*	*4333*	TEX	2.9	1	2.8
Frut243	*Dubrule*	*804*	TAMU	1.35	1	3.6
Frut244	*Lundell*	*12796*	US	1.9	0.8	1.6
Frut245	*Fisher*	*41125*	US	2.1	0.9	1.9
Frut260	*Correll*	*26913*	LL	1.28	1	1.6
Frut261	*Runyon*	*4333*	US	3.1	2	4.1
Frut262	*Pringle*		US	2.4	0.8	2.5
Frut263	*Shiller*	*178*	US	3.1	1.8	4.1
Frut264	*Tharp*	*42-40*	TEX	3.2	1.2	1.8
Frut46	*Carr*	*13206*	TEX	1.9	0.9	1.4
Frut47	*Lundell*	*8850*	TEX	2.3	0.8	3.7
Frut48	*O'Brian*	*1163*	RM	6.1	1.8	4.4
Frut49	*Garcia*	*110*	TEX	2.5	0.9	3.74
Frut50	*Garcia*	*110*	TEX	4.2	1.1	3.9
Frut51	*Santiago*	*7785*	TEX	1.5	1.1	1.85
Frut52	*Corell*	*35452*	GH	1.7	1	2.4
Frut53	*Correll*	*35452*	LL	1.25	0.6	1.5
Frut54	*Runyon*	*3991*	US	2.9	1.2	3.75
Frut55	*Fisher*	*41125*	RM	2.8	1.2	3.1
Frut56	*Johnston*	*541835*	TEX	1.3	1.1	1.8
Frut57	*Runyon*	*2628*	TEX	1.9	1.1	2.6
Frut58	*Muller*	*8053*	TEX	2.9	1.1	1.9
Frut59	*Salinas*	*180*	TEX	4.8	1.7	4.4
Frut60	*Johnston*	*53254.2*	TEX	3.9	1.2	3.3

Table 3 (Cont'd)

Hum16	*Wooton*	*s.n.*	US	1.55	1.8	2.8
Hum17	*Wooton*	*s.n.*	US	5.15	2.2	2.9
Hum18	*Wooton*	*s.n.*	US	3.9	1.6	2.8
Hum19	*Tafoya*	*131*	UNM	3.7	1.2	3.4
Hum20	*Pase*	*3621*	NMC	2.9	1.9	3.8
Hum21	*Abbott*	*s.n.*	UNM	4	1.1	3.1
Hum22	*Pase*	*3566*	NMC	4.2	1.3	3
Hum23	*Goodrow*	*522*	UNM	1.6	1.8	2.5
Hum24	*DeBruin*	*448*	UNM	3.5	1.8	4.1
Hum25	*McIntosh*	*1006*	UNM	2.9	1.2	3
Hum26	*Wooton*	*s.n.*	NMC	4.8	2.1	4.8
Hum27	*Wooton*	*s.n.*	NMC	5.4	1.6	3.1
Hum28	*Higgins*	*7737*	NMC	2.5	1.6	3.4
Hum29	*Carlson*	*SC4*	UNM	3.7	0.9	2.55
Hum30	*Brandt*	*1094*	UNM	3.5	1.8	3.72
Hum31	*Wooton*	*s.n.*	US	1.6	1.2	2.2
inter106	*Correll*	*19009*	TEX	8.4	3.1	7.5
inter107	*Lundell*	*14028*	TEX	6.1	2.9	9.3
inter108	*Warnock*	*46402*	TEX	5.4	2.8	6.2
inter110	*Turner*	*95-179*	TEX	4.5	2.2	6.3
inter111	*Lundell*	*9454*		3.4	2.2	5.5
inter112	*Tyler*	*s.n.*	TEX	4.5	2.1	4.2
inter113	*Carr*	*13889*	TEX	7.5	2.4	5.1
inter116	*Gentry*	*51-1784*	TEX	5.4	2.5	8.1
inter118	*Shinners*	*28599*	TEX	4.2	3.5	6.5
inter119	*Turner*	*94-92*	TEX	7.1	3.4	6.8
inter120	*Ruth*	*978*	MSC	6	2.1	7.55
inter225	*Scora*	*2011*	US	6.4	2.6	6.4
inter226	*Orzell*	*10573*	TEX	3.4	1.8	5.4

Table 3 (Cont'd)

				1	2	3
lasio250	*Orzell*	*11227*	TEX	4.8	2.7	5.8
lasio251	*Croat*	*3853*	MO	6.2	2.8	6.5
lasio252	*Orzell*	*11189*	TEX	5.1	1	4.1
lasio253	*Correll*	*16731*	TEX	4.8	3.2	8.6
lasio254	*Orzell*	*11363*	TEX	4.5	2.4	3.58
lasio255	*Crockett*	*790*	TEX	6.2	3.5	8.5
lasio256	*Orzell*	*10327*	TEX	2.9	1.3	4.6
lasio257	*Albers*	*s.n.*	TEX	4.3	1.8	4.8
lasio258	*Williges*	*413*	TEX	9.5	2.4	6.75
lasio259	*Carr*	*18327*	TEX	5	2.7	5.4
lasio292	*Albers*	*46097*	TEX	5.4	2.1	4.8
lasio293	*Tharp*	*s.n.*	TEX	8.2	3.2	6.2
lasio294	*Strother*	*175*	TEX	5.8	2.2	3.8
lasio295	*Cory*	*5799*	MSC	5.8	2.5	6.15
lasio296	*Runyon*	*4322*	US	4.5	2.4	5.25
lasio61	*Thomas*	*129407*	MO	4.9	1.8	5.7
lasio62	*Nixon*	*17314*	TAMU	5	1.1	4.5
lasio63	*Correll*	*20809*	TEX	5.1	3.8	7.9
lasio64	*Orzell*	*10947*	TEX	5.2	1.1	4.7
lasio65	*Scora*	*2219-i*	TEX	12.8	2.9	7.15
lasio66	*Saenz*	*83*	TEX	7.65	2.8	6.05
lasio67	*Marsh*	*121*	TEX	4.9	1.1	3.75
lasio68	*Scora*	*2133*	TEX	5.3	1.8	4.6
lasio69	*Scora*	*2133*	US	8.5	3.5	10.9
lasio70	*Charette*	*815*	TEX	5.9	2.8	6.2
lasio71	*Orzell*	*10388*	TEX	5	2.8	5.1
lasio72	*Lundell*	*12782*	TEX	6.1	2.4	6.3
lasio73	*Johnston*	*54566*	TEX	2.2	3.9	4.25
lasio74	*Folsom*	*10317*	TEX	8.7	4.5	6.1

Table 3 (Cont’d)

				1	2	3
lasio75	*Correll*	*26370*	TEX	5.35	1.8	4.7
Marit121	*Scora*	*2170*	TEX	2.3	1.2	4.5
Marit122	*Johnston*	*53254.2*	TEX	1.8	1.8	2.8
Marit123	*Scora*	*2170*	US	2.8	1.8	4.05
Marit124	*Johnston*	*53254.2*	TEX	2.25	1.8	3.5
Marit125	*Johnston*	*53254.2*	TEX	2.3	1.8	2.95
Marit126	*Palmer*	*1081*	US	2.8	2	4.05
Marit126	*Palmer*	*1081*	US	1.8	2.2	4.05
Marit127	*Johnston*	*53254.3*	TEX	2.7	2.2	4.6
Marit128	*Palmer*	*1081*	US	2.5	2.8	4.2
Marit129	*Churchill*	*90-930*	MSC	3.1	1.8	4.6
Marit130	*Johnston*	*53254.2*	RM	2.3	1.8	2.9
Marit131	*Tharp*	*1553*	US	2.3	2.4	3.2
Marit132	*Tharp*	*5553*	US	1.45	0.9	4.2
Marit133	*Scora*	*2170*	GH	2.9	2.4	3.6
occ1	*Vogt*	*7*	ARIZ	3.9	1.35	3.4
occ10	*Goodman*	*8379*	OKL	3.6	1.9	6.1
occ11	*Nighswonger*	*3270*	OKL	3.8	1.8	4.1
occ12	*Waterfall*	*14926*	US	2.7	2.9	5.1
occ13	*Warnock*	*7878*	LL	1.2	2.1	4.4
occ14	*Scudday*	*s.n.*	LL	5.5	1.2	5.7
occ15	*Correll*	*33017*	LL	6	2.1	4.6
occ2	*Carletan*	*183*	MSC	4.2	2.05	3.85
occ3	*Drake*	*108*	TEX	3.9	2.5	4.4
occ309	*Folley*	*Nr. 580*	OKL	4.5	1.3	5.6
occ310	*Correll*	*16859*	TEX	2.1	2.1	4.2
occ311	*Bellah*	*76*	OKL	4.2	2	4.8
occ312	*Nighswonger*	*1925*	OKL	3.6	1.8	4.1
occ313	*Wagner*	*3615*	MO	3.1	1.8	3.5

Table 3 (Cont'd)

				1	2	3
occ314	*Cory*	*51996*	US	3.8	2.2	3.8
occ315	*Palmer*	*14116*	US	4.1	2	4.2
occ316	*Reed*	*3437*	US	4.4	2.8	5.4
occ317	*Barclay*	*851*	US	4.4	1.75	4.6
occ318	*Henderson*	*63-834*	TEX	3.1	1.8	4
occ4	*Warnock*	*15444*	LL	2.6	1.8	4.2
occ5	*Stuessy*	*157*	TEX	4.9	3.05	4.3
occ6	*Springer*	*374*	OKL	3.55	1.8	3.95
occ7	*Goodman*	*8090*	OKL	4.6	2	5.2
occ8	*McCarthy*	*ALT0280*	OKL	5	1.9	4.6
occ9	*Laverty*	*7343*	OKL	2.25	2.5	3.9
punc151	*Boon*	*175*	TEX	5.5	1.8	7.4
punc152	*Correll*	*18925*	TEX	6.8	2.1	6.2
punc154	*Massey*	*3387*	NCU	3.3	1.2	3.2
punc155	*Dunun*	*20462*	US	6.5	1.2	3.4
punc158	*Nelson*	*685*	FLAS	5.4	1.5	7.1
punc159	*Nelson*	*4243*	NCU	2.6	2.2	6.9
punc160	*Bozeman*	*11643*	NCU	6.8	2.1	7.2
punc161	*Steele*	*s.n.*	MSC	4.8	1.8	6.8
punc163	*Rudd*	*3940*	TEX	5.4	1.8	4.6
punc164	*Boon*	*388*	TEX	5.6	1.2	6.4
punc165	*Fleetwood*	*9154*	TEX	5.4	0.8	7.4
punc246	*Credle*	*2597*	NCU	5.3	2.4	8.3
punc247	*Traverse*	*169*	MSC	8.2	2.1	6.1
punc248	*Kirkman*	*571*	FLAS	5.1	1.6	7
punc249	*Tharp*	*s.n.*	TEX	6.5	2.1	7
punc301	*Genelle*	*1621*	FLAS	3.1	0.9	3.1
punc302	*Baltzell*	*5424*	FLAS	3.3	1.2	3.2
punc303	*Baltzell*	*1314*	FLAS	3.2	1.2	2.9

Table 3 (Cont'd)

				1	2	3
punc304	*D'Arcy*	*1244*	FLAS	2.9	0.8	2.7
punc305	*Herring*	*349*	FLAS	2.7	1.1	2.2
Stan271	*Tharp*	*s.n.*	TEX	6.2	1.6	4.6
Stan272	*Tharp*	*s.n.*	MICH	5.5	1.8	4.8
Stan273	*Wolff*	*3859*	MSC	7	2.4	5.3
Stan274	*Lundell*	*9029*	MICH	7.5	2.2	7.3
Stan275	*Albers,*	*49070*	CAS	6.8	2.4	5.2
Stan276	*Sammons*	*s.n.*	MSC	7.2	2.5	5.8
Stan91	*Albers*	*s.n.*	TEX	5	2	6.9
Stan92	*Tharp*	*s.n.*	TEX	7	2.2	6.2
Stan93	*Tharp*	*s.n.*	MICH	10.3	1.8	5.9
Stan94	*Tharp*	*s.n.*	MICH	7.9	1.8	4.6
Stan95	*Lundell*	*15109*	MICH	5.7	1.8	4.4
Stan96	*Walters*	*593*	TAMU	8.1	1.9	4.8
Stan97	*Barkley*	*46262*	TEX	6.8	3.2	10.5
Stan98	*Albers*	*s.n.*	TEX	7.2	2.9	3.8
Stan99	*Lundell*	*15109*	US	7.9	1.5	6.6
vill156	*Miller*	*542*	MSC	3.4	1.5	6
vill157	*Miller*	*1828*	MO	6.7	2	7.5
vill162	*Hill*	*15468*	US	6.5	2	7.6
vill207	*Atwood*	*406*	MSC	4.1	1.7	4.5
vill208	*Goff*	*1002*	MSC	3.6	2.1	5.2
vill209	*Drew*	*M171*	MSC	3.3	2	4.8
vill210	*Parmelee*	*819*	MSC	2.2	1.8	5.3
vill211	*Drew*	*M264*	MSC	3.7	2.2	5.8
vill212	*Drew*	*M270*	MSC	4.2	1.2	5.5
vill213	*Churchill*	*s.n.*	MSC	4	1.8	5.7
vill214	*Gilis*	*5889*	MSC	3.8	1.2	5.8
vill215	*Eickwort*	*68*	MSC	3.7	1.5	4.8

Table 3 (Cont'd)

				1	2	3
vill216	*Dodge*	*509*	MSC	4	2.1	8.4
vill217	*Bourdo*	*306*	MSC	3.5	1.6	7.1
vill218	*Gilly*	*1078*	MSC	4.2	1.7	6.8
vill31	*Hoffman*	*310*	MSC	4.3	1.2	5.4
vill32	*Hestbeck*	*10*	MSC	3.65	2.1	6.2
vill33	*Parmelee*	*1015*	MSC	2.1	1.9	5.2
vill34	*Shadick*	*s.n.*	MSC	3.2	1.9	5.1
vill35	*Nielsen*	*s.n.*	MSC	3.85	2.2	5.3
vill36	*Scora*	*498*	US	3.5	1.8	4.6
vill37	*Bourdo*	*20042*	MSC	3.4	1.8	5.7
vill39	*Skeels*	*s.n.*	MSC	3.5	2	6.1
vill40	*Gilly*	*7172*	MSC	3.75	1.8	5.5
vill41	*CP*	*302*	MSC	3.6	1.7	7
vill42	*Pepoon*	*s.n.*	MSC	4.2	1.9	8.6
vill43	*Gillis*	*5415*	MSC	3.8	1.8	4.7
vill44	*Bourdo*	*30340*	MSC	3.75	2.2	5.9
vill45	*Ryel*	*L120*	MSC	3.6	1.7	5.9
Virid136	*Albers*	*40021*	TEX	2.2	1.9	3.1
Virid137	*Tharp*	*46529*	TEX	2.5	1.9	5
Virid138	*Correll*	*19593*	TEX	3.15	1.8	3.9
Virid139	*Correll*	*20400*	TEX	2	1.2	2.5
Virid140	*Duval*	*s.n.*	TEX	2.3	1.8	3.59
Virid141	*Albers*	*45-130*	TEX	2.45	0.9	2.92
Virid142	*Correll*	*19593*	GH	2.5	1.2	5
Virid143	*Tharp*	*52-532*	TEX	4.9	1.3	4.45
Virid144	*Hopkins*	*s.n.*	US	2.4	1.9	3.24
Virid145	*Dubrule*	*1399*	TAMU	2.45	0.9	3.12
Virid146	*Fryxell*	*4965*	TEX	2.4	1.2	4.1
Virid147	*Fryxell*	*4965*	MSC	2.6	1.8	5.2

Table 3 (Cont'd)

				1	2	3
Virid148	*Parks*	*3135*	TEX	2.3	1.5	3.7
Virid149	*Albers*	*45062*	TEX	2.45	1	3.1
Virid150	*McBryde*	*s.n.*	TEX	2.5	1.2	4.85
Virid219	*Parks*	*27802*	TEX	2.4	1.6	3.2
Virid220	*Wright*	*108*	US	2.5	1.7	4.6
Virid221	*Hopkins*	*s.n.*	US	2.3	1.2	3.8
Virid222	*Sperry*	*s.n.*	TAMU	2.52	1.1	3.2
Virid223	*Wolff*	*4843*	MSC	2.35	1.6	3.5
Virid282	*Albers*	*46363*	TEX	4.2	1.2	4.12
Virid283	*Rodgers*	*46529*	MSC	2.7	1.4	4.9
Virid284	*Small*	*223*	TEX	2.56	1.2	3.82
Virid285	*Albers*	*46127*	TEX	2.27	1.5	3.5
Virid286	*Tharp*	*s.n.*	TEX	2.2	1.4	2.8

Table 3 (Cont'd)

	4	5	6	7	8	9	10	11
ark76	1.12	3.45	16.5	4.9	4.95	0.85	6.97	1
ark77	1.4	4.8	24	6.3	5.6	0.4	7.9	3
ark81	1.6	4.4	18	5.8	3.8	0.5	7.8	4
ark83	0.75	1.8	4	2.85	2.45	0.15	4.2	7
ark84	0.9	1.8	6	3.4	2.2	0.3	5.3	4
ark85	1.08	1.6	6	4.1	5.8	0.2	5	2
ark287	0.82	1.6	13	2.75	2.4	0.18	3.9	4
ark288	1.2	3	16	3.4	3.2	0.38	4.8	3
ark289	1.4	4.2	15	3.8	3.4	0.4	6.7	2
ark290	0.94	3.2	12	3.2	2.1	0.3	5.3	3
ark291	0.9	2.8	15	2.4	2.65	0.2	5.3	4
ark408	0.92	1.7	7	2.7	2.9	0.2	5.28	2
ark409	1.05	1.3	7.8	2.6	2.8	0.3	4.02	4
ark410	1.1	2.5	14	4.6	3.5	0.24	5.7	6
ark411	1.3	2.2	11	3.1	3.2	0.2	5.2	2
ark413	1.3	2.3	13	3.4	3.5	0.25	5.3	4
ark414	1.1	2.9	12	5.1	2.1	0.5	6.3	3
ark415	1.3	2.7	12.4	4.6	5.15	0.29	5.96	1
corr460	1.9	3.9	17	5.1	7.1	1.1	7.3	3
corr461	0.7	2.1	10	2.7	4.1	0.3	4.2	2
corr462	0.8	2.8	9	3.5	5.2	0.42	4.7	2
corr463	0.71	2.7	7	2.3	3.2	0.46	3.5	4
corr464	0.84	3.2	13	3.1	6.1	0.9	4.5	3
corr465	0.49	1.6	5.1	1.9	2.1	0.2	2.69	4
corr466	0.8	2.6	9.8	2.4	3.2	0.46	3.12	2
corr468	0.8	2.7	12	2.9	2.6	0.46	4.5	3
corr470	1.2	4.7	19	3.7	4.8	0.65	5.6	3
corr471	0.9	2.7	13	4.8	3.8	0.45	6.55	1
Frut236	0.2	0.85	0.2	0.69	3.3	0.15	2.48	5

Table 3 (Cont'd)

	4	5	6	7	8	9	10	11
Frut237	0.2	1.7	0.23	0.75	2	0.15	2.477	5
Frut238	0.3	2.2	0.2	2.1	2.65	0.25	4.28	6
Frut239	0.22	2.6	0.1	1.4	2.2	0.2	4.19	3
Frut240	0.36	1.8	0.1	1.1	5	0.2	3.59	3
Frut241	0.19	1.8	0.2	1.1	2.2	0.2	3.78	6
Frut242	0.11	1.6	0.18	1.2	2.05	0.2	2.782	4
Frut243	0.91	3	0.18	1.2	2.05	0.2	3.582	2
Frut244	0.21	0.1	0.1	0.5	2	0.2	1.59	4
Frut245	0.21	1.6	0.3	0.55	1.9	0.15	1.87	4
Frut260	0.19	0.8	0.18	0.8	2.05	0.1	1.582	7
Frut261	0.27	2	0.2	1.8	2.2	0.18	3.8	4
Frut262	0.12	1.5	0.22	1.1	2	0.15	2.4	6
Frut263	0.24	2.7	0.1	1.3	2	0.18	4.09	3
Frut264	0.22	1.2	0.1	0.78	1.8	0.2	1.79	8
Frut46	0.13	0.9	0.4	0.41	1.7	0.15	1.36	4
Frut47	0.9	1.9	0.6	1.1	1.8	0.2	3.64	5
Frut48	0.21	2.4	0.4	0.7	4.05	0.2	4.36	1
Frut49	0.36	2.7	0.6	1.1	2.5	0.2	3.68	4
Frut50	0.19	1.8	0.2	1.21	3.2	0.15	3.88	6
Frut51	0.2	1.5	0.1	0.5	1.05	0.15	1.84	9
Frut52	0.22	1.4	0.2	0.72	1.5	0.18	2.38	4
Frut53	0.15	0.96	0.1	0.44	1.9	0.18	1.49	7
Frut54	0.3	1.95	0.2	1.1	1.8	0.2	3.73	6
Frut55	0.35	2.4	0.3	0.9	2.55	0.3	3.07	3
Frut56	0.18	1.5	0.3	0.7	1.8	0.25	1.77	7
Frut57	0.26	1.2	0.2	0.77	1.75	0.2	2.58	7
Frut58	0.19	0.65	0.1	0.57	1.6	0.18	1.89	6
Frut59	0.88	3.4	0.3	1.4	1.45	0.25	4.37	4
Frut60	0.21	2.21	0.2	1.1	2	0.18	3.28	6

Table 3 (Cont'd)

	4	5	6	7	8	9	10	11
Hum16	0.48	1.4	3.8	1.6	2	0.2	2.42	6
Hum17	0.61	1.6	4	1.4	1.25	0.3	2.5	6
Hum18	0.51	1.7	6	1.9	2.75	0.25	3.32	8
Hum19	0.6	1.4	6	2.1	1.6	0.2	2.8	6
Hum20	0.6	1.7	0.9	1.4	4.75	0.2	3.71	4
Hum21	0.6	1	4.5	1.6	2.7	0.3	2.65	7
Hum22	0.52	1.3	2.5	1.35	3.3	0.25	2.75	11
Hum23	0.3	1.3	7	1.3	5.5	0.16	1.8	6
Hum24	0.59	2.4	8	1.45	5.5	0.2	3.3	6
Hum25	0.62	1.6	3	1.6	5.25	0.2	2.7	10
Hum26	0.72	1.6	7	2.7	2.3	0.15	4.1	7
Hum27	0.61	1.15	3.9	1.75	1.15	0.15	2.71	7
Hum28	0.72	0.86	7	1.9	4.25	0.15	2.7	6
Hum29	0.58	0.9	3.5	1.4	2	0.2	2.2	8
Hum30	0.78	1.5	6	2.6	2.8	0.3	3.12	3
Hum31	0.7	0.9	4.2	1.4	0.6	0.15	1.78	3
inter106	0.9	3.1	17	4.6	6	0.45	5.8	1
inter107	1.2	4.9	18	5.6	5.4	1.2	7.5	4
inter108	0.8	3	8	3.9	5.4	1.1	5.4	5
inter110	1.1	2.9	9	3.7	2.95	0.3	5.4	2
inter111	0.8	2.3	6	3.5	4.15	0.35	4.9	5
inter112	0.8	2.1	4.5	2.7	3.15	0.4	3.75	4
inter113	0.95	1	5	3.7	3	0.5	4.6	2
inter116	1.3	4.5	10	4.9	4.85	1	7.1	4
inter118	1.1	2.8	9	3.8	3.1	0.75	5.6	3
inter119	1.2	2.6	10.2	3.65	4.2	0.5	5.78	5
inter120	1.2	2.7	12	4.1	4.8	0.7	5.68	4
inter225	0.9	2.2	5	3.6	5.5	0.55	5.9	3
inter226	0.45	2.1	6	1.9	6	0.25	4.8	3

Table 3 (Cont'd)

	4	5	6	7	8	9	10	11
lasio250	0.5	2.1	7.5	3.2	4.1	0.3	5.05	1
lasio251	1.5	2.6	6.2	3.8	2.5	0.62	5.88	6
lasio252	0.65	1	5	2.1	2.6	0.3	2.9	4
lasio253	1.4	2.5	1.3	4.5	2.1	0.42	8.47	2
lasio254	0.75	1.75	6.3	2.2	3.4	0.28	2.95	2
lasio255	1.4	3	1.7	5.1	2.8	1.1	8.33	2
lasio256	0.56	1.3	7	2.3	3.4	0.32	3.9	3
lasio257	0.38	1.4	5.5	3.3	1.8	0.75	4.25	4
lasio258	1.2	3.5	9	4.8	4.6	1.1	5.85	4
lasio259	0.65	2.4	7.5	2.8	4.35	0.21	4.65	3
lasio292	0.85	1.65	4.5	4.1	2.4	0.59	4.35	4
lasio293	0.7	2.1	8.5	3.9	3.6	0.28	5.35	1
lasio294	0.34	1.3	7	1.8	5.4	0.3	3.1	4
lasio295	1.1	2.8	12.2	4.2	4.35	0.58	4.93	3
lasio296	0.6	2.4	8	3	4.3	2.2	4.45	4
lasio61	0.8	2.4	8.2	3.8	3.15	0.3	4.88	4
lasio62	0.75	1.6	6	2.1	2.7	0.35	3.1	3
lasio63	0.75	3.6	15	4.55	4	0.7	6.4	5
lasio64	0.7	1.7	6	3.5	3.1	0.4	3.15	4
lasio65	1.5	3.8	8.5	5.1	4.65	1.4	6.3	1
lasio66	0.7	3.4	8.5	3.4	4.2	0.85	5.2	1
lasio67	0.7	1.8	6	1.85	3.5	0.3	3.15	2
lasio68	1	1.7	4.5	3.7	2.2	0.58	4.33	1
lasio69	1.1	3.9	9	5.3	4.75	0.7	10	3
lasio70	1.2	2.8	22	3.45	2.4	0.6	4	2
lasio71	0.5	2.3	7.2	2.95	4.2	0.2	4.38	6
lasio72	1.2	3	13	4.1	4.25	0.6	5	4
lasio73	0.81	1.9	9	2.75	2.45	0.45	3.35	6
lasio74	0.65	1.8	9	4.1	3.5	0.25	5.2	3

Table 3 (Cont'd)

	4	5	6	7	8	9	10	11
lasio75	1.1	1.75	4	3.9	2.35	0.6	4.3	4
Marit121	0.7	1.6	1.9	2.1	5.8	0.45	4.31	1
Marit122	0.8	0.7	0.5	1.6	6.25	0.2	2.75	2
Marit123	0.75	0.5	1.6	2.9	3.75	1	3.89	3
Marit124	0.45	0.7	1.3	1.9	2	0.25	3.37	4
Marit125	0.4	2	0.8	1.2	2.85	0.3	2.87	1
Marit126	0.8	1.4	1.2	2.9	3.5	0.6	3.93	1
Marit126	0.72	1.4	1.2	2.9	3.5	0.6	3.93	1
Marit127	0.79	1.5	2	2.2	4.65	0.35	4.4	3
Marit128	0.68	1.5	1.5	2.3	4.1	0.32	4.05	2
Marit129	0.6	1.4	2.1	2.2	4.25	0.42	4.39	4
Marit130	0.41	1.2	0.8	1.6	2.8	0.25	2.82	3
Marit131	0.48	1.3	1	1.9	3.5	0.3	3.1	2
Marit132	0.6	1.4	1.3	2.15	4.62	0.42	4.07	1
Marit133	0.7	1.4	1.2	2	4.25	0.3	3.48	2
occ1	0.6	1.8	8.6	0.16	2.45	0.2	2.54	9
occ10	1.3	2.7	7.2	3.9	1.65	0.55	4.7	4
occ11	0.9	1.3	5.2	3.5	2.2	0.3	3.58	13
occ12	0.6	3.6	6.5	2	3.25	0.3	4.45	10
occ13	0.91	1.8	7	2.5	3.05	0.5	3.7	14
occ14	1.3	2.6	11	3.05	2.8	0.35	4.6	6
occ15	1.1	2.1	10	2.9	4.2	0.55	3.6	7
occ2	0.9	2.2	12.5	1.6	2.35	0.25	2.6	6
occ3	1.1	2.55	7.8	3.1	3	0.6	3.62	1
occ309	1.2	2.5	10.5	3.1	2.7	0.34	4.55	5
occ310	0.9	1.6	6.4	2.4	3	0.42	3.56	4
occ311	1.3	1.4	7	3	4.1	0.3	4.1	10
occ312	0.75	1.4	5.1	3.3	2.4	0.32	3.59	5
occ313	1.1	1.4	8	2	2.4	0.3	2.7	3

Table 3 (Cont'd)

	4	5	6	7	8	9	10	11
occ314	1.2	1.4	8	2.6	2.5	0.35	3.25	2
occ315	1	1.5	0.54	3.2	2.2	0.3	3.6	3
occ316	1.1	2.3	9.3	2.8	3.1	0.4	4.47	7
occ317	0.75	1.7	7	2.6	2.25	0.25	3.9	6
occ318	1	2.4	7	3.2	2.8	0.3	3.3	1
occ4	1.2	1.7	6.5	1.9	3.2	0.43	3.5	7
occ5	1.6	1.8	6	2.1	3.1	0.45	3.7	11
occ6	0.75	1.9	6	2.3	3.3	0.3	3.35	6
occ7	1.1	2.85	11	2.55	1.85	0.25	4.1	6
occ8	0.8	2.2	7	3.5	1.35	0.3	3.9	5
occ9	0.7	1.9	5	2	2.1	0.25	3.4	11
punc151	1.4	2.3	12	5.2	6	0.8	6.2	2
punc152	1.3	0.8	14	4.6	5.5	0.5	4.8	7
punc154	0.59	1.35	5.5	2.1	2.1	0.2	2.9	4
punc155	0.69	1.5	7	1.9	2	0.2	2.8	2
punc158	0.92	2.1	11.4	5.1	3.4	0.48	6.06	4
punc159	1.35	1.7	12.2	4.2	3.5	0.8	5.68	5
punc160	1.3	2.1	12.5	4.8	6	0.7	5.95	6
punc161	0.9	1.9	9.5	4.1	5.4	0.65	5.85	3
punc163	0.98	1.7	11	3.8	2.33	0.6	4.36	4
punc164	1.3	1.6	10.5	3.8	4.8	0.5	5.35	3
punc165	1.2	1.9	9	3.6	4.2	0.48	6.3	1
punc246	0.95	2.8	15	4.75	5.6	0.65	6.8	2
punc247	1.1	1.8	9	4.5	5.7	0.58	5.2	2
punc248	0.9	2	9.8	4.5	3.7	0.4	5.95	5
punc249	1.53	2.3	14.5	4.75	6.15	0.76	5.55	2
punc301	0.6	1.4	7	2.2	2	0.25	3.4	5
punc302	0.7	1.2	6	1.4	3.5	0.2	2.6	5
punc303	0.59	0.7	5	1.9	2.2	0.19	2.4	3

Table 3 (Cont'd)

	4	5	6	7	8	9	10	11
punc304	0.6	0.7	3	1.4	1.8	0.18	2.4	4
punc305	0.68	1.2	5	1.2	0.9	0.3	1.7	5
Stan271	1.3	2.1	10.2	2.6	3.16	0.82	3.58	4
Stan272	1.5	2.2	11.2	2.8	3.27	0.76	3.68	3
Stan273	1.6	2	14.6	3.2	3.14	0.86	3.84	5
Stan274	2.3	2.3	19	3.42	3.88	0.98	4.6	4
Stan275	1.75	2.4	12.5	2.8	2.91	0.83	3.95	2
Stan276	1.8	2.6	13.2	3.5	3.5	0.85	4.48	1
Stan91	2.2	1.9	15.4	5	2	0.7	5.36	2
Stan92	2.3	2.7	17	3.8	4.32	1.1	4.5	5
Stan93	2.1	1.7	16	3.4	3.51	1.45	4.3	4
Stan94	1.55	2.1	10.5	2.8	3	0.55	3.55	6
Stan95	1.9	1.4	7.5	3.65	3.3	0.95	3.65	5
Stan96	1.6	2.4	14	3.2	2.9	0.85	3.4	4
Stan97	2.1	5	24.5	6.1	5.25	1.4	8.05	5
Stan98	1.4	2	7	2.2	2	0.55	3.1	4
Stan99	1.8	2.6	14	4.55	3	0.8	5.2	4
vill156	1.2	2.9	9	2.9	3	0.4	5.1	1
vill157	1.5	3.7	13	5	6.25	0.75	6.2	1
vill162	1.7	4.1	9	5.4	6.6	0.78	6.28	5
vill207	0.95	1.35	9.4	2.3	4.3	0.32	3.56	2
vill208	0.98	0.17	4.5	3.2	5.8	0.31	4.75	2
vill209	0.95	1.5	8.3	2.6	3.2	0.25	3.8	6
vill210	1.2	2.1	7.8	3.3	4.8	0.35	4.7	4
vill211	1.1	1.6	7.5	3.2	2.8	0.18	5.05	6
vill212	0.98	2.8	10.2	2.2	3.2	0.22	4.48	4
vill213	1.1	2.2	10.5	2.8	3.5	0.3	4.65	5
vill214	1.1	2.4	11	3.3	4.8	0.4	4.7	6
vill215	0.8	1.8	9.2	2.3	4.85	0.26	3.88	4

Table 3 (Cont'd)

	4	5	6	7	8	9	10	11
vill216	1.5	3	6.8	4.2	4	0.28	7.72	5
vill217	1.3	3.85	8.5	4.8	4.8	0.38	6.25	3
vill218	1.2	2.4	9.2	3.5	3.6	0.24	5.88	2
vill31	1.08	3.1	11	2.4	3.1	0.2	4.3	5
vill32	1.5	1.8	8	3.3	2.6	0.15	5.4	3
vill33	1.1	1.8	8.1	2.8	4.5	0.31	4.5	5
vill34	0.98	1.6	7	3	3.8	0.28	4.25	2
vill35	0.98	1.78	5	3.5	6.25	0.3	4.8	3
vill36	0.8	1.4	6	2.2	4.2	0.4	4	4
vill37	1.2	2.2	8.4	3.2	5	0.5	4.86	2
vill39	1.4	2.8	9	3.3	3.5	0.4	5.2	3
vill40	1.2	1.6	8	3.6	5	0.35	4.7	4
vill41	1.3	4.3	8.2	6	6	0.4	6.18	2
vill42	1.7	3.8	9	4.1	4.05	0.3	7.7	4
vill43	0.8	1.6	5.6	2.1	4.95	0.25	4.14	6
vill44	1.3	2.3	12	3.5	5.2	0.6	4.7	5
vill45	1.3	2.7	8	3.2	3.7	0.4	5.1	2
Virid136	0.41	0.9	0.1	2.6	1.45	0.25	3.09	2
Virid137	0.45	2.2	4.9	2.7	5.9	0.24	4.51	3
Virid138	0.45	1.3	3.5	1.3	1.8	0.23	3.55	4
Virid139	0.25	0.85	1.2	1.45	1.15	0.18	2.38	8
Virid140	0.55	0.6	2.8	0	0	0	3.31	3
Virid141	0.5	0.7	4.5	1.32	4.75	0.18	2.47	4
Virid142	0.32	1.6	4.2	3.2	7.5	0.2	4.58	4
Virid143	0.42	1.2	4	2.9	3.75	0.28	4.05	9
Virid144	0.41	0.85	1.2	2.5	1.45	0.25	3.12	2
Virid145	0.5	0.7	4.2	1.25	4.5	0.19	2.7	5
Virid146	0.41	1.1	4.2	3.15	7.45	0.18	3.68	3
Virid147	0.47	2.3	4.8	2.65	6.2	0.22	4.72	2

Table 3 (Cont'd)

	4	5	6	7	8	9	10	11
Virid148	0.52	0.7	3.3	1.3	2.2	0.19	3.37	2
Virid149	0.51	0.8	2.9	1.5	4.5	0.18	2.81	4
Virid150	0.42	1.2	3.4	3.1	4.3	0.19	4.51	5
Virid219	0.44	1.4	3.6	1.4	1.6	0.22	2.84	2
Virid220	0.45	2	4.5	2.5	6.3	0.2	4.15	3
Virid221	0.42	1.4	4.2	3.2	6.4	0.2	3.38	2
Virid222	0.53	0.7	4.1	1.5	3.8	0.22	2.79	4
Virid223	0.4	0.82	1.4	2.4	2.2	0.18	3.36	3
Virid282	0.42	1.2	3.8	2.8	4.2	0.24	3.74	7
Virid283	0.48	1.3	4.3	3.1	6.5	0.23	4.47	4
Virid284	0.5	0.89	4.2	1.8	4.1	0.19	3.4	5
Virid285	0.46	0.72	2.5	2.2	2.58	0.23	3.25	2
Virid286	0.36	0.72	1.4	1.65	1.15	0.21	2.66	5

Table 3 (Cont'd)

	12	13	14	15	16	17	18	19
ark76	6.3	8.2	2.6	2.55	9.5	1.15	9.24	1.53
ark77	5.8	12.2	2.6	2.95	11.5	1.05	8.16	1.87
ark81	5.2	8	2.1	2.6	8	1.1	7.82	1.52
ark83	3	6.8	1.2	1.3	6.5	0.7	6.29	1.36
ark84	5.6	8	2.1	2.08	9.1	0.85	8.43	1.42
ark85	4.65	9.2	1.55	1.9	13	0.7	8.59	1.52
ark287	3.8	6.6	1.6	1.4	5.8	0.82	6.62	1.42
ark288	4.5	7.2	2.18	2	6	0.9	7.1	1.58
ark289	5.2	7.8	2.4	2.7	11	1.2	7.66	1.62
ark290	4.8	6.4	2.2	2.7	10	1	7.54	1.55
ark291	4.5	5.2	2.1	1.5	8.1	0.82	6.85	1.59
ark408	3.8	8.6	1.5	2.6	8.2	1.2	7.52	1.64
ark409	4.1	6	1.4	1.5	8.5	0.5	9	1.5
ark410	3.7	6	1.1	2.1	9.1	1	6.8	1.45
ark411	4.8	8.5	2.4	2.1	8.2	1	7.56	1.38
ark413	5.7	10	1.8	2.4	8	1.1	7.59	1.58
ark414	4.6	8.2	1.5	2.2	8.5	0.9	7.61	1.56
ark415	5.08	7.8	1.8	2.3	9.8	1.1	6.82	1.54
corr460	4.9	6.8	3.1	2.5	8.2	1.2	6.26	2.43
corr461	3.4	4	1.6	2.4	7.5	0.75	6.73	2.68
corr462	5.7	10	2.5	2.1	7	0.7	7.29	2.23
corr463	3.3	6	1.1	1.3	6.1	0.6	5.82	2.05
corr464	4.1	6.9	1.7	1.9	6.5	0.9	6.26	1.87
corr465	3.3	3.2	1.4	1.6	5.1	0.65	5.28	1.78
corr466	4.2	7.2	1.8	2	7.8	0.7	6.02	1.75
corr468	4.9	4.4	2.4	2.1	7.8	0.75	5.36	1.94
corr470	6.8	9	4.2	2.8	9	1.9	5.9	1.8
corr471	5.3	4	2.2	2.6	9.8	0.8	5.7	1.85
Frut236	1.45	3	0.3	0.8	4.5	0.3	5.34	1.52

Table 3 (Cont'd)

	12	13	14	15	16	17	18	19
Frut237	3.7	3.2	1.7	1.35	7	0.6	6.23	1.37
Frut238	2.4	4.5	0.7	1.35	7	0.45	6.22	1.6
Frut239	3.7	5	0.7	1.2	8	0.6	6.02	1.39
Frut240	2.1	6.5	0.4	1.9	8.5	0.55	5.26	1.31
Frut241	3.2	3.1	1.1	1.5	9	0.7	5.34	1.38
Frut242	2.8	3.5	0.45	1.55	6	0.71	4.66	1.6
Frut243	2.8	2.4	0.64	1.7	7.1	0.6	6.13	1.55
Frut244	1.6	2.5	0.5	1.2	7	0.61	4.86	1.25
Frut245	1.8	7	1.4	1.6	5	1.3	5.36	1.59
Frut260	1.9	3	0.3	1.1	3.8	0.6	5.21	1.5
Frut261	2.8	4.4	0.6	1.27	7.1	0.5	6.1	1.49
Frut262	1.45	3.5	0.3	1	4.8	0.4	5.48	1.41
Frut263	3.5	4.7	0.68	1.18	6.8	0.58	5.14	1.36
Frut264	1.4	3.1	0.3	1.1	4.75	0.6	6.15	1.52
Frut46	1.4	3.1	0.3	0.9	5.2	0.72	6.15	1.52
Frut47	2.6	3.4	0.6	1.32	7.1	0.65	5.58	1.42
Frut48	3.15	4.8	1.6	1.9	7.1	1.09	5.96	1.43
Frut49	5.6	5.1	3.2	1.9	7	0.9	5.22	1.35
Frut50	2.15	3	0.25	1.05	3.5	0.5	5.09	1.31
Frut51	1.6	2.2	0.4	1.1	5.1	0.7	5.54	1.31
Frut52	1.6	4.5	0.6	1.35	7.5	0.75	6.51	1.35
Frut53	0.89	2.8	0.42	0.84	4.1	0.5	5.14	1.31
Frut54	2.9	2.8	1.1	1.5	4.5	0.8	5.68	1.2
Frut55	1.65	4	0.6	1.15	6	0.65	5.27	1.49
Frut56	1.49	4.5	0.55	1.92	5	0.7	5.28	1.56
Frut57	1.3	4	0.35	0.9	12	0.06	6.34	1.68
Frut58	1.2	2.2	0.3	1.2	6	0.7	5.4	1.33
Frut59	3.1	3.8	0.6	1.2	5	0.2	5.29	1.29
Frut60	1.2	2.9	0.5	1.6	7.1	0.8	5.41	1.21

Table 3 (Cont'd)

	12	13	14	15	16	17	18	19
Hum16	2.3	4	1.3	1.7	6.5	0.9	6.24	1.84
Hum17	2.6	6	1.7	1.6	0.8	1	5.25	1.24
Hum18	3.4	5.1	1.5	1.8	6	1.2	5.26	1.04
Hum19	2.9	6	1.3	1.25	8	0.3	6.54	2.39
Hum20	2.9	3.5	1.1	1.3	4.8	0.36	5.53	1.59
Hum21	3.5	5	1.4	1.4	4	0.21	7.23	1.41
Hum22	2.7	7	1.9	2.2	5.1	1.2	5.25	1.56
Hum23	2.2	3	0.8	1.5	5.1	0.66	5.65	1.62
Hum24	3.7	7.3	2.4	1.1	7.3	0.5	7.33	1.8
Hum25	3.6	3.5	2.1	1.4	7.1	0.9	5.45	1.78
Hum26	3.3	8	2.1	0.19	9.2	0.89	5.23	1.72
Hum27	3.1	6	1.2	1.25	6	0.5	5.09	1.5
Hum28	3.8	4	1.1	1.4	5	0.85	5.64	1.74
Hum29	2.4	2.2	1.2	0.98	5.6	0.45	5.72	1.52
Hum30	3.6	7.2	1.7	1.3	4.5	0.3	5.24	1.48
Hum31	2.4	4	1.1	1.1	5.1	0.49	6.23	1.69
inter106	4.2	9.5	1.3	2.7	10.5	1.1	6.43	2.04
inter107	6.9	10.5	2.5	2.8	12	0.9	7.01	1.74
inter108	4.6	7	1.1	2.25	7	7	6.65	1.19
inter110	5.4	8	3	2.4	12	0.8	6.54	1.47
inter111	4.9	6	1.7	2.1	9	1.1	6.52	1.44
inter112	4.7	7	1.6	2.15	11	0.9	6.54	1.06
inter113	4.7	8	1.3	2.2	13	0.7	6.95	1.44
inter116	4.6	7.8	1.3	2.1	9	0.9	7.1	1.39
inter118	5.5	6.5	2.2	1.8	8.5	0.75	6.04	1.52
inter119	5	8.2	2.2	2.2	9.5	0.85	7.16	1.4
inter120	5.4	7.4	1.8	2	9	9	7.55	1.5
inter225	6	9.5	2.1	3.15	11	1.4	7.02	1.41
inter226	4.1	4	1.6	1.6	5.9	0.7	6.1	1.51

Table 3 (Cont'd)

	12	13	14	15	16	17	18	19
lasio250	3.56	4.8	0.85	2	7.4	0.95	6.61	1.52
lasio251	5.4	8.3	2.1	1.8	7.8	0.92	7.17	1.84
lasio252	5.4	7.8	2.1	2.1	6.2	1.1	7.7	1.92
lasio253	6.5	11.5	1.4	1.9	11.2	0.89	8.32	1.51
lasio254	5.6	7.85	2	2.1	6.5	0.98	7.48	1.68
lasio255	7.2	8	3.8	2.8	9.5	0.8	7.18	1.35
lasio256	5.5	7.8	2.2	2.2	5.5	1.04	7.1	1.48
lasio257	4.3	3.2	2.2	1.9	6.6	0.72	6.92	1.51
lasio258	6.65	7.15	2.2	1.9	8.8	1.15	7.52	1.49
lasio259	3.24	4.8	1.2	2	8.2	1.04	7.12	1.36
lasio292	3.5	8.5	1.4	1.8	7.2	0.82	7.2	1.42
lasio293	5.15	6	1.8	2.2	6.4	0.98	7.06	1.53
lasio294	3.2	2.2	1.6	1.8	5.5	1.4	6.98	1.55
lasio295	4.12	7.2	1.4	2.2	7.6	1.08	7.42	1.42
lasio296	3.2	4.8	1.1	1.8	7.2	1.05	7.15	1.41
lasio61	2.9	4.5	0.45	1.5	6	0.6	8.12	1.38
lasio62	5.5	8.3	2	1	6.5	1	7.69	1.41
lasio63	7.12	5.5	2.6	2.2	7.2	0.7	5.8	1.55
lasio64	5.6	8.8	2.2	2.1	6.6	1.4	8.62	1.51
lasio65	6.8	13	1.9	2.3	10	1.2	6.84	1.39
lasio66	7.5	6.5	4.5	2.1	8.3	0.65	7.91	1.32
lasio67	5.7	8	2.1	2.1	2.8	1.05	7.26	1.35
lasio68	3.4	9	0.8	1.7	6.4	0.73	7.16	1.38
lasio69	7.9	7.5	3.2	2.6	8	0.6	7.92	1.78
lasio70	5.55	8.2	2.2	2.1	8	0.95	7.12	1.45
lasio71	3.15	4.5	0.8	1.8	7	1	7.13	1.38
lasio72	4.05	7.3	1.1	2.2	7.5	1.5	7.03	1.42
lasio73	4.4	4.1	2.6	2.1	9	0.7	7.16	1.36
lasio74	5.2	6.2	0.8	2.1	5.2	0.9	7.01	1.37

Table 3 (Cont'd)

	12	13	14	15	16	17	18	19
lasio75	3.45	9.5	0.73	1.6	6.5	0.72	7.04	1.35
Marit121	4.9	6.4	2.1	1.55	8	0.9	6.83	1.57
Marit122	3.5	5	1.3	2	6	1	5.79	1.47
Marit123	2.6	11	1.1	1.7	8	0.9	7.54	1.65
Marit124	2.2	4.8	0.9	1.2	8.5	0.6	5.92	1.44
Marit125	2.55	7	0.3	1.45	9.5	0.65	5.81	1.5
Marit126	4.5	8.6	1.9	1.55	6	0.75	6.12	1.48
Marit126	4.5	4.8	1.9	1.55	6	0.75	5.86	1.3
Marit127	3.7	6.2	0.9	1.5	9.3	0.6	5.92	1.42
Marit128	3.1	4.85	1.3	1.42	7.2	0.72	6.24	1.42
Marit129	3.2	6.8	1.8	1.5	7.6	0.75	6.11	1.34
Marit130	2.7	3.8	1.1	1.2	7.4	0.6	6.13	1.5
Marit131	3.1	7	0.9	1.3	7.9	0.55	6.21	1.51
Marit132	3.45	4.3	1.5	1.45	8.2	0.9	6.72	1.47
Marit133	5.2	5.4	1.6	1.9	8.5	1	7.69	1.65
occ1	2.9	5	1.3	1.9	7	1.1	5.71	1.32
occ10	3.15	6	1.7	1.9	8	0.9	7.29	2.12
occ11	3.6	5.5	1.8	1.9	8.5	0.75	6.26	2.04
occ12	3.9	6.2	2.4	1.7	8	0.9	5.9	1.41
occ13	3.2	8	1.8	1.85	7.5	0.9	6	1.77
occ14	4.05	7	2.3	2.4	9	1	6.05	1.82
occ15	5.5	10	2.4	2.8	8.5	1.6	5.23	1.59
occ2	3.2	8.5	1.3	2.1	10.5	1.1	6.68	1.93
occ3	2.9	10	1.5	2.5	9	0.9	6.8	1.6
occ309	4	6.5	2.2	2.1	9.4	1.2	5.7	1.3
occ310	3.4	7.2	2	1.75	7.7	1	6.35	1.86
occ311	3.8	6	2.2	1.8	8.2	1.1	7.15	2.05
occ312	3.7	5.8	1.8	2.1	8.4	0.84	6.2	1.82
occ313	3.5	6.9	1.8	2.2	8.5	0.7	6.1	1.45

Table 3 (Cont'd)

	12	13	14	15	16	17	18	19
occ314	3.7	7.6	2.1	2.1	8.2	0.9	6.4	1.51
occ315	3.5	5.9	2.1	2	8.1	0.78	6.5	1.9
occ316	4	8.4	2.2	2.1	8.5	0.9	6.8	1.52
occ317	3.4	7	1.7	1.9	8	0.6	6.1	1.83
occ318	3.6	8.5	1.6	2.1	7	0.6	6.12	1.77
occ4	2.9	5	1.6	2	7	0.8	6.12	1.56
occ5	3.9	12	2	2.1	8	0.7	5.95	1.83
occ6	3.3	7.9	1.2	1.8	7	0.4	6.1	1.92
occ7	4.7	7.5	2.45	2.05	5.1	0.75	5.2	1.31
occ8	4.7	7.1	2.2	2.3	8	0.85	5.75	1.43
occ9	3.4	4.5	1.2	2	7.5	0.5	6.3	1.75
punc151	6.2	11	2.1	3.2	7.2	0.9	6.18	1.43
punc152	5.2	9.5	1.6	3.2	5.6	0.5	5.43	1.23
punc154	2.3	3.5	1.2	1.7	4.1	0.75	4.85	1.69
punc155	2.6	3.9	1.2	1.8	4.1	0.8	4.85	1.63
punc158	5.8	9.8	1.4	3.5	7.6	0.65	8.07	1.77
punc159	5.7	10.5	1.8	3.2	7.4	0.58	8.23	1.63
punc160	5.5	10.2	1.9	3.1	6.8	0.45	6.48	1.46
punc161	6.1	11	2.2	3.3	7.2	0.57	6.95	1.54
punc163	3.5	9.4	0.9	1.65	6.9	0.72	6.9	1.5
punc164	5.2	9.4	1.6	2.9	6.1	0.42	7.09	1.47
punc165	4.8	8.8	1.3	2.8	6.3	0.35	5.67	1.43
punc246	6.1	9.4	2.3	3.5	6.75	0.7	6.1	1.52
punc247	5.4	9.8	1.8	3.1	5.8	0.55	6.86	1.47
punc248	5.9	10	1.7	3.4	7.3	0.58	7.5	1.62
punc249	6.2	12.4	2.4	3.2	7.4	0.6	7.01	1.32
punc301	2.2	3.2	1.3	1.6	3.8	0.7	4.95	1.69
punc302	2.6	4.8	1.2	1.6	4.8	0.82	4.85	1.74
punc303	1.8	4.1	1.1	1.4	3.8	0.8	4.75	1.63

Table 3 (Cont'd)

	12	13	14	15	16	17	18	19
punc304	1.7	4.2	0.8	1.8	4.1	0.7	4.9	1.65
punc305	1.3	3.2	0.4	1.3	4.2	0.38	4.8	1.62
Stan271	4.3	8	1.5	2.5	5.9	0.8	7.52	1.95
Stan272	6.2	11	2.6	2.2	9.8	0.8	7.34	1.72
Stan273	4.8	12	1.8	2.6	10.4	0.85	8.64	1.86
Stan274	3.7	9	1.5	2.1	8.2	0.95	7.12	1.72
Stan275	3.5	10	1.3	1.8	6.5	0.63	8.31	1.72
Stan276	4.1	11	1.5	1.75	8.6	0.82	7.68	1.81
Stan91	5	11	1.8	1.9	10	0.7	8.22	1.23
Stan92	4.4	1.3	1.2	2.4	11.5	0.7	7.87	1.45
Stan93	4.4	11	1.4	2	7.5	0.55	7.43	1.64
Stan94	3.9	12	1.6	1.9	9	0.82	7.52	1.86
Stan95	3.2	8	0.09	1.7	6.3	0.52	8.41	1.67
Stan96	3.8	8.9	1.6	2.35	9	1	6.83	1.72
Stan97	5.3	11	1.9	2.8	11	0.9	8.82	1.84
Stan98	7.8	9	3.6	2.7	10	0.9	7.32	1.66
Stan99	5.3	9	1.1	2.6	6.5	0.8	7.36	2.4
vill156	3.9	9	1.4	1.8	6.9	1.3	6.5	1.35
vill157	6.3	13	2.5	3.4	7.5	0.6	6.4	1.52
vill162	6.5	13.4	2.4	3.4	7.6	0.63	6.73	1.29
vill207	3.8	6.2	2.2	1.8	7.5	0.9	5.87	1.14
vill208	4.1	6.3	2.1	2.2	8.2	1.2	6.87	1.96
vill209	3.7	6.2	1.8	1.7	6.8	0.9	6.52	1.2
vill210	4.2	7.2	2.1	2	8	1.1	6.79	1.36
vill211	3.6	5.4	1.8	1.6	6.4	1.1	5.13	1.56
vill212	3.4	6.35	1.6	1.5	7	0.8	5.91	1.22
vill213	3.8	5.8	2.1	1.4	6.2	0.95	6.72	1.72
vill214	4.4	6.1	1.8	1.8	5.5	0.98	6.53	1.22
vill215	4.2	4.7	1.8	2	7.2	0.6	6.68	1.38

Table 3 (Cont’d)

	12	13	14	15	16	17	18	19
vill216	5.45	7.8	2.5	2.2	5.4	1.2	5.28	1.58
vill217	0.5	7.5	2.6	2.3	7	1.1	5.74	1.21
vill218	3.5	6.2	1.9	1.8	6.2	0.9	6.72	1.82
vill31	3.2	6.5	1.55	1.7	6.5	0.7	5.92	1.21
vill32	3.4	5.5	1.9	1.7	6	1	5.23	1.42
vill33	3.8	6.8	2	1.9	7.5	0.95	6.81	1.35
vill34	3.7	6.6	1.9	1.7	7.3	0.93	6.72	1.32
vill35	4.2	8.5	2.1	2.4	8	1.3	6.49	1.82
vill36	3.8	6.2	1.2	2.2	8.5	0.85	5.96	1.21
vill37	3.5	7	2.3	1.9	6	1.2	5.72	1.48
vill39	3.6	7	1.7	1.75	7	1.25	6.43	1.22
vill40	4.3	7.5	2	2.2	7	1.4	6.85	1.81
vill41	5.6	8	2.8	2.2	8	0.9	5.92	1.22
vill42	5.4	8	2.8	2.5	5	1.4	5.24	1.46
vill43	4.1	4.5	2	1.9	7	0.4	6.52	1.35
vill44	4.2	6	1.7	1.8	5	0.9	6.35	1.32
vill45	3.4	7.1	1.5	1.8	6.2	1.3	6.58	1.54
Virid136	2.9	3.4	0.51	1.6	7.2	1.2	7.38	1.62
Virid137	4.2	4.2	0.75	2.3	7	0.7	7.28	1.55
Virid138	2.45	4.5	0.65	1.7	9.2	0.8	7.04	1.59
Virid139	2.35	3.9	0.6	1.3	8.6	0.52	7.12	1.64
Virid140	2.35	6.5	0.75	1.6	7.2	0.75	6.59	1.62
Virid141	2.6	6	0.6	1.82	7.2	0.65	6.82	1.63
Virid142	2.65	4.8	0.98	2.35	6.9	1.1	6.72	1.57
Virid143	2.7	6.5	1.2	1.7	5.6	0.75	6.63	1.58
Virid144	2.8	3.7	0.61	1.6	8.1	1.2	6.56	1.63
Virid145	2.6	5.1	0.6	1.62	6.9	0.75	7.2	1.68
Virid146	2.65	4.5	0.98	2.15	7	1.2	6.62	1.59
Virid147	3.2	4.6	0.76	2.2	6.8	0.82	7.45	1.56

Table 3 (Cont'd)

	12	13	14	15	16	17	18	19
Virid148	2.42	6.2	0.8	1.7	7.3	0.74	6.95	1.53
Virid149	2.55	5.8	0.62	1.83	6.3	0.68	6.59	1.57
Virid150	2.64	4.2	0.87	2.15	6.2	1	6.48	1.62
Virid219	2.4	4.4	0.6	1.5	8.5	0.8	7.15	1.58
Virid220	3.1	4.5	0.74	2.3	6.7	0.82	7.18	1.63
Virid221	2.75	4.4	0.85	2.14	6.8	0.9	6.98	1.64
Virid222	2.5	5.5	0.62	1.54	6.5	0.76	7.26	1.65
Virid223	2.7	4.2	0.61	1.7	7.2	0.8	7.32	1.62
Virid282	2.6	6.4	0.83	1.8	5.8	0.78	6.74	1.63
Virid283	2.54	4.6	0.84	2.2	6.9	0.8	6.89	1.57
Virid284	2.55	5.8	0.64	1.7	7.14	0.6	7.14	1.59
Virid285	2.2	6.2	0.72	1.5	1.16	0.72	7.26	1.58
Virid286	2.3	3.8	0.64	1.4	7.6	0.5	7.18	1.62

Table 3 (Cont'd)

	20	21	22	23	24	25	26	27
ark76	0.63	1.62	0.37	0.42	5.92	3.26	3.18	1.17
ark77	0.65	1.58	0.3	0.46	6.05	3.42	3.3	1.09
ark81	0.89	1.37	0.29	0.9	6.12	3.35	3.35	1.26
ark83	0.68	1.34	0.25	0.5	4.35	3.31	3.26	1.25
ark84	0.79	1.21	0.27	0.49	4.21	2.94	2.58	1.29
ark85	0.53	1.42	0.26	0.3	6.05	3.4	3.42	1.3
ark287	0.64	1.1	0.25	0.37	4.15	3.9	2.67	1.25
ark288	0.72	1.17	0.22	0.42	5.89	3.15	2.98	1.26
ark289	0.78	1.18	0.27	0.45	5.82	3.26	3.35	1.25
ark290	0.71	1.25	0.29	0.47	6.05	3.3	3.3	1.23
ark291	0.65	1.1	0.26	0.46	4.5	3.1	2.7	1.31
ark408	0.75	1.23	0.25	0.46	5.9	3.4	3.4	1.32
ark409	0.62	1.52	0.32	0.38	5.86	3.31	3.12	1.15
ark410	0.65	1.26	0.26	0.39	4.2	3.85	2.75	1.1
ark411	0.69	1.32	0.2	0.41	5.91	3.2	2.86	1.25
ark413	0.75	1.19	0.26	0.46	5.86	3.22	3.25	1.26
ark414	0.69	1.23	0.28	0.45	5.9	3.31	3.1	1.21
ark415	0.63	1.12	0.27	0.45	4.8	3.2	2.8	1.29
corr460	0.9	1.22	0.29	0	5.64	3.04	2.58	1.28
corr461	0.93	1.21	0.26	0	7.11	3.7	2	1.09
corr462	0.87	1.49	0.57	0	8.45	3.75	1.84	1.22
corr463	0.91	1.59	0.42	0	4.16	2.27	1.43	0.87
corr464	0.92	1.66	0.54	0	3.37	1.57	1.04	0.68
corr465	0.9	1.03	0.4	0	3.68	1.82	1.37	0.82
corr466	0.87	1.06	0.37	0	2.88	2.51	1.66	0.88
corr468	1.1	1.08	0.48	0.8	6.52	2.31	1.94	0.98
corr470	0.84	1.7	0.3	0	4.61	1.85	1.19	0.9
corr471	0.95	1.4	0.46	0	4.5	2.1	1.2	0.8
Frut236	0.84	1.18	0.28	0.6	4.13	2.96	1.89	1.07

Table 3 (Cont'd)

	20	21	22	23	24	25	26	27
Frut237	0.72	1.23	0.22	0.41	4.32	2.78	1.4	1.31
Frut238	0.7	1.29	0.38	0.56	4.25	2.3	1.59	0.83
Frut239	0.6	1.9	0.27	0.53	3.62	2.01	1.61	1.09
Frut240	0.76	1.75	0.36	0.49	3.32	2.54	1.56	1.16
Frut241	0.69	1.15	0.39	0.61	3.18	2.64	1.95	1.15
Frut242	0.65	1.91	0.39	0.87	4.46	2.64	2.37	1.49
Frut243	1.26	1.58	0.4	1.13	5.4	2.85	2.34	1.33
Frut244	0.56	1.17	0.39	0.57	4.82	2.52	2.32	1.24
Frut245	0.67	1.14	0.28	0.51	3.68	2.32	1.4	0.8
Frut260	0.61	1.2	0.3	0.53	3.72	2.19	2.18	1.1
Frut261	0.61	1.23	0.31	0.52	4.32	2.5	1.69	1.1
Frut262	0.71	1.2	0.25	0.57	4.05	2.46	1.5	1.1
Frut263	0.52	2.15	0.31	0.61	3.84	2.05	1.84	0.82
Frut264	0.55	1.37	0.44	0.55	2.76	1.75	1.76	0.99
Frut46	0.67	1.37	0.44	0.52	2.76	1.75	1.76	0.99
Frut47	0.69	2.01	0.29	0.48	3.03	1.78	1.86	1.47
Frut48	0.57	1.72	0.37	0.47	2.97	2.23	1.44	1.02
Frut49	0.78	1.38	0.26	0.58	3.47	2.42	1.93	1.15
Frut50	0.45	1.29	0.25	0.61	3.01	2.23	2.05	1.03
Frut51	0.67	1.48	0.24	0.57	2.4	1.85	1.41	0.91
Frut52	0.5	1.23	0.23	0.55	2.38	1.92	1.3	0.8
Frut53	0.78	2.16	0.16	0.49	3.79	1.84	1.47	0.68
Frut54	0.56	1.28	0.14	0.59	4.82	2.35	2.52	1.33
Frut55	0.43	2.1	0.2	0.57	3.84	2.29	2.38	1.11
Frut56	0.73	1.03	0.23	0.51	4.17	2.09	1.36	0.81
Frut57	0.54	1.36	0.26	0.48	3.24	2.07	1.48	0.73
Frut58	0.43	1.42	0.44	0.56	2.75	1.82	1.33	0.64
Frut59	0.47	1.39	0.45	0.54	3.92	2.04	1.85	1.2
Frut60	0.5	1.28	0.25	0.62	3.67	1.98	1.6	0.88

Table 3 (Cont'd)

	20	21	22	23	24	25	26	27
Hum16	0.39	1.06	0.34	0.4	3.23	1.6	1.27	0.71
Hum17	0.31	0.39	0.24	0.42	2.08	1.44	1.2	1.1
Hum18	0.33	0.61	0.57	0.41	2.59	1.92	0.82	0.81
Hum19	0.64	0.71	0.47	0.43	3.25	2.41	1.82	2.19
Hum20	0.36	0.81	0.44	0.41	2.88	1.9	2.1	1.25
Hum21	0.51	0.59	0.38	0.41	2.86	1.76	1.91	1.36
Hum22	0.45	0.72	0.4	0.42	3.74	2.4	3.42	1.16
Hum23	0.4	0.64	0.48	0.41	2.78	2.6	1.5	1.12
Hum24	0.46	0.72	0.48	0.41	2.84	2.89	1.7	1.15
Hum25	0.51	0.66	0.54	0.42	3.77	3.21	2.12	1.27
Hum26	0.45	0.71	0.52	0.43	3.78	3.13	1.5	1.3
Hum27	0.42	0.81	0.5	0.44	2.85	2.75	1.42	1.02
Hum28	0.53	0.68	0.46	0.41	2.9	2.84	1.5	1.11
Hum29	0.34	0.82	0.52	0.41	3.1	3.12	1.63	1.19
Hum30	0.46	0.76	0.39	0.42	3.63	3.11	1.38	1.21
Hum31	0.58	0.74	0.42	0.41	3.7	3.13	1.49	1.06
inter106	0	1.37	0.4	0.85	6.96	2.63	2.63	1.04
inter107	0	1.21	0.32	0.71	6.61	2.43	2.23	0.85
inter108	0.63	0.77	0.26	0.68	5.8	2.42	1.43	0.76
inter110	0.52	1.16	0.45	0.69	6.65	2.5	1.88	0.81
inter111	0.62	1.16	0.26	0.75	4.8	2.46	1.57	1.01
inter112	0	1.01	0.24	0.68	7.08	2.38	2.14	1.1
inter113	0	1.24	0.39	0.66	6.72	2.18	1.47	0.86
inter116	0.55	1.63	0.3	0.65	6.72	2.69	1.92	0.85
inter118	0.62	1.06	0.23	0.64	6.38	2.51	1.76	1.17
inter119	0.71	1.29	0.2	0.96	6.59	2.31	2.88	0.83
inter120	0.63	1.35	0.33	1.1	6.98	2.8	2.1	0.98
inter225	0	1.25	0.25	0.46	6.61	2.42	2.73	0.84
inter226	0	1.23	0.24	0.48	6.42	2.53	1.82	1.12

Table 3 (Cont'd)

	20	21	22	23	24	25	26	27
lasio250	0	1.44	0.32	0.71	6.12	2.21	2.8	1.1
lasio251	0.59	1.36	0.31	0.68	7.2	3.21	2.77	1.2
lasio252	0.58	1.14	0.31	0.65	5.8	2.9	1.3	1.01
lasio253	0.64	1.63	0.47	0.61	5.73	2.99	3.56	0.81
lasio254	0.68	1.59	0.45	0.71	8.36	3.92	2.89	1.65
lasio255	0.71	1.19	0.28	0.6	6.35	3.38	1.79	0.85
lasio256	0	1.65	0.36	0.73	4.18	2.14	1.71	0.81
lasio257	0	1.32	0.37	0.64	6.11	2.96	2.23	1.07
lasio258	0	1.33	0.32	0.69	4.66	3.12	1.7	0.96
lasio259	0	1.31	0.31	0.63	6.42	2.57	2.84	0.92
lasio292	0.58	1.24	0.31	0.65	6.23	3.24	1.82	0.87
lasio293	0.71	1.55	0.37	0.7	4.42	2.38	2.15	0.92
lasio294	0.63	1.33	0.4	0.75	6.05	3.1	2.19	1.05
lasio295	0.62	1.29	0.35	0.74	5.23	3.05	1.92	0.95
lasio296	0	1.36	0.33	0.67	6.08	2.62	2.63	0.96
lasio61	0.7	1.41	0.29	0.74	8.02	4.32	2.8	0.96
lasio62	0.67	1.36	0.31	0.6	6.3	3.56	1.5	1.2
lasio63	0.69	1.28	0.29	0.63	3.33	1.86	1.7	0.84
lasio64	0.68	1.36	0.33	0.68	6.5	3.5	1.7	1.13
lasio65	0.67	1.34	0.34	0.74	7.9	3.24	2.52	1.26
lasio66	0.63	1.32	0.33	0.78	6.9	3.1	2.46	0.98
lasio67	0.58	1.31	0.32	0.75	5.02	2.54	1.54	0.76
lasio68	0.65	1.3	0.33	0.7	6.5	3.35	1.3	1.1
lasio69	0.58	1.61	0.42	0.63	8.49	4.29	3.05	1.68
lasio70	0	1.3	0.31	0.65	4.95	2.34	1.54	0.92
lasio71	0	1.29	0.32	0.81	5.24	3.1	2.1	1.1
lasio72	0.64	1.42	0.3	0.68	5.44	2.48	1.3	0.85
lasio73	0	1.3	0.29	0.71	4.54	2.54	1.13	0.68
lasio74	0.63	1.32	0.31	0.65	5.75	2.6	1.49	0.86

Table 3 (Cont'd)

	20	21	22	23	24	25	26	27
lasio75	0.68	1.33	0.33	0.72	6.78	3.52	1.26	1.13
Marit121	0	1.31	0.42	0	4.86	3.01	1.85	1.03
Marit122	0	1.24	0.45	0	3.53	2.98	1.5	0.79
Marit123	0	1.69	0.4	0	6.3	2.98	2.05	1.13
Marit124	0	2.32	0.41	1.2	3.77	2.95	1.48	0.74
Marit125	0	0.76	0.43	1.15	4.21	2.87	1.54	0.81
Marit126	0	1.8	0.39	0	4.12	3.01	1.52	0.82
Marit126	0	1.24	0.41	0	4.52	2.94	1.64	0.86
Marit127	0	1.62	0.4	0	3.64	2.92	1.45	0.76
Marit128	0	1.23	0.42	0	4.61	2.89	1.56	0.87
Marit129	0	1.13	0.39	0	4.57	3.14	1.4	0.85
Marit130	0	1.2	0.31	0.7	3.89	3.12	1.6	0.8
Marit131	0	0.9	0.41	0	4.21	2.85	1.65	0.83
Marit132	0	1.29	0.4	0	4.72	2.95	1.76	0.98
Marit133	0	1.6	0.28	0	6.3	3.02	2.12	1.16
occ1	0	0.93	0.27	0.61	4.8	0.84	1.24	0.59
occ10	0	0.7	0.27	0.61	5.65	1.91	1.51	0.59
occ11	0	0.92	0.51	0.55	5.5	1.93	1.3	0.54
occ12	0	0.75	0.39	0.57	4.6	2.3	1.15	0.61
occ13	0	1.09	0.34	0.56	4.2	2.4	1.26	0.71
occ14	0	0.66	0.31	0.55	6.52	2.18	2	1.07
occ15	0	0.74	0.5	0.58	4.3	1.58	1.15	0.49
occ2	0	0.61	0.34	0.56	4.3	2.86	1.32	0.78
occ3	0	0.8	0.34	0.54	4.2	2.2	1.28	0.73
occ309	0	0.76	0.38	0.55	4.8	2.1	1.23	0.79
occ310	0	0.93	0.42	0.58	5.6	2.1	1.29	0.61
occ311	0	0.82	0.31	0.59	5.5	2.07	1.36	0.62
occ312	0	0.96	0.33	0.57	4.3	2.32	1.25	0.69
occ313	0	0.69	0.34	0.57	5.1	2.19	1.3	0.65

Table 3 (Cont'd)

	20	21	22	23	24	25	26	27
occ314	0	0.85	0.35	0.59	5.62	2.2	1.4	0.78
occ315	0	0.86	0.48	0.55	5.6	2	1.35	0.58
occ316	0	0.92	0.39	0.61	5.8	2.3	1.42	0.84
occ317	0	0.72	0.3	0.64	5.8	2.2	1.38	1.1
occ318	0	1.05	0.31	0.67	4.5	2.35	1.2	0.82
occ4	0	0.82	0.32	0.55	4.1	2.19	1.27	0.71
occ5	0	0.98	0.33	0.58	4.3	2.26	1.22	0.72
occ6	0	0.72	0.29	0.61	5.45	2.32	1.67	0.74
occ7	0	0.92	0.31	0.62	4.2	2.2	1.42	0.75
occ8	0	0.76	0.35	0.58	4.8	2.15	1.28	0.69
occ9	0	0.96	0.32	0.62	4.6	2.19	1.32	0.84
punc151	0.52	1.58	0.25	0	4.89	2.42	2.24	1.2
punc152	0	0.66	0.16	0	6.3	2.28	2.24	1.2
punc154	0.66	1.1	0.22	0	5.4	2.14	2	0.85
punc155	0.59	0.98	0.35	0	5.6	2.3	1.81	0.8
punc158	0.49	1.14	0.44	0	10.24	2.98	2.24	1.44
punc159	0.57	1.22	0.31	0.42	8.65	2.65	2.81	1.55
punc160	0.62	1.29	0.28	0	7.4	2.96	2.27	0.72
punc161	0.58	0.96	0.3	0	7.47	2.62	2.42	1.22
punc163	0.4	1.25	0.22	0	6.23	3.24	1.28	1.08
punc164	0.46	1.14	0.27	0	5.64	2.74	1.85	1.3
punc165	0.52	1.41	0.24	0.3	7.52	2.36	2.22	1.35
punc246	0.49	1.35	0.26	0	7.32	2.29	2.15	1.26
punc247	0.56	1.2	0.3	0	6.1	2.65	2.04	1.25
punc248	0.52	1.08	0.28	0	9.5	2.81	2.1	1.2
punc249	0.63	0.85	0.25	0	5.96	2.68	2.06	1.14
punc301	0.67	1.09	0.2	0.98	5.2	2.1	1.9	0.82
punc302	0.63	0.96	0.19	0.95	4.8	2	1.8	0.73
punc303	0.58	1.08	0.2	0.97	5.4	2.08	1.9	0.78

Table 3 (Cont’d)

	20	21	22	23	24	25	26	27
punc304	0.56	1.06	0.21	0.95	5.3	2.2	2.1	0.8
punc305	0.51	1.25	0.19	0.96	5.5	2.12	2.05	0.8
Stan271	0.78	1.55	0.45	0.71	3.1	1.68	2.1	0.84
Stan272	0.81	1.51	0.34	0.69	3.15	1.59	2.12	0.81
Stan273	0.79	1.41	0.31	0.68	3.2	1.74	2.22	0.78
Stan274	0.82	1.56	0.37	0.73	3.15	1.52	1.95	0.75
Stan275	0.81	1.42	0.35	0.71	3.1	1.49	1.9	0.73
Stan276	0.83	1.31	0.41	0.69	3.12	1.35	2.1	0.75
Stan91	0.84	1.14	0.39	0.72	3.39	1.8	2.35	0.64
Stan92	0.82	1.27	0.38	0.71	3.3	1.69	2.11	0.73
Stan93	0.85	1.47	0.38	0.68	2.96	1.72	2.15	0.68
Stan94	0.75	1.27	0.4	0.71	3.12	1.25	1.96	0.74
Stan95	0.68	1.41	0.31	0.65	2.9	1.54	1.8	0.75
Stan96	0.93	1.56	0.36	0.62	3.11	1.53	1.85	0.76
Stan97	0.82	1.35	0.28	0.84	3.25	1.86	2.28	0.79
Stan98	0.89	1.53	0.37	0.6	3.16	1.62	2.16	0.8
Stan99	0.76	1.69	0.54	0.73	3.11	1.72	1.88	0.85
vill156	0.5	1.2	0.27	0.38	7.24	2.8	2.55	1.56
vill157	0.5	1.14	0.2	0	6.5	2.67	2.95	2.19
vill162	0.48	1.12	0.22	0.41	5.58	2.75	1.74	1.04
vill207	0.48	0.91	0.2	0.48	5.84	2.76	2.31	0.89
vill208	0.51	1.19	0.27	0.52	6.93	2.67	2.4	1.26
vill209	0.51	1.04	0.25	0.45	7.81	2.82	3.38	1.33
vill210	0.48	1.26	0.25	0.46	6.4	2.31	2.46	1.22
vill211	0.52	1.16	0.25	0.42	4.97	2.24	2.36	1.1
vill212	0.47	0.94	0.21	0.38	5.64	2.81	2.29	1.14
vill213	0.53	1.12	0.26	0.41	7.1	2.72	2.31	1.28
vill214	0.47	1.1	0.25	0.42	7.23	2.91	3.14	1.27
vill215	0.49	1.14	0.24	0.48	5.9	2.38	2.52	1.19

Table 3 (Cont'd)

	20	21	22	23	24	25	26	27
vill216	0.48	1.15	0.23	0.47	5.2	2.34	2.33	1.12
vill217	0.53	0.98	0.21	0.42	5.56	2.71	2.42	1.08
vill218	0.51	1.13	0.25	0.45	6.82	2.64	2.39	1.23
vill31	0.48	1.05	0.22	0.42	6.12	2.52	2.32	0.92
vill32	0.44	1.15	0.25	0.51	5.22	2.31	2.41	1.15
vill33	0.54	1.24	0.24	0.62	6.15	2.43	2.39	1.23
vill34	0.49	1.08	0.26	0.37	7.62	2.72	2.24	1.28
vill35	0.54	1.2	0.25	0	6.82	2.62	2.38	1.15
vill36	0	1.17	0.22	0.29	6.22	2.5	2.31	0.91
vill37	0.52	1.15	0.25	0.51	5.12	2.32	2.35	1.15
vill39	0.48	1.09	0.25	0.38	7.72	2.67	2.82	1.36
vill40	0.49	1.18	0.26	0.38	7.1	2.59	2.52	1.27
vill41	0.51	1.08	0.21	0.37	6.45	2.56	2.42	0.95
vill42	0.52	1.12	0.27	0.38	5.12	2.31	2.46	1.17
vill43	0.48	1.22	0.26	0.39	6.35	2.43	2.41	1.26
vill44	0.51	1.14	0.24	0.51	7.42	2.72	3.05	1.34
vill45	0.46	1.16	0.25	0.38	7.1	2.71	2.58	1.22
Virid136	0.39	1.15	0.39	0.63	2.9	1.85	1.5	1.15
Virid137	0.4	1.32	0.4	0.71	3.4	1.96	2.82	1.15
Virid138	0.43	1.35	0.41	0.64	2.87	1.87	1.75	1.11
Virid139	0.41	1.19	0.38	0.59	5.72	2.07	1.95	1.14
Virid140	0.39	1.42	0.39	0.63	3.19	2.1	1.8	1.12
Virid141	0.4	1.22	0.42	0.61	3.6	1.94	1.76	1.24
Virid142	0.4	1.18	0.39	0.58	3.3	1.85	1.78	0.98
Virid143	0.42	1.16	0.41	0.53	3.51	2.25	2.57	1.34
Virid144	0.4	1.23	0.42	0.52	5.89	2.74	1.8	1.2
Virid145	0.39	1.42	0.41	0.7	3.4	1.95	2.63	1.19
Virid146	0.4	1.1	0.43	0.61	3.34	1.78	1.87	1.19
Virid147	0.39	1.22	0.44	0.58	5.79	2.85	1.94	1.41

Table 3 (Cont'd)

	20	21	22	23	24	25	26	27
Virid148	0.42	1.18	0.42	0.62	3.49	1.82	1.81	1.64
Virid149	0.4	1.55	0.39	0.5	3.43	1.8	2.16	1.28
Virid150	0.41	1.55	0.41	0.72	3.5	1.75	2	0.95
Virid219	0.38	1.26	0.38	0.64	3.12	1.83	1.43	1.04
Virid220	0.4	1.18	0.42	0.63	3.5	2.36	1.65	1.09
Virid221	0.37	1.19	0.43	0.62	3.32	1.95	1.75	1.23
Virid222	0.4	1.36	0.44	0.65	3.47	2.75	1.96	1.27
Virid223	0.41	1.47	0.39	0.63	3.64	1.9	2.52	1.36
Virid282	0.4	1.5	0.38	0.6	3.24	1.92	1.56	1.1
Virid283	0.39	1.39	0.44	0.68	3.62	2.25	1.74	1.14
Virid284	0.39	1.27	0.42	0.71	3.48	2.1	1.83	1.32
Virid285	0.38	1.19	0.41	0.59	3.5	2.86	2.05	1.48
Virid286	0.41	1.18	0.39	0.65	4.1	2.12	2.1	1.42

Table 3 (Cont'd)

	28	29	30	31	32	33	34	35
ark76	1.02	0.76	10.87	4.05	0.41	0.22	0.65	1
ark77	1.32	1.01	11.18	4.23	0.39	0.23	0.66	1
ark81	1.02	0.87	11.22	4.09	0.41	0.27	0.65	1
ark83	1.04	0.8	11.23	4.05	0.39	0.26	0.65	1
ark84	1.02	0.76	8.24	3.84	0.14	0.21	0.69	1
ark85	1.03	0.88	10.87	4.12	0.38	0.23	0.66	1
ark287	1.22	0.96	8.12	3.85	0.31	0.24	0.69	1
ark288	1.15	0.99	8.25	3.76	0.33	0.25	0.7	1
ark289	1.09	0.96	9.52	4.05	0.41	0.24	0.65	1
ark290	1.1	0.91	10.18	4.15	0.42	0.26	0.66	1
ark291	1.19	0.85	7.62	3.82	0.28	0.25	0.64	1
ark408	1.1	0.95	9.48	4.08	0.39	0.2	0.22	1
ark409	1.1	0.75	10.7	4.02	0.4	0.23	0.66	1
ark410	1.2	0.92	8.5	4	0.35	0.25	0.67	1
ark411	1.17	0.95	8.35	3.9	0.34	0.26	0.69	1
ark413	1.1	0.94	9.51	4.01	0.39	0.25	0.66	1
ark414	1.12	0.89	9.8	4.2	0.41	0.27	0.65	1
ark415	1.21	0.86	7.8	3.81	0.31	0.27	0.63	1
corr460	0.97	0.75	7.95	3.6	0.12	0.26	1.1	1
corr461	0.92	0.75	7.08	4.15	0.11	0.24	1.1	1
corr462	0.65	0.99	9.31	4.89	0.11	0.25	1.1	1
corr463	0.55	0.58	8.5	3.44	0.21	0.23	1.2	1
corr464	0.61	0.57	6.59	2.7	0.14	0.23	0.4	1
corr465	0.68	0.52	4.42	2.58	0.18	0.22	1.2	1
corr466	0.7	0.82	3.45	2.04	0.18	0.19	1.2	1
corr468	1.04	0.75	5.8	2.8	0.17	0.21	1.1	1
corr470	0.92	0.75	5.4	2.24	0.14	0.16	1.1	1
corr471	0.91	0.6	5.7	2.43	0.15	0.2	1.2	1
Frut236	1.19	0.85	6.76	2.81	0.25	0.27	0.99	1

Table 3 (Cont'd)

	28	29	30	31	32	33	34	35
Frut237	1.49	0.98	7.1	3.8	0.25	0.28	0.57	1
Frut238	1.49	0.72	6.8	3.3	0.26	0.25	0.77	1
Frut239	1.39	0.76	11.92	3.01	0.46	0.36	0.33	1
Frut240	1.37	0.84	7.29	2.04	0.28	0.39	0.77	1
Frut241	1.17	1.25	5.85	2.24	0.6	0.8	0.88	1
Frut242	1.67	1.57	7.1	3.65	0.2	0.51	1.1	1
Frut243	1.36	1.51	7.07	4.15	0.18	0.52	0.56	1
Frut244	1.38	1.05	6.8	3.8	0.18	0.49	0.39	1
Frut245	1.23	0.82	6	3.2	0.13	0.24	0.28	1
Frut260	1.2	0.6	7.25	2.8	0.13	0.12	0.45	1
Frut261	1.39	0.85	7.1	3.45	0.2	0.26	0.62	1
Frut262	0.98	0.84	6.58	2.72	0.2	0.27	0.99	1
Frut263	1.02	0.62	7.2	2.85	0.14	0.15	0.5	1
Frut264	0.8	1.2	6.72	3.15	0.16	0.27	0.62	1
Frut46	0.8	1.2	6.75	3.2	0.16	0.27	0.62	1
Frut47	0.77	0.96	6.27	2.7	0.32	0.37	0.72	1
Frut48	1.35	0.89	6.98	2.52	0.63	0.55	0.55	1
Frut49	0.94	0.99	7.01	3.52	0.14	0.08	0.81	1
Frut50	1.17	0.86	7.09	3.94	0.37	0.33	0.7	1
Frut51	1.03	0.66	6.61	3.23	0.18	0.11	0.9	1
Frut52	0.78	0.48	5.72	2.42	0.17	0.08	0.85	1
Frut53	0.88	0.6	5.33	2.65	0.12	0.16	0.8	1
Frut54	1.21	0.69	6.72	3.46	0.16	0.05	0.52	1
Frut55	1.25	0.66	7.37	2.92	0.14	0.09	0.39	1
Frut56	0.43	0.68	6.47	3.19	0.25	0.2	0.73	1
Frut57	0.83	0.63	6.81	3.21	0.1	0.05	0.4	1
Frut58	0.83	0.47	5.78	2.51	0.08	0.12	0.2	1
Frut59	0.53	0.76	5.7	2.07	0.11	0.26	0.52	1
Frut60	0.89	0.79	5.79	2.48	0.08	0.18	0.49	1

Table 3 (Cont'd)

	28	29	30	31	32	33	34	35
Hum16	0.47	0.61	6.5	2.55	0.13	0.21	0.47	1
Hum17	0.82	0.87	4.18	2.22	0.18	0.19	0.35	1
Hum18	0.43	0.48	4.86	2.51	0.14	0.21	0.4	1
Hum19	1.5	1.46	5.67	2.75	0.11	0.25	0.41	1
Hum20	1.3	0.98	4.8	2.5	0.12	0.22	0.39	1
Hum21	1.12	0.91	4.95	2.84	0.22	0.26	0.19	1
Hum22	1.01	0.61	5.24	2.68	0.22	0.28	0.2	1
Hum23	1.2	0.89	4.88	2.99	0.18	0.18	0.38	1
Hum24	0.82	1.9	5.3	2.8	0.11	0.17	0.36	1
Hum25	0.97	0.87	4.62	2.73	0.12	0.15	0.4	1
Hum26	0.88	0.79	5.1	2.89	0.14	0.21	0.41	1
Hum27	0.86	0.77	4.12	2.48	0.09	0.12	0.42	1
Hum28	0.96	0.9	4.65	2.56	0.08	0.11	0.41	1
Hum29	1.05	0.86	4.98	2.97	0.1	0.18	0.42	1
Hum30	1.19	0.97	5.12	2.86	0.13	0.21	0.4	1
Hum31	1.3	0.72	5.23	2.81	0.14	0.19	0.42	1
inter106	1.2	0.8	7.5	3.25	0.18	0.21	0.98	1
inter107	1.97	0.75	7.04	3.9	0.21	0.24	1	1
inter108	1.01	0.64	7.12	3.2	0.22	0.23	0.82	1
inter110	1.32	0.45	5.98	2.4	0.21	0.21	0.78	1
inter111	1.2	0.64	6.83	3.2	0.22	0.24	1.01	1
inter112	0.78	0.8	6.92	2.25	0.19	0.21	1.08	1
inter113	0.7	0.8	7.98	3.12	0.18	0.2	1.53	1
inter116	1.14	0.7	5.75	2.2	0.22	0.2	0.8	1
inter118	1.24	0.76	6.95	3.3	0.22	0.24	1.3	1
inter119	1.09	0.52	8.12	3.17	0.19	0.21	0.92	1
inter120	1.25	0.89	7.2	2.75	0.21	0.24	0.93	1
inter225	1.1	0.59	7.98	3.38	0.21	0.22	0.94	1
inter226	1.22	0.72	7.12	3.24	0.21	0.24	1.2	1

Table 3 (Cont'd)

	28	29	30	31	32	33	34	35
lasio250	1.12	0.95	7.56	3.28	0.3	0.45	1.05	1
lasio251	1.27	0.91	10.12	4.6	0.31	0.38	1.09	1
lasio252	0.8	0.62	7.5	3.2	0.28	0.48	1.12	1
lasio253	1.3	0.87	10.22	3.74	0.3	0.45	1.45	1
lasio254	1.39	1.06	10.35	4.14	0.37	0.56	1.05	1
lasio255	1.45	0.85	7.61	4.87	0	0	1.13	1
lasio256	1.21	0.84	7.13	4.78	0.25	0.54	1.04	1
lasio257	1.16	0.62	8.09	4.04	0.3	0.47	0.98	1
lasio258	0.71	0.77	5.66	3.34	0.29	0.5	1	1
lasio259	1.25	0.86	7.68	3.41	0.35	0.43	1.05	1
lasio292	1.25	0.86	8.12	4.82	0.26	0.45	1.12	1
lasio293	1.31	0.83	7.43	4.68	0.26	0.54	1.1	1
lasio294	1.22	0.72	7.95	4.09	0.29	0.48	1.14	1
lasio295	0.86	0.81	6.2	3.32	0.31	0.51	0.98	1
lasio296	1.12	0.85	7.75	3.46	0.34	0.42	0.99	1
lasio61	1.18	0.96	8.32	3.7	0.25	0.51	1.11	1
lasio62	0.96	0.88	7.7	3.8	0.31	0.47	1.16	1
lasio63	0.88	0.56	6.23	2.44	0.3	0.2	1.15	1
lasio64	1.39	0.92	7.85	4	0.31	0.5	1.14	1
lasio65	1.46	0.94	8.35	2.85	0.27	0.58	1.12	1
lasio66	0.77	0.82	7.59	3.28	0.21	0.39	1.13	1
lasio67	0.88	0.57	7.61	3.3	0.24	0.52	1.05	1
lasio68	0.81	0.91	7.8	4.02	0.28	0.46	1.13	1
lasio69	1.7	1.23	9.95	5.05	0.28	0.53	1.06	1
lasio70	1.09	0.85	7.98	3.94	0.31	0.39	1.06	1
lasio71	0.85	0.84	7.65	3.52	0.3	0.43	1.12	1
lasio72	0.55	0.76	8.21	4.01	0.34	0.51	1.03	1
lasio73	0.66	0.53	7.48	3.62	0.28	0.5	1.05	1
lasio74	0.76	0.87	8.32	3.89	0.27	0.52	1.11	1

Table 3 (Cont'd)

	28	29	30	31	32	33	34	35
lasio75	0.83	0.93	7.74	3.81	0.31	0.45	1.15	1
Marit121	0.85	0.72	7.6	4.2	0.19	0.28	0.32	1
Marit122	0.76	0.66	6.85	3.94	0.11	0.14	0.15	1
Marit123	0.96	0.79	8.54	4.21	0.19	0.35	0.37	1
Marit124	0.72	0.6	6.73	3.89	0.12	0.13	0.17	1
Marit125	0.78	0.68	6.9	3.89	1.13	0.17	0.2	1
Marit126	0.75	0.68	6.92	4.12	0.1	0.15	0.24	1
Marit126	0.82	0.65	6.93	3.97	0.13	0.17	0.26	1
Marit127	0.69	0.7	6.76	4.02	0.99	0.2	0.19	1
Marit128	0.8	0.62	6.76	3.94	0.11	0.14	0.35	1
Marit129	0.72	0.67	6.72	3.85	0.11	0.13	0.26	1
Marit130	0.75	0.68	6.92	3.76	0.14	0.12	0.16	1
Marit131	0.81	0.69	7.01	3.79	0.12	0.14	0.21	1
Marit132	0.79	0.72	7.4	3.95	0.16	0.27	0.21	1
Marit133	0.94	0.86	8.78	4.03	0.22	0.39	0.38	1
occ1	0.69	0.58	3.6	1.3	0.14	0.21	0.55	1
occ10	0.38	0.52	4.64	1.6	0.13	0.18	0.6	1
occ11	0.4	0.53	7.2	2.2	0.14	0.2	0.61	1
occ12	0.62	0.58	5.5	2.5	0.14	0.21	0.34	1
occ13	0.69	0.57	6	2.26	0.15	0.21	0.59	1
occ14	0.85	0.64	6.3	3.96	0.12	0.17	0.52	1
occ15	0.45	0.51	5.7	2.45	0.13	0.16	0.59	1
occ2	0.74	0.54	7.92	4.5	0.14	0.14	0.98	1
occ3	0.76	0.58	4.2	2.8	0.13	0.2	0.49	1
occ309	0.71	0.55	5.5	2.2	0.13	0.18	0.52	1
occ310	0.52	0.55	6.3	2.25	0.13	0.19	0.54	1
occ311	0.55	0.56	5.5	1.98	0.14	0.19	0.52	1
occ312	0.72	0.58	5.85	2.3	0.15	0.21	0.53	1
occ313	0.68	0.56	5.5	2.2	0.14	0.18	0.49	1

Table 3 (Cont'd)

	28	29	30	31	32	33	34	35
occ314	0.73	0.58	6.2	2.4	0.14	0.2	0.5	1
occ315	0.55	0.53	6.5	2.3	0.14	0.18	0.53	1
occ316	0.78	0.6	6.5	2.8	0.15	0.2	0.55	1
occ317	0.72	0.63	6.2	3.19	0.13	0.17	0.49	1
occ318	0.68	0.61	6.5	2.56	0.14	0.19	0.6	1
occ4	0.74	0.61	3.89	1.03	0.14	0.22	0.54	1
occ5	0.72	0.58	5.8	2.3	0.14	0.2	0.55	1
occ6	0.81	0.63	5.7	3.3	0.14	0.18	0.5	1
occ7	0.73	0.53	4.1	1.8	0.13	0.2	0.51	1
occ8	0.74	0.54	5.7	2.42	0.13	0.21	0.42	1
occ9	0.66	0.58	6.2	2.36	0.14	0.2	0.55	1
punc151	1.06	0.73	7.3	3.46	0.22	0.29	1.12	1
punc152	0.62	0.8	6.2	2.66	0.18	0.24	0.88	1
punc154	0.96	0.67	8.2	3.45	0.2	0.27	0.99	1
punc155	0.91	0.67	7.6	4.1	0.22	0.3	1.1	1
punc158	0.72	0.74	8.4	3.3	0.19	0.13	1.17	1
punc159	1.18	1.03	9.2	4.6	0.24	0.35	1.19	1
punc160	0.92	0.69	7.58	3.2	0.21	0.24	0.85	1
punc161	0.72	0.71	10.25	4.26	0.17	0.21	1.1	1
punc163	0.85	0.78	7.85	4.1	0.28	0.44	1.14	1
punc164	0.66	0.68	6.32	3.06	0.24	0.31	0.99	1
punc165	0.59	0.7	7.01	2.28	0.21	0.38	1.66	1
punc246	0.79	0.69	7.54	3.14	0.24	0.35	1.42	1
punc247	0.78	0.69	6.43	3.12	0.24	0.32	1.12	1
punc248	0.68	0.72	9.4	3.45	0.19	0.19	1.1	1
punc249	0.84	0.86	8.86	3.89	0.23	0.31	1.16	1
punc301	0.95	0.64	7.75	3.5	0.22	0.26	1.1	1
punc302	0.96	0.68	7.15	3.26	0.25	0.28	1.1	1
punc303	0.89	0.67	7.62	3.1	0.19	0.28	1.16	1

Table 3 (Cont'd)

	28	29	30	31	32	33	34	35
punc304	1.2	0.7	7.15	3.3	0.21	0.29	1.12	1
punc305	0.91	0.63	6.8	3.2	0.26	0.31	1.21	1
Stan271	1.05	0.82	7.13	3.12	0.09	0.12	1.14	1
Stan272	1.15	1.1	7.41	3.49	0.085	0.13	1.1	1
Stan273	1.19	0.82	7.55	3.24	0.09	0.13	1.1	1
Stan274	0.72	0.61	7.38	3.58	0.09	0.12	1.18	1
Stan275	0.88	0.75	7.41	3.51	0.08	0.12	1.1	1
Stan276	1.2	0.72	7.19	3.61	0.09	0.12	1.12	1
Stan91	1.27	0.7	7.63	3.26	0.09	0.12	1.54	1
Stan92	0.96	0.8	7.56	3.32	0.09	0.13	1.45	1
Stan93	0.82	0.72	7.89	3.95	0.09	0.13	1.43	1
Stan94	1.34	0.73	7.22	3.57	0.09	0.13	1.08	1
Stan95	0.6	0.71	7.45	3.48	0.085	0.11	1.05	1
Stan96	0.66	0.58	7.3	3.54	0.09	0.13	1.21	1
Stan97	1.18	0.76	7.56	3.18	0.09	0.14	0.98	1
Stan98	1.31	1.26	7.43	3.52	0.08	0.12	0.89	1
Stan99	1.19	0.55	7.12	2.95	0.09	0.13	1.11	1
vill156	1.22	0.9	7.9	2.1	0.2	0.32	1.4	1
vill157	1.1	0.72	8.1	3.89	0.21	3.1	1.2	1
vill162	1.1	0.73	8.3	3.85	0.22	0.31	1.14	1
vill207	0.95	0.56	6.91	3.55	0.11	0.18	1.12	1
vill208	1.07	0.63	8.1	3.9	0.27	0.54	1.17	1
vill209	1.13	0.83	6.8	3.35	0.19	0.3	1.15	1
vill210	1.16	0.77	7.9	3.2	0.21	0.24	1.17	1
vill211	1.03	0.79	6.21	2.72	0.24	0.26	1.15	1
vill212	1.02	0.59	7.2	3.4	0.18	0.22	1.19	1
vill213	1.04	0.65	7.85	3.8	0.25	0.45	1.27	1
vill214	1.12	0.82	7.72	3.45	0.21	0.32	1.36	1
vill215	1.15	0.76	6.53	3.3	0.22	0.26	1.12	1

Table 3 (Cont'd)

	28	29	30	31	32	33	34	35
vill216	1.1	0.75	6.42	2.9	0.23	0.28	1.18	1
vill217	1.02	0.58	7.28	3.6	0.19	0.22	1.19	1
vill218	1.05	0.68	7.86	3.75	0.26	0.48	1.23	1
vill31	1.01	0.55	6.8	3.61	0.21	0.27	1.15	1
vill32	0.98	0.77	6.62	2.92	0.25	0.28	1.18	1
vill33	1.12	0.78	7.5	3.1	0.24	0.25	1.16	1
vill34	1.13	0.82	7.3	3.28	0.22	0.32	1.15	1
vill35	1.06	0.62	8.2	3.86	0.26	0.41	1.16	1
vill36	1.01	0.58	7.4	3.45	0.19	0.33	1.13	1
vill37	1	0.76	6.81	2.7	0.25	0.32	1.23	1
vill39	1.11	0.84	8.67	2.2	0.22	0.31	1.36	1
vill40	1.08	0.61	7.98	3.8	0.28	0.48	1.28	1
vill41	0.98	0.62	7.2	3.45	0.19	0.29	1.16	1
vill42	1.02	0.81	7.34	2.89	0.25	0.31	1.17	1
vill43	1.13	0.75	6.45	3.15	0.22	0.32	1.16	1
vill44	1.12	0.82	8.3	3.25	0.23	0.33	1.32	1
vill45	1.09	0.64	7.62	3.85	0.25	0.48	1.21	1
Virid136	1.2	1.04	8.5	3.6	0.25	0.31	0.86	1
Virid137	1.55	1.36	9.24	3.98	0.28	0.33	0.89	1
Virid138	1.22	0.95	6.85	3.24	0.26	0.31	0.91	1
Virid139	1.77	1.14	7.56	4.1	0.27	0.33	0.95	1
Virid140	1.7	0.78	7.73	3.72	0.34	0.34	0.97	1
Virid141	1.05	0.81	7.45	3.58	0.29	0.3	0.92	1
Virid142	0.69	0.82	7.85	3.49	0.3	0.33	1.1	1
Virid143	1.6	1.16	8.65	3.86	0.31	0.32	0.98	1
Virid144	1.65	0.96	9.6	4.2	0.28	0.31	0.85	1
Virid145	1.77	1.16	7.54	3.65	0.26	0.28	0.88	1
Virid146	1.06	0.78	7.82	3.71	0.38	0.32	1	1
Virid147	1.27	1.16	9.54	4.13	0.33	0.31	0.95	1

Table 3 (Cont'd)

	28	29	30	31	32	33	34	35
Virid148	1.36	1.23	7.56	3.61	0.25	0.3	0.98	1
Virid149	1.3	1.21	7.72	3.6	0.22	0.28	0.76	1
Virid150	1.27	1.18	6.52	3.52	0.25	0.31	0.92	1
Virid219	0.93	0.99	6.52	2.81	0.26	0.32	0.94	1
Virid220	1.76	0.91	7.86	3.63	0.27	0.33	0.96	1
Virid221	1.24	1.1	7.43	3.49	0.29	0.31	0.88	1
Virid222	1.62	1.13	8.41	4.24	0.32	0.3	0.91	1
Virid223	1.75	0.86	7.51	3.58	0.26	0.29	0.95	1
Virid282	1.12	0.98	6.6	3.2	0.25	0.31	0.95	1
Virid283	1.64	0.95	7.7	3.72	0.26	0.32	0.95	1
Virid284	1.32	0.99	7.52	3.55	0.28	0.32	0.91	1
Virid285	1.58	1.05	8.35	4.3	0.29	0.31	0.9	1
Virid286	1.62	0.92	7.74	3.62	0.3	0.28	0.94	1

Table 3 (Cont'd)

	36	37	38	39	40	41	42	43
ark76	1	1	1	1	1	1	1	1
ark77	0	1	1	1	0	1	1	1
ark81	1	1	1	1	1	1	1	1
ark83	0	1	1	1	1	1	1	1
ark84	0	1	1	1	1	1	1	1
ark85	0	0	1	1	0	1	1	1
ark287	0	1	0	1	0	1	1	1
ark288	1	1	1	1	1	1	1	1
ark289	0	1	0	1	0	1	1	1
ark290	1	1	1	1	1	1	1	1
ark291	0	1	0	1	0	1	1	1
ark408	0	0	0	1	0	1	1	1
ark409	1	0	1	1	1	1	1	1
ark410	0	1	1	1	0	1	1	1
ark411	1	1	1	1	1	1	1	1
ark413	1	1	1	1	1	1	1	1
ark414	1	1	1	1	1	1	1	1
ark415	1	1	1	1	1	1	1	1
corr460	0	1	0	1	0	1	1	1
corr461	0	1	0	1	0	1	1	1
corr462	0	1	0	1	0	1	1	1
corr463	0	1	0	1	0	1	1	1
corr464	0	1	0	1	0	1	1	1
corr465	0	1	0	1	0	1	1	1
corr466	0	1	0	1	0	1	1	1
corr468	0	1	0	1	0	1	1	1
corr470	0	1	0	1	0	1	1	1
corr471	0	1	0	1	0	1	1	1
Frut236	0	1	0	1	0	1	0	1

Table 3 (Cont'd)

	36	37	38	39	40	41	42	43
Frut237	0	1	0	1	0	1	0	1
Frut238	0	1	0	1	0	1	0	1
Frut239	0	1	0	1	0	1	0	1
Frut240	0	1	0	1	0	1	0	1
Frut241	0	1	0	1	0	1	0	1
Frut242	0	1	0	1	0	1	0	1
Frut243	0	1	0	1	0	1	0	1
Frut244	0	1	0	1	0	1	0	1
Frut245	0	1	0	1	0	1	0	1
Frut260	0	1	0	1	0	1	0	1
Frut261	0	1	0	1	0	1	0	1
Frut262	0	1	0	1	0	1	0	1
Frut263	0	1	0	1	0	1	0	1
Frut264	0	1	0	1	0	1	0	1
Frut46	0	1	0	1	0	1	0	1
Frut47	0	1	0	1	0	1	0	1
Frut48	0	1	0	1	0	1	0	1
Frut49	0	1	0	1	0	1	0	1
Frut50	0	1	0	1	0	1	0	1
Frut51	0	1	0	1	0	1	0	1
Frut52	0	1	0	1	0	1	0	1
Frut53	0	1	0	1	0	1	0	1
Frut54	0	1	0	1	0	1	0	1
Frut55	0	1	0	1	0	1	0	1
Frut56	0	1	0	1	0	1	0	1
Frut57	0	1	0	1	0	1	0	1
Frut58	0	1	0	1	0	1	0	1
Frut59	0	1	0	1	0	1	0	1
Frut60	0	1	0	1	0	1	0	1

Table 3 (Cont'd)

	36	37	38	39	40	41	42	43
Hum16	0	1	0	1	0	1	0	1
Hum17	0	1	0	1	0	1	0	1
Hum18	0	1	0	1	0	1	0	1
Hum19	0	1	0	1	0	1	0	1
Hum20	0	1	0	1	0	1	0	1
Hum21	0	1	0	1	0	1	0	1
Hum22	0	1	0	1	0	1	0	1
Hum23	0	1	0	1	0	1	0	1
Hum24	0	1	0	1	0	1	0	1
Hum25	0	1	0	1	0	1	0	1
Hum26	0	1	0	1	0	1	0	1
Hum27	0	1	0	1	0	1	0	1
Hum28	0	1	0	1	0	1	0	1
Hum29	0	1	0	1	0	1	0	1
Hum30	0	1	0	1	0	1	0	1
Hum31	0	1	0	1	0	1	0	1
inter106	0	1	0	1	0	1	1	1
inter107	0	1	0	1	0	1	1	1
inter108	0	1	0	1	0	1	0	1
inter110	0	1	0	1	0	1	1	1
inter111	0	1	0	1	0	1	1	1
inter112	0	1	0	1	0	1	1	1
inter113	0	1	0	1	0	1	1	1
inter116	0	1	0	1	0	1	1	1
inter118	0	1	0	1	0	1	1	1
inter119	0	1	0	1	0	1	1	1
inter120	0	1	0	1	0	1	1	1
inter225	0	1	0	1	0	1	1	1
inter226	0	1	0	1	0	1	0	1

Table 3 (Cont'd)

	36	37	38	39	40	41	42	43
lasio250	0	1	0	1	0	1	1	1
lasio251	0	1	0	1	0	1	1	1
lasio252	0	1	0	1	0	1	1	1
lasio253	0	1	0	1	0	1	1	1
lasio254	0	1	0	1	0	1	1	1
lasio255	0	1	0	1	0	1	1	1
lasio256	0	1	0	1	0	1	1	1
lasio257	0	1	0	1	0	1	1	1
lasio258	0	1	0	1	0	1	1	1
lasio259	0	1	0	1	0	1	1	1
lasio292	0	1	0	1	0	1	1	1
lasio293	0	1	0	1	0	1	1	1
lasio294	0	1	0	1	0	1	1	1
lasio295	0	1	0	1	0	1	1	1
lasio296	0	1	0	1	0	1	1	1
lasio61	1	1	1	1	1	1	1	1
lasio62	0	1	0	1	0	1	1	1
lasio63	0	1	0	1	0	1	1	1
lasio64	0	1	0	1	0	1	1	1
lasio65	0	1	0	1	0	1	1	1
lasio66	0	1	0	1	0	1	1	1
lasio67	0	1	0	1	0	1	1	1
lasio68	0	1	0	1	0	1	1	1
lasio69	0	1	0	1	0	1	1	1
lasio70	0	1	0	1	0	1	1	1
lasio71	0	1	0	1	0	1	0	1
lasio72	0	1	0	1	0	1	0	1
lasio73	0	1	0	1	0	1	1	1
lasio74	0	1	0	1	0	1	1	1

Table 3 (Cont'd)

	36	37	38	39	40	41	42	43
lasio75	0	1	0	1	0	1	1	1
Marit121	1	1	1	1	1	1	1	0
Marit122	1	1	1	1	1	1	1	0
Marit123	1	1	1	1	1	1	1	0
Marit124	1	1	1	1	1	1	1	0
Marit125	1	1	1	1	1	1	1	0
Marit126	1	1	1	1	1	1	1	0
Marit126	1	1	1	1	1	1	1	0
Marit127	1	1	1	1	1	1	1	0
Marit128	1	1	1	1	1	1	1	0
Marit129	1	1	1	1	1	1	1	0
Marit130	1	1	1	1	1	1	1	0
Marit131	1	1	1	1	1	1	1	0
Marit132	1	1	1	1	1	1	1	0
Marit133	1	1	1	1	1	1	1	0
occ1	0	1	0	1	0	1	0	1
occ10	0	1	0	1	0	1	0	1
occ11	0	1	0	1	0	1	0	1
occ12	0	1	0	1	0	1	0	1
occ13	0	1	0	1	0	1	0	1
occ14	0	1	0	1	0	1	0	1
occ15	0	1	0	1	0	1	0	1
occ2	0	1	0	1	0	1	0	1
occ3	0	1	0	1	0	1	0	1
occ309	0	1	0	1	0	1	0	1
occ310	0	1	0	1	0	1	0	1
occ311	0	1	0	1	0	1	0	1
occ312	0	1	0	1	0	1	0	1
occ313	0	1	0	1	0	1	0	1

Table 3 (Cont'd)

	36	37	38	39	40	41	42	43
occ314	0	1	0	1	0	1	0	1
occ315	0	1	0	1	0	1	0	1
occ316	0	1	0	1	0	1	0	1
occ317	0	1	0	1	0	1	0	1
occ318	0	1	0	1	0	1	0	1
occ4	0	1	0	1	0	1	0	0
occ5	0	1	0	1	0	1	0	1
occ6	0	1	0	1	0	1	0	1
occ7	0	1	0	1	0	1	0	1
occ8	0	1	0	1	0	1	0	1
occ9	0	1	0	1	0	1	0	1
punc151	0	1	0	1	0	1	1	1
punc152	0	1	0	1	0	1	1	1
punc154	1	1	1	1	1	1	1	1
punc155	1	1	1	1	1	1	1	1
punc158	0	1	0	1	0	1	0	1
punc159	1	1	1	1	1	1	1	1
punc160	1	1	1	1	1	1	1	1
punc161	0	1	0	1	0	1	0	1
punc163	0	1	0	1	0	1	0	1
punc164	0	1	0	1	0	1	1	1
punc165	0	1	0	1	0	1	1	1
punc246	1	1	1	1	1	1	1	1
punc247	0	1	0	1	0	1	1	1
punc248	0	1	0	1	0	1	0	1
punc249	0	1	0	1	0	1	1	1
punc301	1	1	1	1	1	1	1	1
punc302	1	1	1	1	1	1	1	1
punc303	1	1	1	1	1	1	1	1

Table 3 (Cont'd)

	36	37	38	39	40	41	42	43
punc304	1	1	1	1	1	1	1	1
punc305	1	1	1	1	1	1	1	1
Stan271	0	1	0	1	0	1	0	1
Stan272	0	1	0	1	0	1	0	1
Stan273	0	1	0	1	0	1	0	1
Stan274	0	1	0	1	0	1	0	1
Stan275	0	1	0	1	0	1	0	1
Stan276	0	1	0	1	0	1	0	1
Stan91	0	1	0	1	0	1	0	1
Stan92	0	1	0	1	0	1	0	1
Stan93	0	1	0	1	0	1	0	1
Stan94	0	1	0	1	0	1	0	1
Stan95	0	1	0	1	0	1	0	1
Stan96	0	1	0	1	0	1	0	1
Stan97	0	1	0	1	0	1	0	1
Stan98	0	1	0	1	0	1	0	1
Stan99	0	1	0	1	0	1	0	1
vill156	1	1	1	1	1	1	1	1
vill157	1	1	1	1	1	1	1	1
vill162	1	1	1	1	1	1	1	1
vill207	1	1	1	1	1	1	1	1
vill208	1	1	1	1	1	1	1	1
vill209	1	1	1	1	1	1	1	1
vill210	1	1	1	1	1	1	1	1
vill211	1	1	1	1	1	1	1	1
vill212	1	1	1	1	1	1	1	1
vill213	1	1	1	1	1	1	1	1
vill214	1	1	1	1	1	1	1	1
vill215	1	1	1	1	1	1	1	1

Table 3 (Cont'd)

	36	37	38	39	40	41	42	43
vill216	1	1	1	1	1	1	1	1
vill217	1	1	1	1	1	1	1	1
vill218	1	1	1	1	1	1	1	1
vill31	1	1	1	1	1	1	1	1
vill32	1	1	1	1	1	1	1	1
vill33	1	1	1	1	1	1	1	1
vill34	1	1	1	1	1	1	1	1
vill35	1	1	1	1	1	1	1	1
vill36	1	1	1	1	1	1	1	1
vill37	1	1	1	1	1	1	1	1
vill39	1	1	1	1	1	1	1	1
vill40	1	1	1	1	1	1	1	1
vill41	1	1	1	1	1	1	1	1
vill42	1	1	1	1	1	1	1	1
vill43	1	1	1	1	1	1	1	1
vill44	1	1	1	1	1	1	1	1
vill45	1	1	1	1	1	1	1	1
Virid136	0	1	0	1	0	1	1	1
Virid137	0	1	0	1	0	1	1	1
Virid138	0	1	0	1	0	1	1	1
Virid139	0	1	0	1	0	1	1	1
Virid140	0	1	0	0	0	1	1	1
Virid141	0	1	0	0	0	1	1	1
Virid142	0	1	0	0	0	1	1	1
Virid143	0	1	0	0	0	1	1	1
Virid144	0	1	0	0	0	1	1	1
Virid145	0	1	0	0	0	1	1	1
Virid146	0	1	0	0	0	1	1	1
Virid147	0	1	0	0	0	1	1	1

Table 3 (Cont'd)

	36	37	38	39	40	41	42	43
Virid148	0	1	0	0	0	1	1	1
Virid149	0	1	0	0	0	1	1	1
Virid150	0	1	0	0	0	1	1	0
Virid219	0	1	0	1	0	1	1	1
Virid220	0	1	0	1	0	1	1	1
Virid221	0	1	0	1	0	1	1	1
Virid222	0	1	0	1	0	1	1	1
Virid223	0	1	0	1	0	1	1	1
Virid282	0	1	0	1	0	1	1	1
Virid283	0	1	0	1	0	1	0	1
Virid284	0	1	0	1	0	1	0	1
Virid285	0	1	0	1	0	1	0	1
Virid286	0	1	0	1	0	1	0	1

Table 3 (Cont'd)

	44	45	46	47	48	49	50
ark76	1	1	1	1	1	1	0
ark77	1	1	1	1	1	1	0
ark81	1	1	1	1	1	1	0
ark83	1	1	1	1	1	1	0
ark84	1	1	1	1	1	1	0
ark85	1	1	1	1	0	1	0
ark287	1	1	1	1	1	1	0
ark288	1	1	1	1	1	1	0
ark289	1	1	1	1	1	1	0
ark290	1	1	1	1	1	1	0
ark291	1	1	0	1	0	1	0
ark408	1	1	0	1	1	1	0
ark409	1	1	1	1	1	1	0
ark410	1	1	1	1	1	1	0
ark411	1	1	1	1	0	1	0
ark413	1	1	1	1	1	1	0
ark414	1	1	1	1	1	1	0
ark415	1	1	0	1	1	1	0
corr460	1	1	0	1	0	1	0
corr461	1	1	0	1	0	1	0
corr462	1	1	0	1	0	1	0
corr463	1	1	0	1	0	1	0
corr464	1	1	0	1	0	1	0
corr465	1	1	0	1	0	1	0
corr466	1	1	0	1	0	1	0
corr468	1	1	0	1	0	1	0
corr470	1	1	0	1	0	1	0
corr471	1	1	0	1	0	1	0
Frut236	0	1	0	1	0	1	0

Table 3 (Cont'd)

	44	45	46	47	48	49	50
Frut237	0	1	0	1	0	1	0
Frut238	0	1	0	1	0	1	0
Frut239	0	1	0	1	0	1	0
Frut240	0	1	0	1	0	1	0
Frut241	0	1	0	1	0	1	0
Frut242	0	1	0	1	0	1	0
Frut243	0	1	0	1	0	1	0
Frut244	0	1	0	1	0	1	0
Frut245	0	1	0	1	0	1	0
Frut260	0	1	0	1	0	1	0
Frut261	0	1	0	1	0	1	0
Frut262	0	1	0	1	0	1	0
Frut263	0	1	0	1	0	1	0
Frut264	0	1	0	1	0	1	0
Frut46	0	1	0	1	0	1	0
Frut47	0	1	0	1	0	1	0
Frut48	0	1	0	1	0	1	0
Frut49	0	1	0	1	0	1	0
Frut50	0	1	0	1	0	1	0
Frut51	0	1	0	1	0	1	0
Frut52	0	1	0	1	0	1	0
Frut53	0	1	0	1	0	1	0
Frut54	0	1	0	1	0	1	0
Frut55	0	1	0	1	0	1	0
Frut56	0	1	0	1	0	1	0
Frut57	0	1	0	1	0	1	0
Frut58	0	1	0	1	0	1	0
Frut59	0	1	0	1	0	1	0
Frut60	0	1	0	1	0	1	0

Table 3 (Cont'd)

	44	45	46	47	48	49	50
Hum16	0	1	0	1	0	0	0
Hum17	0	1	0	1	0	0	0
Hum18	0	1	0	1	0	0	0
Hum19	0	1	0	1	0	0	0
Hum20	0	1	0	1	0	0	0
Hum21	0	1	0	1	0	0	0
Hum22	0	1	0	1	0	0	0
Hum23	0	1	0	1	0	0	0
Hum24	0	1	0	1	0	0	0
Hum25	0	1	0	1	0	0	0
Hum26	0	1	0	1	0	0	0
Hum27	0	1	0	1	0	0	0
Hum28	0	1	0	1	0	0	0
Hum29	0	1	0	1	0	0	0
Hum30	0	1	0	1	0	0	0
Hum31	0	1	0	1	0	0	0
inter106	1	1	0	1	0	1	0
inter107	1	1	0	1	0	1	0
inter108	0	1	0	1	0	0	0
inter110	1	1	0	1	0	1	0
inter111	1	1	0	1	0	1	0
inter112	1	1	0	1	0	1	0
inter113	1	1	0	1	0	1	0
inter116	1	1	0	1	0	1	0
inter118	1	1	0	1	0	1	0
inter119	1	1	0	1	0	1	0
inter120	1	1	0	1	0	1	0
inter225	1	1	0	1	0	1	0
inter226	0	1	0	1	0	1	0

Table 3 (Cont'd)

	44	45	46	47	48	49	50
lasio250	1	1	0	1	0	1	0
lasio251	1	1	1	1	1	1	0
lasio252	1	1	1	1	1	1	0
lasio253	1	1	0	1	0	1	0
lasio254	1	1	0	1	0	1	0
lasio255	1	1	0	1	0	1	0
lasio256	1	1	1	1	1	1	0
lasio257	1	1	0	1	0	1	0
lasio258	1	1	0	1	0	1	0
lasio259	1	1	0	1	0	1	0
lasio292	1	1	0	1	0	1	0
lasio293	1	1	0	1	0	1	0
lasio294	1	1	0	1	0	1	0
lasio295	1	1	0	1	0	1	0
lasio296	1	1	0	1	0	1	0
lasio61	1	1	1	1	1	1	0
lasio62	1	1	1	1	1	1	0
lasio63	1	1	0	1	0	1	0
lasio64	1	1	1	1	1	1	0
lasio65	1	1	0	1	0	1	0
lasio66	1	1	0	1	0	1	0
lasio67	1	1	1	1	1	1	0
lasio68	1	1	1	1	1	1	0
lasio69	1	1	1	1	1	1	0
lasio70	1	1	0	1	0	1	0
lasio71	0	1	0	1	0	1	0
lasio72	0	1	0	1	0	1	0
lasio73	1	1	0	1	0	1	0
lasio74	1	1	0	1	0	1	0

Table 3 (Cont'd)

	44	45	46	47	48	49	50
lasio75	1	1	1	1	1	1	0
Marit121	1	0	1	0	1	1	0
Marit122	1	0	1	0	1	1	0
Marit123	1	0	1	0	1	1	0
Marit124	1	0	1	0	1	1	0
Marit125	1	0	1	0	1	1	0
Marit126	1	0	1	0	1	1	0
Marit126	1	0	1	0	1	1	0
Marit127	1	0	1	0	1	1	0
Marit128	1	0	1	0	1	1	0
Marit129	1	0	1	0	1	1	0
Marit130	1	0	1	0	1	1	0
Marit131	1	0	1	0	1	1	0
Marit132	1	0	1	0	1	1	0
Marit133	1	0	1	0	1	1	0
occ1	0	1	0	1	0	0	0
occ10	0	1	0	1	0	0	0
occ11	0	1	0	1	0	0	0
occ12	0	1	0	1	0	0	0
occ13	0	1	0	1	0	0	0
occ14	0	1	0	1	0	0	0
occ15	0	1	0	1	0	0	0
occ2	0	1	0	1	0	0	0
occ3	0	1	0	1	0	0	0
occ309	0	1	0	1	0	0	0
occ310	0	1	0	1	0	0	0
occ311	0	1	0	1	0	0	0
occ312	0	1	0	1	0	0	0
occ313	0	1	0	1	0	0	0

Table 3 (Cont'd)

	44	45	46	47	48	49	50
occ314	0	1	0	1	0	0	0
occ315	0	1	0	1	0	0	0
occ316	0	1	0	1	0	0	0
occ317	0	1	0	1	0	0	0
occ318	0	1	0	1	0	0	0
occ4	0	0	0	0	0	0	0
occ5	0	1	0	1	0	0	0
occ6	0	1	0	1	0	0	0
occ7	0	1	0	1	0	0	0
occ8	0	1	0	1	0	0	0
occ9	0	1	0	1	0	0	0
punc151	1	1	1	1	1	1	0
punc152	1	1	1	1	1	1	0
punc154	1	1	1	1	1	1	0
punc155	1	1	1	1	1	1	0
punc158	1	1	1	1	1	1	0
punc159	1	1	1	1	1	1	0
punc160	1	1	1	1	1	1	0
punc161	1	1	1	1	1	1	0
punc163	1	1	0	1	0	1	0
punc164	1	1	0	1	0	1	0
punc165	1	1	1	1	1	1	0
punc246	1	1	1	1	1	1	0
punc247	1	1	0	1	0	1	0
punc248	1	1	1	1	1	1	0
punc249	1	1	0	1	0	1	0
punc301	1	1	1	1	1	1	0
punc302	1	1	1	1	1	1	0
punc303	1	1	1	1	1	1	0

Table 3 (Cont'd)

	44	45	46	47	48	49	50
punc304	1	1	1	1	1	1	0
punc305	1	1	1	1	1	1	0
Stan271	0	1	0	1	0	0	0
Stan272	0	1	0	1	0	0	0
Stan273	0	1	0	1	0	0	0
Stan274	0	1	0	1	0	0	0
Stan275	0	1	0	1	0	0	0
Stan276	0	1	0	1	0	0	0
Stan91	0	1	0	1	0	0	0
Stan92	0	1	0	1	0	0	0
Stan93	0	1	0	1	0	0	0
Stan94	0	1	0	1	0	0	0
Stan95	0	1	0	1	0	0	0
Stan96	0	1	0	1	0	0	0
Stan97	0	1	0	1	0	0	0
Stan98	0	1	0	1	0	0	0
Stan99	0	1	0	1	0	0	0
vill156	1	1	1	1	1	1	1
vill157	1	1	1	1	1	1	1
vill162	1	1	1	1	1	1	1
vill207	1	1	1	1	1	1	1
vill208	1	1	1	1	1	1	1
vill209	1	1	1	1	1	1	1
vill210	1	1	1	1	1	1	1
vill211	1	1	1	1	1	1	1
vill212	1	1	1	1	1	1	1
vill213	1	1	1	1	1	1	1
vill214	1	1	1	1	1	1	1
vill215	1	1	1	1	1	1	1

Table 3 (Cont'd)

	44	45	46	47	48	49	50
vill216	1	1	1	1	1	1	1
vill217	1	1	1	1	1	1	1
vill218	1	1	1	1	1	1	1
vill31	1	1	1	1	1	1	1
vill32	1	1	1	1	1	1	1
vill33	1	1	1	1	1	1	1
vill34	1	1	1	1	1	1	1
vill35	1	1	1	1	1	1	1
vill36	1	1	1	1	1	1	1
vill37	1	1	1	1	1	1	1
vill39	1	1	1	1	1	1	1
vill40	1	1	1	1	1	1	1
vill41	1	1	1	1	1	1	1
vill42	1	1	1	1	1	1	1
vill43	1	1	1	1	1	1	1
vill44	1	1	1	1	1	1	1
vill45	1	1	1	1	1	1	1
Virid136	1	1	1	1	1	1	0
Virid137	1	1	0	1	0	1	0
Virid138	1	1	1	1	1	1	0
Virid139	1	1	0	1	1	1	0
Virid140	1	1	1	1	1	1	0
Virid141	1	1	1	1	1	1	0
Virid142	1	1	1	1	1	1	0
Virid143	1	1	1	1	1	1	0
Virid144	1	1	1	1	1	1	0
Virid145	1	1	1	1	1	1	0
Virid146	1	1	1	1	1	1	0
Virid147	1	1	1	1	1	1	0

Table 3 (Cont'd)

	44	45	46	47	48	49	50
Virid148	1	1	1	1	1	1	0
Virid149	1	1	1	1	1	1	0
Virid150	1	1	0	1	0	1	0
Virid219	1	1	0	1	0	1	0
Virid220	1	1	1	1	1	1	0
Virid221	1	1	1	1	1	1	0
Virid222	1	1	1	1	1	1	0
Virid223	1	1	1	1	1	1	0
Virid282	1	1	1	1	1	1	0
Virid283	1	1	1	1	1	1	0
Virid284	1	1	1	1	1	1	0
Virid285	1	1	1	1	1	1	0
Virid286	1	1	1	1	1	1	0

APPENDIX B

Morphometric data for *Monarda* section *Aristatae*. Character numbers correspond to those presented in the Materials and Methods section

Table 4. Morphometric data for *Monarda* Section *Aristatae*

				1	2
austro383	*Maysilles*	*8272*	TEX	5.1	1
austro384	*Laferriere*	*2017*	TEX	4.7	1.2
austro385	*Van Devender*	*96-378*	ARIZ	4.2	1.8
austro386	*LeSueur*	*887*	TEX	3.1	1.1
austro387	*Worthington*	*8910*	TEX	4.2	1
austro388	*Correll*	*20146*	LL	4.1	1.3
austro389	*Neff*	*91-13*	TEX	6.5	1.1
austro390	*Wilson*	*8457*	TEX	4.5	1.5
austro391	*Martin*	*s.n.*	ARIZ	4.4	2.5
austro392	*Scora*	*2716*	TEX	3.2	0.9
austro393	*Bye*	*2684*	MEXU	4.7	1.1
austro394	*Jenkins*	*89-308*	TEX	3.8	1.2
austro395	*Bye*	*8725*	MEXU	5.2	0.9
austro396	*Spellenberg*	*9243*	MEXU	4.7	1.4
austro397	*Scora*	*2716*	TEX	4.3	1.8
austro398	*Jenkins*	*89-297*	ARIZ	3.6	1
austro399	*Bye*	*1795*	MEXU	4.1	1.1
austro400	*Bolanos*	*1448*	MEXU	4.1	1.1
austro401	*Neff*	*91-13*	MEXU	5.8	1.3
austro402	*Benitez*	*1984*	MEXU	4.7	1.2
austro403	*Vega*	*2541*	MEXU	4.2	1.7
austro404	*Tenorio*	*1773*	MEXU	3.1	1.2
austro405	*Granfelt*	*6-224*	ARIZ	3.8	1.4
austro406	*Turner*	*2098*	ARIZ	3.5	1.3
austro407	*Lane*	*2767*	TEX	3.3	1.2
n.sp.1_440	*Estrada*	*2681*	CAS	2.2	3.2
citriodora358	*Dorr*	*2381*	TEX	2.4	1.2
citriodora359	*Vanderpool*	*759*	OKL	4.85	1.8
citriodora360	*Nighswonger*	*3143*	OKL	6.4	2.8

Table 4 (Cont'd)

				1	2
citriodora361	*Johnson*	*254*	OKL	5.8	2.2
citriodora362	*Ettner*	*77-1*	OKL	5.8	2.1
citriodora363	*Williams*	*331*	OKL	5.7	2.2
citriodora364	*First*	*7*	OKL	6.2	2.4
citriodora365	*Massey*	*2070*	OKL	4.9	2.7
citriodora366	*Semple*	*566*	OKL	5.2	2.5
citriodora367	*Folley*	*564*	OKL	5.6	2.2
citriodora368	*Goodman*	*7849*	OKL	6.3	2.6
citriodora369	*Goodman*	*8384*	OKL	4.9	2.4
citriodora370	*Albers*	*35013*	TEX	5.3	1.8
citriodora371	*Carr*	*13595*	TEX	2.6	1.4
citriodora372	*Thalis*	*30*	TEX	4.2	1.8
citriodora373	*Tharp*	*54996*	TEX	5.95	2.2
citriodora374	*Howell*	*2*	LL	5.86	2
citriodora375	*Correll*	*25295*	LL	6.32	1.8
citriodora376	*Correll*	*19007*	LL	6.2	2.5
citriodora377	*Correll*	*32917*	LL	4.92	2.4
citriodora378	*Correll*	*18997*	LL	6.21	2.6
citriodora379	*Correll*	*16806*	TEX	5.9	2.5
citriodora380	*Correll*	*19448*	TEX	5.85	1.8
citriodora381	*Henderson*	*63-938*	TEX	6.3	2.4
citriodora382	*Lundell*	*15083*	LL	6.1	2.4
clino166	*Crook*	*953*	OKL	4.7	1.6
clino167	*Crook*	*1009*	OKL	4.6	1.6
clino168	*Nighswonger*	*672*	OKL	2.6	1.8
clino169	*Nighswonger*	*1221*	OKL	4.2	1.6
clino170	*Pearce*	*57*	OKL	4.4	1.5
clino171	*Sanders*	*132*	OKL	3.6	1.8
clino172	*Lawson*	*40*	OKL	6.3	1.4

Table 4 (Cont'd)

				1	2
clino173	*Pearce*	*57*	OKL	5.3	1.6
clino174	*Proctor*	*KEG0328*	OKL	7.2	2.6
clino175	*Thompson*	*S0520*	OKL	4.3	1.2
clino176	*Thompson*	*S0527*	OKL	4.7	2.5
clino177	*Thompson*	*S0486*	OKL	2.3	1.4
clino178	*Huff*	*1391*	OKL	5.2	1.8
clino328	*Correll*	*27489*	LL	4.1	1.7
clino329	*Correll*	*16407*	LL	3.4	1.3
clino330	*Correll*	*23400*	LL	4.5	1.8
clino331	*Correll*	*32847*	LL	4.6	1.3
clino332	*Kutac*	*s.n.*	TEX	5.2	1.8
clino333	*Albers*	*48019*	TEX	6.2	2
clino334	*Albers*	*45Ph025*	TEX	5.7	1.5
clino335	*Tharp*	*51-535*	TEX	3.8	1.7
clino336	*Correll*	*16741*	LL	4.5	1.6
clino337	*Landon*	*172*	RM	4.3	1.5
clino338	*Simpson*	*139*	TAMU	2.8	1.7
clino339	*Carter*	*91*	TAMU	4.7	1.5
clino340	*Ajilvshi*	*8400*	TAMU	3.8	1.7
clino341	*Starbuck*	*1926*	TAMU	5.2	1.5
clino342	*Dubrule*	*307*	TAMU	4.5	1.8
clino343	*Mahler*	*1135*	TEX	4.3	1.7
clino344	*Carter*	*13788*	TEX	4.1	1.6
mexicana475	*Maysilles*	*7771*	TEX	3.3	1.8
mexicana476	*Garcia*	*399*	MICH	3.5	2
parva450	*Scora*	*2222*	TEX	6	3.2
parva451	*Semple*	*599*	MO	5.3	1.9
parva452	*Semple*	*578*	MO	4.5	1.9
parva453	*Segers*	*s.n.*	RM	5.8	2.2

Table 4 (Cont'd)

				1	2
parva454	*Webster*	*7075*	TEX	5.5	2.1
pectinata181	*Correll*	*18391*	TEX	6.9	2.5
pectinata182	*Sanders*	*75084*	TEX	6	3.1
pectinata183	*Correll*	*33768*	TEX	5.9	2.4
pectinata184	*Lundell*	*14224*	TEX	6.9	2.9
pectinata185	*Correll*	*22048*	TEX	4.5	2.2
pectinata186	*Rachaner*	*132*	TEX	5.2	1.5
pectinata187	*Warnock*	*5672*	TEX	5.6	3.2
pectinata188	*Hutchins*	*1133*	TEX	5.4	2.3
pectinata189	*Shinners*	*30061*	TEX	4.5	2.2
pectinata190	*Ballinger*	*s.n.*	TEX	2.7	2.9
pectinata191	*Sanders*	*75084*	TEX	8.6	2.5
pectinata192	*LeSassier*	*225*	TEX	3.2	2.4
pectinata193	*Lawsen*	*384*	MSC	3.9	2.6
pectinata194	*Daniels*	*13*	MSC	3.7	1.9
pectinata195	*Tracy*	*7991*	MSC	4.1	1.2
pectinata345	*Higgins*	*6948*	MSC	3.8	1.8
pectinata346	*Rosson*	*956*	MSC	3.8	2.1
pectinata347	*Demaree*	*7554*	TEX	3.7	2.4
pectinata348	*Churchil*	*7482138*	MSC	3.3	2.5
pectinata349	*Theiret*	*59653*	KNK	4.2	2.3
pectinata350	*Haynes*	*9692*	KNK	3.5	2.5
pectinata351	*Wooton*	*s.n.*	NMC	2.5	2.1
pectinata352	*Wooton*	*s.n.*	NMC	4.2	2.4
pectinata353	*Wooton*	*s.n.*	NMC	5.5	2.8
pectinata354	*Neely*	*3566*	RM	5.4	1.9
pectinata355	*Porter*	*9356*	RM	4.2	1.7
pectinata356	*Long*	*s.n.*	RM	5.4	2.4
pectinata357	*Kugel*	*2098*	MSC	5.6	2.6

Table 4 (Cont'd)

	3	4	5	6	7	8	9
austro383	5.1	0.44	1.8	1.1	3.1	2.9	0.24
austro384	5.3	0.9	1.8	2.1	2.8	3.9	0.3
austro385	3.2	0.6	1.7	1.8	2.3	3.5	0.28
austro386	3.6	0.51	1.5	1	1.5	3.2	0.24
austro387	3.7	0.63	1.8	1.3	2.1	3.5	0.32
austro388	5.8	0.61	2.9	1.5	3.2	3.8	0.28
austro389	4.9	0.42	2.9	1	3.4	3.3	0.23
austro390	5.3	1	3.1	9.2	2.9	3.2	0.24
austro391	3.5	0.5	1.5	4.2	2.1	4.1	0.31
austro392	3.2	0.42	1.3	1.2	1.6	3.5	0.3
austro393	3.5	0.7	1.4	1.4	2.2	3.4	0.24
austro394	6.6	0.6	4.6	1.6	4.2	4.1	0.28
austro395	5.3	0.41	2.7	0.8	3.3	4.3	0.34
austro396	5.2	1.2	2.7	1.5	3.1	4.2	0.31
austro397	4.1	0.52	1.6	1.9	2.4	3.2	0.26
austro398	3.6	0.43	1.2	2.2	1.7	3.3	0.29
austro399	3.7	0.62	1.7	1.6	2.1	4.1	0.3
austro400	7.2	0.57	2.7	1.8	3.3	3.6	0.31
austro401	5.1	0.45	2.5	2.1	3.6	3.4	0.32
austro402	5.4	0.8	2.8	1.5	3.1	3.5	0.3
austro403	4.1	0.68	1.7	1.6	2.2	3.7	0.31
austro404	3.3	0.53	1.2	1.8	2.1	3.3	0.27
austro405	3.2	0.62	1.6	1.4	2.4	3.3	0.28
austro406	5.7	0.51	3.2	1.8	2.9	4.2	0.29
austro407	4.2	0.51	2.1	1.8	2.6	3.8	0.31
n.sp.1_440	3.4	0.6	1.3	0.8	1.5	4.1	0.18
citriodora358	3.6	0.3	2.2	3	2.3	3.8	0.25
citriodora359	7.2	0.85	5	11	3.9	3.7	0.26
citriodora360	7.8	1.2	4.8	11.5	4.1	3.9	0.28

Table 4 (Cont'd)

	3	4	5	6	7	8	9
citriodora361	6.9	1.1	4.2	10.5	3.6	4.1	0.3
citriodora362	6.8	0.86	4.7	9.5	3.8	3.7	0.27
citriodora363	4.9	0.92	3.8	10	3	3.9	0.26
citriodora364	6.6	0.85	4.5	11	3.6	3.8	0.25
citriodora365	6.8	0.76	4.4	8.5	3.7	2.9	0.26
citriodora366	7.2	0.98	4.6	8	4.1	3.9	0.27
citriodora367	7.1	0.95	4.8	10.5	4	3.8	0.28
citriodora368	7.4	1.1	4.7	11	3.9	3.9	0.29
citriodora369	6.5	0.86	4.4	8.5	3.8	3.7	0.3
citriodora370	6.6	0.8	4.3	9.5	3.8	3.8	0.28
citriodora371	4.8	0.52	3.5	7.5	2.5	3.8	0.28
citriodora372	5.9	0.63	3.9	10.5	4.1	3.8	0.27
citriodora373	5.5	0.68	4.2	10	3.6	3.9	0.29
citriodora374	6.4	0.72	4.5	11.5	3.7	3.5	0.26
citriodora375	7.2	0.86	4.8	11	3.8	3.6	0.28
citriodora376	6.2	0.73	4.5	10.5	3.6	3.5	0.26
citriodora377	6.5	0.75	4.5	11	4.1	3.7	0.25
citriodora378	6.4	8.6	4.6	9.5	4	3.8	0.28
citriodora379	7.4	1.2	4.9	8.5	3.5	3.9	0.27
citriodora380	7.2	0.98	4.7	9.5	3.8	4.1	0.26
citriodora381	6.8	0.98	4.6	11	3.7	4.1	0.28
citriodora382	7.5	1.1	4.8	10.5	3.8	3.9	0.27
clino166	4.5	0.84	0.9	2.5	2.8	4.1	0.26
clino167	4.2	0.75	0.85	2.4	2.85	3.6	0.23
clino168	4.6	0.9	1	3.1	3	4.2	0.25
clino169	4.7	0.93	1.2	3.2	3.2	4.1	0.45
clino170	4.55	0.86	1.1	2.8	3.05	4.05	0.25
clino171	5.1	0.95	2.2	6.1	3.3	4.5	0.36
clino172	4.7	0.62	1.3	2.6	3.1	2.9	0.26

Table 4 (Cont'd)

	3	4	5	6	7	8	9
clino173	5.15	1.05	2.8	2.4	3.2	4.2	0.34
clino174	3.8	0.6	0.9	1.8	2.6	3.8	0.22
clino175	4.3	0.72	1.1	1.9	2.9	3.75	0.19
clino176	4.6	0.9	1.1	2.6	3.2	4.1	0.26
clino177	4.4	0.75	1.2	2.4	3.1	4	0.25
clino178	4.65	1.2	1.2	3	3.15	4.2	0.3
clino328	4.5	1.05	1.1	2.5	3.2	4.1	0.29
clino329	4.3	0.81	1.2	2.5	3.2	4.1	0.26
clino330	4.45	0.88	1.2	2.6	3.1	4	0.27
clino331	4.35	0.8	0.9	2.2	2.8	3.8	0.23
clino332	5.2	0.98	1.4	2.2	3.1	4.1	0.32
clino333	3.9	0.52	0.8	2	2.6	3.75	0.24
clino334	4.5	0.74	1.1	2.4	3.2	3.2	0.27
clino335	5.2	0.92	1.8	5.2	3.2	4.35	0.31
clino336	4.6	0.9	0.9	3.1	3.1	4.08	0.24
clino337	4.6	0.89	1.1	3.1	3.1	4.05	0.32
clino338	4.5	0.85	0.98	3.2	2.9	4.15	0.26
clino339	4.3	0.7	0.86	2.6	2.9	3.5	0.25
clino340	5.2	0.96	1.4	4	3.2	4.2	0.35
clino341	4.6	0.65	1.1	2.5	3.1	3.2	0.3
clino342	4.4	0.87	0.85	2.4	2.85	4.1	0.26
clino343	4.65	0.88	0.9	2.7	3.1	4.1	0.26
clino344	4.6	0.92	0.95	3.2	3.1	4.1	0.4
mexicana475	5.6	1.2	1	0.7	4.9	0	0
mexicana476	5.7	1.1	1.2	0.6	5.1	0	0
parva450	7.3	1	7.8	8.5	3.4	3.8	0.25
parva451	5.2	0.69	2.7	9.8	3.4	3.9	0.26
parva452	6.3	0.78	4.4	10.5	4.3	3.5	0.28
parva453	6.5	0.84	4.4	13	3.5	3.6	0.27

Table 4 (Cont'd)

	3	4	5	6	7	8	9
parva454	6.4	0.75	4.2	9.2	3.3	3.5	0.28
pectinata181	3.8	0.6	1.3	3.5	2.3	3.5	0.25
pectinata182	4.8	0.9	2.3	3.8	3.1	5	0.33
pectinata183	5.2	1.1	1.6	4.1	3.2	4.5	0.46
pectinata184	4.2	0.72	1.8	4	2.55	3.95	0.3
pectinata185	3.8	0.6	1.5	3.6	2.3	3.5	0.28
pectinata186	4.5	0.8	1.7	3.6	2.4	3.7	0.28
pectinata187	4.2	0.8	1.6	3.8	2.6	4.2	0.33
pectinata188	4	0.65	1.6	3.7	2.1	3.4	0.28
pectinata189	4.2	0.7	1.7	3.8	2.6	3.78	0.3
pectinata190	4.1	0.71	1.7	4.1	2.6	4	0.32
pectinata191	6.5	0.7	2.7	7.2	4.3	3.8	0.5
pectinata192	4.6	0.78	1.9	4.23	2.6	3.8	0.26
pectinata193	3.7	0.62	1.5	3.5	2.53	3.6	0.27
pectinata194	4.3	0.73	1.7	4.2	2.6	4.1	0.34
pectinata195	3.8	0.62	1.5	3.2	2.1	3	0.25
pectinata345	3.6	0.58	1.6	3.4	1.9	3.2	0.28
pectinata346	4.1	0.62	1.5	4.1	2.5	3.9	0.31
pectinata347	3.8	0.63	1.7	3.7	2.6	3.7	0.29
pectinata348	4.2	0.81	1.8	4.2	2.5	3.6	0.27
pectinata349	5.8	0.75	2.4	5.2	3.8	3.7	0.3
pectinata350	4.5	0.72	2.1	4.5	3.1	3.8	0.33
pectinata351	3.6	0.56	1.4	3.2	2.4	3.2	0.26
pectinata352	3.9	0.6	1.5	2.5	2.3	3.5	0.29
pectinata353	4.1	0.72	1.7	2.6	2.4	4.1	0.31
pectinata354	4.3	0.76	1.5	2.4	2.6	4	0.27
pectinata355	3.5	0.68	1.3	2.8	2.4	3.6	0.24
pectinata356	4.1	0.65	1.7	3.8	2.6	3.8	0.27
pectinata357	5.8	0.72	1.8	4	2.1	4.2	0.32

Table 4 (Cont'd)

	10	11	12	13	14	15	16
austro383	4.99	3	3	4.1	1.1	0.72	0.9
austro384	5.09	3	3.5	4.7	0.9	0.85	0.9
austro385	3.02	4	2.7	4.2	0.8	1.1	1.1
austro386	3.5	2	2	3.8	1	0.9	1.1
austro387	3.57	3	2.8	5.2	1.2	0.9	0.9
austro388	5.65	5	2.2	1.8	1.1	1.2	0.9
austro389	4.8	5	3.2	5.2	1.2	0.85	1.1
austro390	4.38	1	3.8	5.2	1	0.9	0.9
austro391	3.08	5	2.5	4.5	1	1.2	1.1
austro392	3.08	2	1.7	3.2	0.6	0.9	1.1
austro393	3.36	4	3.4	5.5	1.4	1.1	1.2
austro394	6.44	4	2	1.2	0.7	1.2	0.8
austro395	5.22	4	3.3	4.6	0.9	0.1	0.9
austro396	5.05	2	3.5	4.8	1.1	0.95	0.8
austro397	3.91	6	2.7	5.2	1.2	1.1	1.1
austro398	3.38	1	2.1	3.3	0.8	0.9	1.2
austro399	3.54	8	3.2	4.7	1.2	1	1.1
austro400	7.02	5	3.1	2.5	0.9	1.1	0.9
austro401	4.89	4	2.9	4.6	0.8	1	1.3
austro402	5.25	3	2.7	5.1	1	1.1	1.1
austro403	3.94	5	2.5	4.2	1.1	1.2	1.2
austro404	3.12	2	2.3	3.6	0.8	1.2	1.3
austro405	3.06	7	3.3	5.1	1.2	1.3	1.2
austro406	5.52	6	2.7	2.7	1.1	1.2	0.8
austro407	4.02	2	2.9	4.8	0.9	1.2	0.9
n.sp.1_440	3.2	5	1.9	1.9	0.8	0.55	0.9
citriodora358	3.3	5	3.3	2.2	1.3	1.75	4.5
citriodora359	6.1	2	3	4.2	1.5	1.55	4.5
citriodora360	6.65	3	3.35	4.5	1.2	1.7	6

Table 4 (Cont'd)

	10	11	12	13	14	15	16
citriodora361	5.85	2	3	4.2	1.2	2.1	6
citriodora362	5.85	4	3.4	3.9	1.4	1.8	5
citriodora363	3.9	3	3.35	4.1	1.2	1.76	4.5
citriodora364	5.5	5	3.37	4.2	1.3	1.65	5.5
citriodora365	5.95	2	3.29	4.4	1.3	1.64	6
citriodora366	6.4	4	3.31	4.3	1.2	1.74	6
citriodora367	6.05	2	3.3	4.4	1.4	1.85	5.5
citriodora368	6.3	5	3.25	4.2	1.4	1.92	5
citriodora369	5.65	3	3.27	4	1.3	1.83	5
citriodora370	5.65	2	3.3	3.8	1.2	1.74	4.5
citriodora371	4.05	2	3	2.6	1.3	1.52	4.4
citriodora372	4.85	2	3.1	3.9	1.3	1.65	4.5
citriodora373	4.5	4	3.15	4.1	1.4	1.74	5
citriodora374	5.25	5	3.25	4.1	1.5	1.76	5.5
citriodora375	6.1	4	3.25	4.3	1.4	1.62	6
citriodora376	5.15	3	3.15	4.2	1.4	1.83	5.5
citriodora377	5.4	4	3.14	4.5	1.3	1.76	5
citriodora378	5.45	2	3.19	3.8	1.5	1.92	5.5
citriodora379	6.55	2	3.07	3.9	1.2	1.59	4.5
citriodora380	6.25	2	3.16	4.1	1.3	1.74	5
citriodora381	5.7	3	3.2	4.1	1.4	1.76	5.5
citriodora382	6.45	2	3.15	4.3	1.4	1.9	5
clino166	4.25	2	2.2	4.5	0.6	1.5	4.5
clino167	3.96	1	3.7	5.2	0.49	1.6	4.5
clino168	4.29	1	3.6	6.2	0.55	1.6	4.7
clino169	4.38	2	2.6	4.3	0.54	1.3	4.2
clino170	4.27	3	3.5	6	0.65	1.7	4.8
clino171	4.49	2	3.9	6.8	0.7	1.9	4.2
clino172	4.44	3	3.2	5.4	0.63	1.8	4.6

Table 4 (Cont'd)

	10	11	12	13	14	15	16
clino173	4.91	1	4.2	7.3	3.2	1.5	4.2
clino174	3.62	2	3.32	4.8	0.56	1.5	4.55
clino175	4.11	2	3.2	4.8	0.6	1.5	4.3
clino176	4.34	2	3.6	5.8	0.7	1.9	4.2
clino177	4.16	1	3.4	5.2	0.58	1.5	4.3
clino178	4.35	4	3.4	4.8	0.6	1.8	4.9
clino328	4.25	1	3.3	4.7	0.58	1.7	4.7
clino329	4.05	1	3.3	4.9	0.6	1.6	4.2
clino330	4.19	1	3.5	5.6	0.65	1.8	4.3
clino331	4.13	1	3.3	5.1	0.62	1.6	4.6
clino332	4.98	1	3.8	6.2	0.51	1.4	4.4
clino333	3.7	1	3.4	4.9	0.59	1.6	4.4
clino334	4.26	1	3.4	5.8	0.61	1.9	4.5
clino335	4.68	4	3.5	5.8	0.68	1.8	4.4
clino336	4.29	7	3.4	6.1	0.66	1.7	4.7
clino337	4.29	1	3.2	4.5	0.57	1.5	4.3
clino338	4.18	6	3.5	5.5	0.58	1.5	4.5
clino339	4.04	2	3.6	5.3	0.52	1.6	4.6
clino340	4.8	1	3.5	5.4	0.66	1.8	4.4
clino341	4.35	5	3.3	5.2	0.61	1.8	4.5
clino342	4.16	1	3.1	4.8	0.58	1.7	4.6
clino343	4.38	1	3.4	5.8	0.64	1.6	4.7
clino344	4.28	1	3.1	4.6	0.57	1.5	4.3
mexicana475	4.9	1	4	17	1.4	1.2	4.1
mexicana476	5.1	1	4.3	19	1.6	1.1	4
parva450	6.4	1	3.7	4.3	2	1.6	4.8
parva451	4.3	1	3.1	4	1.2	1.73	4.8
parva452	5.3	1	3.2	3.9	1.3	1.65	5.4
parva453	5.5	1	3.2	4.4	1.2	1.74	5.3

Table 4 (Cont'd)

	10	11	12	13	14	15	16
parva454	5.5	5	3.25	4.1	1.5	1.65	5.7
pectinata181	3.45	14	3.6	5.2	1.6	1.2	3.6
pectinata182	4.42	4	5.6	6.2	1.7	1.7	3
pectinata183	4.79	8	3.8	7	2.6	1.9	3.4
pectinata184	3.8	8	4	7.2	2.1	1.6	3.2
pectinata185	3.4	6	3.8	6.4	2.3	1.4	3.1
pectinata186	4.14	4	2.1	3.5	1.3	1	2.6
pectinata187	3.82	5	4.6	6	2.6	1.7	2.9
pectinata188	3.63	3	3.5	5.4	1.8	1.4	2.7
pectinata189	3.8	14	3.6	5.8	2	1.4	2.9
pectinata190	3.69	9	3.2	6.8	1.9	1.3	2.9
pectinata191	5.78	4	5.8	6.3	2.2	2.3	3.8
pectinata192	4.177	1	4.1	6.8	2.1	1.7	2.9
pectinata193	3.35	11	3.7	6.6	1.9	1.3	2.7
pectinata194	3.88	5	4.2	7	2.3	1.8	3.45
pectinata195	3.48	1	3.6	7.1	3.9	1.4	2.7
pectinata345	3.26	3	3.7	6.9	3.2	1.3	2.6
pectinata346	3.69	2	4.1	6.8	2.4	1.5	3.4
pectinata347	3.43	8	3.8	6.7	2.1	1.6	2.8
pectinata348	3.78	9	4	6.7	1.9	1.5	2.7
pectinata349	5.28	5	4.8	6.4	2.5	1.9	3.5
pectinata350	4.05	7	3.5	6.5	2.3	1.5	3.1
pectinata351	3.28	10	2.9	3.8	1.7	1.2	3.1
pectinata352	3.65	9	3.4	5.1	1.85	1.3	2.8
pectinata353	3.84	6	4.5	5.8	2.5	1.5	2.7
pectinata354	4.06	4	2.9	4.1	1.5	1.4	2.7
pectinata355	3.22	5	2.4	3.5	1.4	1.6	2.9
pectinata356	3.72	6	3.8	5.8	2.3	1.6	3.1
pectinata357	5.4	7	3.7	6.2	2.2	1.4	3.2

Table 4 (Cont'd)

	17	18	19	20	21	22	23
austro383	0.19	7.22	1.71	0.58	3.61	0.07	0.98
austro384	0.24	6.99	2.2	0.48	3.59	0.07	0.62
austro385	0.21	7.04	2.65	0.6	5.59	0.06	1.15
austro386	0.25	6.43	1.94	0.5	4.41	0.06	1.07
austro387	0.28	6.65	2.21	0.5	3.25	0.06	0.97
austro388	0.21	6.98	2.53	0.72	2.02	0.06	0
austro389	0.18	6.53	2.19	0.7	4.2	0.07	0
austro390	0.25	7.18	2.43	0.55	3.66	0.06	0
austro391	0.24	7.08	2.51	0.35	3.67	0.07	1.05
austro392	0.26	6.86	2.41	0.39	3.56	0.07	1.04
austro393	0.35	6.92	2.46	0.49	3.77	0.07	1.03
austro394	0.2	6.59	2.25	0.53	4.56	0.07	0.86
austro395	0.2	7.07	2.63	0.58	4.23	0.07	0.92
austro396	0.26	6.49	2.15	0.49	3.71	0.07	1.04
austro397	0.23	6.63	2.21	0.61	3.95	0.06	1.03
austro398	0.25	6.87	2.31	0.64	3.74	0.07	1.05
austro399	0.28	6.75	2.29	0.54	3.52	0.06	0.97
austro400	0.18	6.61	2.1	0.57	3.29	0.07	0.96
austro401	0.19	7.12	2.24	0.56	3.61	0.06	1.09
austro402	0.21	7.05	2.15	0.51	3.74	0.06	1.1
austro403	0.19	6.72	2.13	0.53	4.05	0.06	1.08
austro404	0.24	6.65	2.22	0.51	3.2	0.07	0.97
austro405	0.27	6.83	1.98	0.52	3.68	0.07	0.75
austro406	0.25	6.88	2.06	0.62	3.6	0.06	0.86
austro407	0.26	6.79	2.18	0.63	3.9	0.07	1.04
n.sp.1_440	0.3	3.02	1.36	0.38	2.36	0.06	0.75
citriodora358	0.5	7.6	1.5	0.56	4.25	0.13	0.98
citriodora359	0.5	7.2	1.62	0.59	4.36	0.13	0.88
citriodora360	0.6	7.32	1.49	0.55	4.15	0.16	0.95

Table 4 (Cont'd)

	17	18	19	20	21	22	23
citriodora361	0.7	7.85	1.55	0.56	4.18	0.12	0.92
citriodora362	0.5	7.76	1.56	0.62	4.36	0.13	0.94
citriodora363	0.5	7.52	1.54	0.64	4.28	0.17	0.86
citriodora364	0.5	8.12	1.63	0.61	4.39	0.16	0.86
citriodora365	0.6	7.76	1.69	0.58	4.42	0.18	0.89
citriodora366	0.6	8.15	1.54	0.57	4.16	0.2	0.84
citriodora367	0.5	7.52	1.62	0.55	3.98	0.15	0.81
citriodora368	0.5	7.68	1.55	0.56	3.85	0.14	0.89
citriodora369	0.5	8.42	1.6	0.56	4.19	0.14	0.95
citriodora370	0.5	7.58	1.57	0.62	1.2	0.18	0.94
citriodora371	0.5	7.86	1.59	0.63	4.6	0.15	0.92
citriodora372	0.5	7.68	1.73	0.58	4.2	0.14	0.92
citriodora373	0.5	8.21	1.48	0.63	3.89	0.13	0.95
citriodora374	0.5	7.3	1.64	0.57	4.2	0.14	0.99
citriodora375	0.6	7.5	1.52	0.52	4.12	0.15	0.98
citriodora376	0.6	7.72	1.48	0.54	4.19	0.13	1.02
citriodora377	0.5	7.5	1.58	0.64	4.25	0.14	0.96
citriodora378	0.6	7.55	1.56	0.62	3.95	0.15	0.95
citriodora379	0.5	8.26	1.57	0.56	3.98	0.15	0.94
citriodora380	0.5	7.6	1.58	0.55	2.85	0.17	0.95
citriodora381	0.6	7.72	1.6	0.58	4.2	0.14	0.98
citriodora382	0.5	7.59	1.68	0.55	4.15	0.13	0.96
clino166	0.47	7.72	1.61	0.64	3.55	0.15	0.66
clino167	0.39	8.51	1.69	0.58	4.01	0.13	0.66
clino168	0.43	7.04	1.51	0.7	3.33	0.16	0.65
clino169	0.39	6.16	1.68	0.68	3.6	0.11	0.62
clino170	0.45	7.43	1.59	0.64	4.73	0.13	0.64
clino171	0.43	7.5	1.68	0.71	3.62	0.13	0.65
clino172	0.46	8.32	1.72	0.77	3.95	0.15	0.66

Table 4 (Cont'd)

	17	18	19	20	21	22	23
clino173	0.39	7.18	1.53	0.7	3.45	0.16	0.6
clino174	0.42	7.62	1.59	0.5	3.66	0.14	0.49
clino175	0.42	8.32	1.58	0.66	3.85	0.12	0.71
clino176	0.46	7.12	1.48	0.61	3.42	0.15	0.7
clino177	0.44	6.52	1.67	0.53	3.52	0.12	0.51
clino178	0.36	7.52	1.6	0.75	3.86	0.12	0.52
clino328	0.35	7.52	1.58	0.63	4.12	0.12	0.68
clino329	0.42	6.88	1.59	0.67	3.69	0.13	0.65
clino330	0.45	7.35	1.55	0.65	3.66	0.15	0.62
clino331	0.43	8.21	1.68	0.68	4.02	0.12	0.64
clino332	0.41	7.14	1.55	0.69	3.72	0.12	0.64
clino333	0.43	7.82	1.62	0.61	3.81	0.14	0.71
clino334	0.42	8.43	1.68	0.66	3.62	0.14	0.68
clino335	0.44	7.69	1.59	0.65	3.71	0.13	0.63
clino336	0.46	7.53	1.58	0.64	3.86	0.15	0.67
clino337	0.42	6.88	1.72	0.66	3.72	0.12	0.64
clino338	0.42	7.15	1.55	0.65	3.42	0.15	0.65
clino339	0.39	8.42	1.63	0.66	4	0.12	0.68
clino340	0.43	8.12	1.68	0.65	3.98	0.14	0.64
clino341	0.47	7.26	1.53	0.67	3.55	0.13	0.65
clino342	0.44	7.68	1.32	0.62	3.62	0.12	0.69
clino343	0.45	7.64	1.64	0.68	3.62	0.15	0.6
clino344	0.41	7.25	1.57	0.7	3.42	0.16	0.72
mexicana475	3.5	6	2	0.8	1.5	0.21	0.38
mexicana476	3.5	6.1	1.9	0.8	1.4	0.2	0.4
parva450	0.5	7.68	2.19	0.58	3.5	0.15	0.94
parva451	0.5	7.73	2.07	0.63	1.7	0.12	0.94
parva452	0.55	7.49	1.86	0.62	2.67	0.14	0.92
parva453	0.54	7.5	2.05	0.63	2.39	0.13	0.85

Table 4 (Cont'd)

	17	18	19	20	21	22	23
parva454	0.5	7.42	1.74	0.63	1.92	0.12	0.93
pectinata181	0.5	6.21	1.58	0.63	2.6	0.09	0.62
pectinata182	0.6	8.56	1.84	0.65	2.94	0.05	0.73
pectinata183	0.53	9.58	2.41	0.68	2.84	0.07	0.74
pectinata184	0.45	9.9	1.88	0.64	3.5	0.05	0.71
pectinata185	0.45	7.6	1.76	0.65	2.72	0.06	0.66
pectinata186	0.22	8.5	1.83	0.65	2.8	0.06	0.69
pectinata187	0.5	9.4	1.95	0.66	3.1	0.07	0.68
pectinata188	0.43	6.8	1.72	0.68	2.65	0.05	0.75
pectinata189	0.41	7.78	1.8	0.66	2.8	0.06	0.65
pectinata190	0.38	6.82	1.62	0.65	2.67	0.08	0.64
pectinata191	0.51	8.21	1.79	0.67	2.89	0.05	0.62
pectinata192	0.41	6.68	1.85	0.66	2.74	0.06	0.6
pectinata193	0.39	7.6	1.82	0.64	2.81	0.07	0.65
pectinata194	0.48	8.12	1.86	0.62	2.96	0.06	0.64
pectinata195	0.4	7.1	1.8	0.53	2.68	0.04	0.62
pectinata345	0.41	6.92	1.75	0.63	2.76	0.04	0.64
pectinata346	0.47	8.89	1.89	0.64	2.88	0.05	0.75
pectinata347	0.41	8.45	1.85	0.62	2.82	0.06	0.63
pectinata348	0.38	6.59	1.83	0.7	2.8	0.06	0.65
pectinata349	0.48	8.47	1.82	0.68	2.9	0.07	0.62
pectinata350	0.37	6.42	1.62	0.67	2.59	0.08	0.64
pectinata351	0.34	6.32	1.63	0.66	2.61	0.09	0.65
pectinata352	0.41	7.12	1.71	0.65	2.79	0.07	0.66
pectinata353	0.49	9.12	1.86	0.65	3.12	0.06	0.68
pectinata354	0.32	8.3	1.85	0.65	2.81	0.05	0.67
pectinata355	0.28	6.72	1.83	0.64	2.82	0.05	0.6
pectinata356	0.44	9.5	1.92	0.66	3.45	0.08	0.62
pectinata357	0.51	9.4	2.02	0.65	2.92	0.09	0.65

Table 4 (Cont'd)

	24	25	26	27	28	29	30
austro383	5.52	2.17	2	1.47	0.69	0.9	4.73
austro384	8.6	2.6	2.6	2.01	1.55	1.61	7.6
austro385	9.53	2.52	4.61	2.43	1.12	1.18	7.2
austro386	7.19	2.7	2.5	1.29	1.21	1.04	6.47
austro387	7.42	2.48	3.55	2.37	1.45	1.04	5.5
austro388	6.59	2.5	2.42	0.95	1.2	0.9	6.27
austro389	9.27	2.47	3.82	2.67	1.65	1.5	5.26
austro390	6.26	2.49	2.5	2.07	1.6	1.26	7.1
austro391	7.33	2.12	2.78	2.48	1.39	1.45	6.84
austro392	7.37	2.54	3.07	1.88	1.26	1.04	6.55
austro393	8.82	3.14	3.4	1.69	1.44	1.48	6.92
austro394	10.02	2.53	3.38	1.75	1.03	1.28	6.4
austro395	6.85	2.47	2.56	1.86	1.25	1.18	6.92
austro396	7.12	2.53	3.72	2.13	1.27	1.24	5.32
austro397	6.62	2.64	3.64	2.42	1.39	1.46	5.71
austro398	7.19	2.49	3.42	1.68	1.53	1.57	6.48
austro399	7.24	2.56	2.86	1.75	1.08	1.38	6.28
austro400	7.32	2.51	2.64	2.38	1.09	1.35	5.96
austro401	7.19	2.42	2.38	2.08	1.24	1.27	7.42
austro402	7.24	2.46	3.74	2.19	1.57	1.09	7.13
austro403	7.42	2.45	3.68	2.27	1.61	1.07	6.37
austro404	6.82	2.51	2.55	1.86	1.45	1.28	6.58
austro405	6.94	2.45	2.57	2.38	1.38	1.26	6.78
austro406	6.83	2.43	3.64	2.47	1.46	1.34	6.92
austro407	6.47	2.56	2.39	2.62	1.47	1.28	6.82
n.sp.1_440	4.8	2.41	1.4	1.2	0.8	0.76	5
citriodora358	7.62	2	2.21	1.28	1	0.94	8.2
citriodora359	5.81	2.1	2.16	1.26	1.12	0.88	8.8
citriodora360	6.4	2.1	2.21	1.32	1.13	0.94	8.6

Table 4 (Cont'd)

	24	25	26	27	28	29	30
citriodora361	6.33	2.15	2.2	1.28	1.05	0.88	8.56
citriodora362	5.52	1.96	2.15	1.19	1.19	0.82	8.3
citriodora363	6.1	2.13	2.14	1.56	1.09	0.92	8.53
citriodora364	5.92	2.21	2.15	1.36	1.12	0.87	8.74
citriodora365	5.43	1.92	2.09	1.19	1.14	0.75	8.46
citriodora366	7.45	1.9	2.22	1.25	1.13	0.92	9.21
citriodora367	5.3	2.1	2.12	1.19	1.15	0.88	8.52
citriodora368	5.8	2.1	2.22	1.82	1.2	0.93	8.59
citriodora369	5.84	2.14	2.19	1.32	1.08	0.86	7.89
citriodora370	5.62	1.98	1.99	1.22	1.15	0.72	7.85
citriodora371	7.2	1.95	2.4	1.62	1.08	0.93	8.23
citriodora372	6.25	1.96	2.2	1.29	1.15	0.91	7.65
citriodora373	6.34	2.1	2.19	1.24	1.08	0.94	8.47
citriodora374	5.6	2.13	2.12	1.25	1.11	0.9	8.7
citriodora375	6.3	2.14	2.14	1.28	1.09	0.92	8.8
citriodora376	3.25	2.13	2.1	1.26	1.11	0.87	8.5
citriodora377	5.62	1.98	2.13	1.24	1.15	0.86	8.4
citriodora378	5.7	2.01	2.11	1.75	1.19	0.92	8.6
citriodora379	5.74	2.04	2.14	1.26	1.1	0.79	7.9
citriodora380	5.63	1.75	2.1	1.15	1.12	0.82	7.8
citriodora381	7.14	2.02	2.2	1.48	1.11	0.87	8.3
citriodora382	6.3	1.98	2.3	1.3	1.08	0.89	8.1
clino166	5.45	1.84	1.91	1.17	1.31	0.61	5.4
clino167	5.94	2.32	2.17	1.42	1.03	0.83	5.89
clino168	6	1.98	2.23	2	1.13	0.97	5.58
clino169	5.5	2.03	2.03	1.2	1.22	0.87	5.49
clino170	7.98	1.85	3.18	2.36	0.92	1.14	6.1
clino171	5.5	1.86	2.05	1.22	1.19	0.68	5.45
clino172	5.86	2.22	2.15	1.43	1.1	0.86	5.72

Table 4 (Cont'd)

	24	25	26	27	28	29	30
clino173	6.12	2.14	2.22	1.82	1.14	0.94	5.49
clino174	5.42	1.94	2.04	1.21	1.29	0.72	5.3
clino175	6.22	2.31	2.19	1.43	1.09	0.87	5.78
clino176	6.15	1.99	2.22	1.52	1.11	0.95	5.56
clino177	5.72	2.01	2.14	1.25	1.13	0.86	5.5
clino178	7.83	1.92	2.3	1.32	0.98	0.95	5.9
clino328	7.14	1.96	2.72	2.26	1	1.02	5.8
clino329	5.78	2.01	2.1	1.3	1.18	0.89	5.5
clino330	6.47	2.03	2.22	1.9	1.16	0.95	5.47
clino331	6.17	2.24	2.34	1.5	1.01	0.84	5.72
clino332	6.52	1.97	2.3	1.95	1.14	0.95	5.62
clino333	5.68	1.96	1.86	1.26	1.27	0.71	5.34
clino334	5.81	2.22	2.14	1.43	1.13	0.82	5.76
clino335	5.53	1.76	2.08	1.27	1.25	0.72	5.39
clino336	7.85	1.82	3.15	2.14	1.02	1.01	6.15
clino337	5.84	1.99	2.1	1.42	1.18	0.89	5.52
clino338	6.05	2.13	2.19	1.65	1.12	0.94	5.74
clino339	5.96	2.29	2.15	1.52	1.1	0.93	5.92
clino340	6.14	2.23	2.15	1.43	1.01	0.85	5.72
clino341	6.28	2.1	2.21	1.96	1.12	0.89	5.59
clino342	5.53	1.96	1.98	1.19	1.28	0.75	5.38
clino343	5.52	1.92	2.01	1.21	1.29	0.72	5.44
clino344	6.21	1.97	2.15	2.01	1.12	0.95	5.62
mexicana475	8	4.2	2	0.8	0.9	0.78	7.4
mexicana476	7.2	4.1	2.1	0.9	0.9	0.88	9
parva450	9.65	3.5	2.14	2.05	1.81	1.36	7.8
parva451	6.19	3.2	3.71	1.89	0.89	0.93	7.89
parva452	5.2	3.02	2.4	1.68	0.77	0.86	7.92
parva453	6.5	3.2	3	1.7	1.01	1.2	8.15

Table 4 (Cont'd)

	24	25	26	27	28	29	30
parva454	5.3	3.12	1.92	1.42	0.79	0.9	8.4
pectinata181	6.44	2.22	2.15	0.99	0.86	0.8	6.59
pectinata182	7.8	2.74	3.6	1.12	0.72	0.93	9.8
pectinata183	9.23	2.69	3.53	1.75	0.61	0.78	10.2
pectinata184	7.93	2.87	2.11	1.31	0.9	1.01	11.54
pectinata185	7.06	2.35	2.27	1.13	0.77	0.85	6.2
pectinata186	7.3	2.4	2.2	1.28	0.75	0.85	6.24
pectinata187	8.2	2.75	2.4	1.35	0.82	0.9	7.2
pectinata188	6.5	2.19	2.14	1.12	0.65	0.79	5.4
pectinata189	7.4	2.5	2.4	1.18	0.78	0.84	7.1
pectinata190	6.52	2.45	2.24	1.1	0.84	0.86	6.6
pectinata191	7.8	2.8	2.42	1.09	0.79	0.92	8.2
pectinata192	8.2	3.2	2.52	1.12	0.82	0.83	6.45
pectinata193	7.4	2.52	2.3	1.29	0.76	0.84	6.3
pectinata194	8.1	2.58	2.19	1.28	0.81	0.88	6.9
pectinata195	6.4	2.3	2.21	1.15	0.72	0.8	5.5
pectinata345	6.6	2.2	2.19	1.11	0.66	0.78	5.9
pectinata346	8.1	2.56	2.41	1.22	0.83	0.91	7.1
pectinata347	7.1	2.45	2.35	1.23	0.76	0.84	6.3
pectinata348	8.2	2.8	2.67	1.1	0.87	0.86	6.35
pectinata349	7.2	2.75	2.54	1.13	0.73	0.92	8.75
pectinata350	6.72	2.31	2.19	0.98	0.85	0.81	6.68
pectinata351	6.48	2.29	2.23	1.06	0.81	0.82	6.62
pectinata352	6.65	2.21	2.21	1.09	0.71	0.82	5.57
pectinata353	8.42	2.64	2.28	1.25	0.83	0.89	7.12
pectinata354	7.45	2.61	2.31	1.26	0.76	0.84	6.35
pectinata355	8.3	2.52	2.75	1.12	0.87	0.83	5.98
pectinata356	8.1	2.92	3.21	1.33	0.91	0.97	8.56
pectinata357	8.4	2.86	3.48	1.41	0.82	0.94	8.23

Table 4 (Cont'd)

	31	32	33	34	35	36	37
austro383	2.59	0.6	0.83	0	1	0	1
austro384	3.7	0.58	0.58	0	1	0	1
austro385	3.5	0.65	0.66	0	1	0	1
austro386	2.58	0.49	0.66	0	1	0	1
austro387	2.6	0.52	0.59	0	1	0	1
austro388	2.8	0.61	0.62	0	1	0	1
austro389	2.73	0.51	0.63	0	1	0	1
austro390	3.4	0.64	0.59	0	1	0	1
austro391	3.1	0.61	0.61	0	1	0	1
austro392	2.9	0.59	0.6	0	1	0	1
austro393	2.87	0.62	0.61	0	1	0	1
austro394	2.62	0.58	0.59	0	1	0	1
austro395	2.91	0.57	0.57	0	1	0	1
austro396	2.63	0.51	0.61	0	1	0	1
austro397	2.58	0.53	0.63	0	1	0	1
austro398	3.24	0.57	0.4	0	1	0	1
austro399	3.1	0.55	0.64	0	1	0	1
austro400	2.67	0.52	0.61	0	1	0	1
austro401	3.5	0.64	0.59	0	1	0	1
austro402	3.42	0.6	0.6	0	1	0	1
austro403	3.08	0.57	0.63	0	1	0	1
austro404	2.92	0.56	0.65	0	1	0	1
austro405	3.04	0.6	0.64	0	1	0	1
austro406	2.88	0.61	0.61	0	1	0	1
austro407	2.79	0.63	0.62	0	1	0	1
n.sp.1_440	2.93	0.08	0.16	0	1	0	1
citriodora358	4.1	0.96	0.72	1.1	1	0	1
citriodora359	3.8	0.86	0.81	1.2	1	0	1
citriodora360	4.31	0.91	0.77	0.98	1	0	1

Table 4 (Cont'd)

	31	32	33	34	35	36	37
citriodora361	4.82	0.85	0.63	1.1	1	0	1
citriodora362	3.75	0.84	0.68	0.97	1	0	1
citriodora363	3.9	0.8	0.72	1.1	1	0	1
citriodora364	4.5	0.82	0.61	1.12	1	0	1
citriodora365	4.32	0.82	0.64	0.97	1	0	1
citriodora366	4.87	0.95	0.72	1.03	1	0	1
citriodora367	4.63	0.81	0.73	1.1	1	0	1
citriodora368	3.89	0.84	0.71	0.99	1	0	1
citriodora369	3.85	0.81	0.62	1.01	1	0	1
citriodora370	3.65	0.85	0.65	1.02	1	0	1
citriodora371	4.12	0.9	0.71	0.98	1	0	1
citriodora372	3.95	0.86	0.82	0.99	1	0	1
citriodora373	4.25	0.82	0.73	1.03	1	0	1
citriodora374	4	0.85	0.82	1.1	1	0	1
citriodora375	4.2	0.92	0.75	1.01	1	0	1
citriodora376	4.7	0.86	0.63	1.04	1	0	1
citriodora377	3.8	0.83	0.69	0.98	1	0	1
citriodora378	3.9	0.82	0.73	1.02	1	0	1
citriodora379	3.86	0.82	0.67	0.97	1	0	1
citriodora380	3.7	0.87	0.66	0.98	1	0	1
citriodora381	7.1	0.89	0.75	0.97	1	0	1
citriodora382	4.1	0.9	0.79	0.92	1	0	1
clino166	2.5	0.87	0.67	0.12	1	0	1
clino167	2.8	0.76	0.59	0.15	1	0	1
clino168	3.3	0.9	0.72	0.17	1	0	1
clino169	2.69	0.83	0.84	0.13	1	0	1
clino170	3.2	0.96	0.69	0.12	1	0	1
clino171	2.7	0.83	0.65	0.12	1	0	1
clino172	2.65	0.78	0.58	0.16	1	0	1

Table 4 (Cont'd)

	31	32	33	34	35	36	37
clino173	2.9	0.91	0.73	0.15	1	0	1
clino174	2.75	0.85	0.68	0.12	1	0	1
clino175	2.82	0.82	0.61	0.16	1	0	1
clino176	3.21	0.92	0.75	0.17	1	0	1
clino177	2.74	0.85	0.82	0.12	1	0	1
clino178	3.15	0.95	0.71	0.11	1	0	1
clino328	3.12	0.91	0.72	0.12	1	0	1
clino329	2.86	0.84	0.83	0.12	1	0	1
clino330	3.4	0.92	0.71	0.16	1	0	1
clino331	2.8	0.81	0.58	0.16	1	0	1
clino332	2.4	0.89	0.73	0.15	1	0	1
clino333	2.7	0.84	0.65	0.13	1	0	1
clino334	2.73	0.77	0.55	0.12	1	0	1
clino335	2.46	0.88	0.65	0.13	1	0	1
clino336	3.15	0.84	0.72	0.14	1	0	1
clino337	2.72	0.85	0.85	0.15	1	0	1
clino338	3.2	0.86	0.76	0.16	1	0	1
clino339	2.9	0.77	0.61	0.15	1	0	1
clino340	2.7	0.77	0.61	0.13	1	0	1
clino341	3.4	0.92	0.73	0.16	1	0	1
clino342	2.7	0.86	0.68	0.13	1	0	1
clino343	2.4	0.83	0.66	0.15	1	0	1
clino344	3.1	0.91	0.68	0.17	1	0	1
mexicana475	2.1	0.2	0.19	0	1	1	1
mexicana476	2.1	0.2	0.18	0	1	1	1
parva450	3.89	0.43	0.3	0	1	0	1
parva451	3.8	0.41	0.38	0	1	0	1
parva452	3.47	0.36	0.31	0	1	0	1
parva453	3.2	0.39	0.32	0	1	0	1

Table 4 (Cont'd)

	31	32	33	34	35	36	37
parva454	2.9	0.37	0.29	0	1	0	1
pectinata181	2.05	0.5	0.29	0.89	1	0	1
pectinata182	3.6	0.52	0.3	0.9	1	0	1
pectinata183	2.9	0.54	0.32	0.85	1	0	1
pectinata184	2.6	0.5	0.31	0.79	1	0	1
pectinata185	2.45	0.5	0.31	0.8	1	0	1
pectinata186	2.7	0.52	0.31	0.79	1	0	1
pectinata187	2.8	0.51	0.32	0.8	1	0	1
pectinata188	2.5	0.5	0.28	0.82	1	0	1
pectinata189	2.6	0.51	0.3	0.86	1	0	1
pectinata190	2.3	0.51	0.28	0.84	1	0	1
pectinata191	3.1	0.51	0.32	0.85	1	0	1
pectinata192	2.8	0.53	0.32	0.78	1	0	1
pectinata193	2.9	0.51	0.31	0.78	1	0	1
pectinata194	2.7	0.5	0.3	0.82	1	0	1
pectinata195	2.6	0.52	0.29	0.81	1	0	1
pectinata345	2.4	0.52	0.39	0.81	1	0	1
pectinata346	2.75	0.51	0.31	0.84	1	0	1
pectinata347	2.6	0.51	0.31	0.78	1	0	1
pectinata348	2.65	0.5	0.3	0.79	1	0	1
pectinata349	3.1	0.51	0.29	0.92	1	0	1
pectinata350	2.2	0.52	0.3	0.91	1	0	1
pectinata351	2.3	0.52	0.28	0.9	1	0	1
pectinata352	2.6	0.5	0.29	0.85	1	0	1
pectinata353	2.7	0.53	0.32	0.83	1	0	1
pectinata354	2.63	0.51	0.3	0.81	1	0	1
pectinata355	2.72	0.52	0.3	0.82	1	0	1
pectinata356	2.85	0.5	0.32	0.83	1	0	1
pectinata357	2.9	0.52	0.33	0.85	1	0	1

Table 4 (Cont'd)

	38	39	40	41	42	43	44
austro383	0	1	0	1	0	1	1
austro384	0	1	0	1	0	1	1
austro385	0	1	0	1	0	1	1
austro386	0	1	0	1	0	1	1
austro387	0	1	0	1	0	1	1
austro388	0	1	0	1	0	1	1
austro389	0	1	0	1	0	1	1
austro390	0	1	0	1	0	1	1
austro391	0	1	0	1	0	1	1
austro392	0	1	0	1	0	1	1
austro393	0	1	0	1	0	1	1
austro394	0	1	0	1	0	1	1
austro395	0	1	0	1	0	1	1
austro396	0	1	0	1	0	1	1
austro397	0	1	0	1	0	1	1
austro398	0	1	0	1	0	1	1
austro399	0	1	0	1	0	1	1
austro400	0	1	0	1	0	1	1
austro401	0	1	0	1	0	1	1
austro402	0	1	0	1	0	1	1
austro403	0	1	0	1	0	1	1
austro404	0	1	0	1	0	1	1
austro405	0	1	0	1	0	1	1
austro406	0	1	0	1	0	1	1
austro407	0	1	0	1	0	1	1
n.sp.1_440	0	1	0	1	0	1	0
citriodora358	0	1	0	1	0	1	1
citriodora359	0	1	0	1	0	1	1
citriodora360	0	1	0	1	0	1	1

Table 4 (Cont'd)

	38	39	40	41	42	43	44
citriodora361	0	1	0	1	0	1	1
citriodora362	0	1	0	1	0	1	1
citriodora363	0	1	0	1	0	1	1
citriodora364	0	1	0	1	0	1	1
citriodora365	0	1	0	1	0	1	1
citriodora366	0	1	0	1	0	1	1
citriodora367	0	1	0	1	0	1	1
citriodora368	0	1	0	1	0	1	1
citriodora369	0	1	0	1	0	1	1
citriodora370	0	1	0	1	0	1	1
citriodora371	0	1	0	1	0	1	1
citriodora372	0	1	0	1	0	1	1
citriodora373	0	1	0	1	0	1	1
citriodora374	0	1	0	1	0	1	1
citriodora375	0	1	0	1	0	1	1
citriodora376	0	1	0	1	0	1	1
citriodora377	0	1	0	1	0	1	1
citriodora378	0	1	0	1	0	1	1
citriodora379	0	1	0	1	0	1	1
citriodora380	0	1	0	1	0	1	1
citriodora381	0	1	0	1	0	1	1
citriodora382	0	1	0	1	0	1	1
clino166	0	1	0	1	1	1	1
clino167	0	1	0	1	1	1	1
clino168	0	1	0	1	1	1	1
clino169	0	1	0	1	1	1	1
clino170	0	1	0	1	1	1	1
clino171	0	1	0	1	1	1	1
clino172	0	1	0	1	1	1	1

Table 4 (Cont'd)

	38	39	40	41	42	43	44
clino173	0	1	0	1	1	1	1
clino174	0	1	0	1	1	1	1
clino175	0	1	0	1	1	1	1
clino176	0	1	0	1	1	1	1
clino177	0	1	0	1	1	1	1
clino178	0	1	0	1	1	1	1
clino328	0	1	0	1	1	1	1
clino329	0	1	0	1	1	1	1
clino330	0	1	0	1	1	1	1
clino331	0	1	0	1	1	1	1
clino332	0	1	0	1	1	1	1
clino333	0	1	0	1	1	1	1
clino334	0	1	0	1	1	1	1
clino335	0	1	0	1	1	1	1
clino336	0	1	0	1	1	1	1
clino337	0	1	0	1	1	1	1
clino338	0	1	0	1	1	1	1
clino339	0	1	0	1	1	1	1
clino340	0	1	0	1	1	1	1
clino341	0	1	0	1	1	1	1
clino342	0	1	0	1	1	1	1
clino343	0	1	0	1	1	1	1
clino344	0	1	0	1	1	1	1
mexicana475	0	1	1	1	0	1	0
mexicana476	0	1	1	1	0	1	0
parva450	0	1	0	1	0	1	0
parva451	0	1	0	1	0	1	0
parva452	0	1	0	1	0	1	0
parva453	0	1	0	1	0	1	0

Table 4 (Cont'd)

	38	39	40	41	42	43	44
parva454	0	1	0	1	0	1	0
pectinata181	0	1	0	1	0	1	1
pectinata182	0	1	0	1	0	1	1
pectinata183	0	1	0	1	0	1	1
pectinata184	0	1	0	1	0	1	1
pectinata185	0	1	0	1	0	1	1
pectinata186	0	1	0	1	0	1	1
pectinata187	0	1	0	1	0	1	1
pectinata188	0	1	0	1	0	1	1
pectinata189	0	1	0	1	0	1	1
pectinata190	0	1	0	1	0	1	1
pectinata191	0	1	0	1	0	1	1
pectinata192	0	1	0	1	0	1	1
pectinata193	0	1	0	1	0	1	1
pectinata194	0	1	0	1	0	1	1
pectinata195	0	1	0	1	0	1	1
pectinata345	0	1	0	1	0	1	1
pectinata346	0	1	0	1	0	1	1
pectinata347	0	1	0	1	0	1	1
pectinata348	0	1	0	1	0	1	1
pectinata349	0	1	0	1	0	1	1
pectinata350	0	1	0	1	0	1	1
pectinata351	0	1	0	1	0	1	1
pectinata352	0	1	0	1	0	1	1
pectinata353	0	1	0	1	0	1	1
pectinata354	0	1	0	1	0	1	1
pectinata355	0	1	0	1	0	1	1
pectinata356	0	1	0	1	0	1	1
pectinata357	0	1	0	1	0	1	1

Table 4 (Cont'd)

	45	46	47	48
austro383	1	0	1	0
austro384	1	0	1	0
austro385	1	0	1	0
austro386	1	0	1	0
austro387	1	0	1	0
austro388	1	0	1	0
austro389	1	0	1	0
austro390	1	0	1	0
austro391	1	0	1	0
austro392	1	0	1	0
austro393	1	0	1	0
austro394	1	0	1	0
austro395	1	0	1	0
austro396	1	0	1	0
austro397	1	0	1	0
austro398	1	0	1	0
austro399	1	0	1	0
austro400	1	0	1	0
austro401	1	0	1	0
austro402	1	0	1	0
austro403	1	0	1	0
austro404	1	0	1	0
austro405	1	0	1	0
austro406	1	0	1	0
austro407	1	0	1	0
n.sp.1_440	1	0	1	0
citriodora358	1	0	1	0
citriodora359	1	0	1	0
citriodora360	1	0	1	0

Table 4 (Cont'd)

	45	46	47	48
citriodora361	1	0	1	0
citriodora362	1	0	1	0
citriodora363	1	0	1	0
citriodora364	1	0	1	0
citriodora365	1	0	1	0
citriodora366	1	0	1	0
citriodora367	1	0	1	0
citriodora368	1	0	1	0
citriodora369	1	0	1	0
citriodora370	1	0	1	0
citriodora371	1	0	1	0
citriodora372	1	0	1	0
citriodora373	1	0	1	0
citriodora374	1	0	1	0
citriodora375	1	0	1	0
citriodora376	1	0	1	0
citriodora377	1	0	1	0
citriodora378	1	0	1	0
citriodora379	1	0	1	0
citriodora380	1	0	1	0
citriodora381	1	0	1	0
citriodora382	1	0	1	0
clino166	1	0	1	0
clino167	1	0	1	0
clino168	1	0	1	0
clino169	1	0	1	0
clino170	1	0	1	0
clino171	1	0	1	0
clino172	1	0	1	0

Table 4 (Cont'd)

	45	46	47	48
clino173	1	0	1	0
clino174	1	0	1	0
clino175	1	0	1	0
clino176	1	0	1	0
clino177	1	0	1	0
clino178	1	0	1	0
clino328	1	0	1	0
clino329	1	0	1	0
clino330	1	0	1	0
clino331	1	0	1	0
clino332	1	0	1	0
clino333	1	0	1	0
clino334	1	0	1	0
clino335	1	0	1	0
clino336	1	0	1	0
clino337	1	0	1	0
clino338	1	0	1	0
clino339	1	0	1	0
clino340	1	0	1	0
clino341	1	0	1	0
clino342	1	0	1	0
clino343	1	0	1	0
clino344	1	0	1	0
mexicana475	1	0	1	0
mexicana476	1	0	1	0
parva450	1	0	1	0
parva451	1	0	1	0
parva452	1	0	1	0
parva453	1	0	1	0

Table 4 (Cont'd)

	45	46	47	48
parva454	1	0	1	0
pectinata181	1	0	1	0
pectinata182	1	0	1	0
pectinata183	1	0	1	0
pectinata184	1	0	1	0
pectinata185	1	0	1	0
pectinata186	1	0	1	0
pectinata187	1	0	1	0
pectinata188	1	0	1	0
pectinata189	1	0	1	0
pectinata190	1	0	1	0
pectinata191	1	0	1	0
pectinata192	1	0	1	0
pectinata193	1	0	1	0
pectinata194	1	0	1	0
pectinata195	1	0	1	0
pectinata345	1	0	1	0
pectinata346	1	0	1	0
pectinata347	1	0	1	0
pectinata348	1	0	1	0
pectinata349	1	0	1	0
pectinata350	1	0	1	0
pectinata351	1	0	1	0
pectinata352	1	0	1	0
pectinata353	1	0	1	0
pectinata354	1	0	1	0
pectinata355	1	0	1	0
pectinata356	1	0	1	0
pectinata357	1	0	1	0

LITERATURE CITED

Aiken, G., S. Alderan, et al. (2003). "Tall Fescue, online monograph." from http://forages.oregonstate.edu/tallfescuemonograph/.

Anderson, M. J. and T. J. Willis (2003). "Canonical Analysis of Principal Coordinates: A Useful Method of Constrained Ordination for Ecology." Ecology **84**(2): 511-525.

Askevold, I. (O'Brien, C). "Delta, an invaluable computer program for generation of taxonomic monographs." Annual Review of the Entomological Society of America **87**: 1-16.

Binns, S. E., B. R. Baum, et al. (2002). "A Taxonomic Revision of Echinaceae (Asteraceae: Heliantheae)." Systematic Botany **27**(3): 610-632.

Brach, A. R. and H. Song (2006). "eFloras: New directions for online floras exemplified by the flora of China project." Taxon **55**(1): 188-192.

Chevallier, A. (1996). The encyclopedia of medicinal plants. New York

Boston, DK Pub. ;Distributed by Houghton Mifflin.

Correll, D. S. (1968). "Some additions and corrections to the flora of Texas -VI." Wrightia **4**: 74 - 78.

Correll, D. S. and M. C. Johnston, Eds. (1979). Manual of vascular plants of Texas, The University of Texas at Dallas.

Cory (1953). Field and Laboratory **21**.

Cresswell, J. E. (1990). "HOW AND WHY DO NECTAR-FORAGING BUMBLEBEES INITIATE MOVEMENTS BETWEEN INFLORESCENCES OF WILD BERGAMOT MONARDA-FISTULOSA (LAMIACEAE)." Oecologia **82**(4): 450-460.

Dallwitz, M. (2005). "Overview of the Delta system." from http://delta-intkey.com.

De Queiroz, K. (2007). "Species concepts and species delimitation." Systematic Biology **56**(6): 879-886.

Dorman, H. J. D. and S. G. Deans (2004). "Chemical composition, antimicrobial and in vitro antioxidant properties of Monarda citriodora var. citriodora, Myristica fragrans, Origanum vulgare ssp hirtum, Pelargonium sp and Thymus zygis oils." Journal of Essential Oil Research **16**(2): 145-150.

Epling, C. (1935). "Notes on *Monarda*: the subgenus *Cheilyctis*." Madroño **3**: 20-31.

Frank, S. D., P. M. Shrewsbury, et al. (2008). "Spatial and temporal variation in natural enemy assemblages on Maryland native plant species." Environmental Entomology **37**(2): 478-486.

Gower, J. (1971). "A general coefficient of similarity and some of its properties." Biometrics **27**: 671-857.

Keith, J. A. (2003). Monarda section cheilyctis patterns of speciation and endemism, Michigan State University. Dept. of Plant Biology, 2003.: x, 104 leaves.

Kovach Computing Services (1998). Multi-Variate Statistical Package. Anglesey, Wales, Data Description Inc.

Marcus, L. F. (1996). Advances in morphometrics. New York, Plenum Press.

McCauley, R. A. and H. E. Ballard (2007). "Systematics of North American Froelichia (Amaranthaceae subfam. Gomphrenoideae) I: Identification of consistent morphological variation and segregation of species complexes." Brittonia **59**(3): 255-274.

McClintock, E. and C. Epling (1942). "A review of the genus *Monarda* (Labiatae)." University of California Publications in Botany **20**: 147-194.

Morawetz, J. J. and A. D. Wolfe (2011). "Taxonomic Revision of the Alectra sessiliflora Complex (Orobanchaceae)." Systematic Botany **36**(1): 141-152.

Mouseau, T. (2009). "South Carolina Plant Atlas." from http://cricket.biol.sc.edu/acmoore/scplantatlas.html.

Pammel, L. H. (1911). A manual of poinsonous plants, chiefly of eastern north america, with brief notes on economic and medicinal plants, and numerous illustrations. Cedar Rapids, The Torch Press.

Pennell (1919). Bull. Tor. Bot. Club **46**.
Pereira, M. P., G. E. Perez, et al. (2007). "European sweet vernal grasses (Anthoxanthum : Poaceae, Pooideae, Aveneae): A morphometric taxonomical approach." Systematic Botany **32**(1): 43-59.

Podani, J. and D. Schmera (2006). "On dendrogram-based measures of functional diversity." Oikos **115**(1): 179-185.

Prather, L. A. and J. A. Keith (2003). "*Monarda humilis* (Lamiaceae), a new combination for a species from New Mexico, and a key to the species of section *Cheilyctis*." Novon **13**(1): 104-109.

Prather, L. A., A. K. Monfils, et al. (2002). "Monophyly and phylogeny of *Monarda* (Lamiaceae): Evidence from the internal transcribed spacer (ITS) region of nuclear ribosomal DNA." Systematic Botany **27**(1): 127-137.

R Development Core Team (2009). R: A Language and Environment for Statistical Computing. Vienna, Austria, R Foundation for Statistical Computing.

Reyment, R. A., R. E. Blackith, et al. (1984). Multivariate morphometrics. London ; Orlando, Academic Press.

Rios, N. and H. Bart (2010). GeoLocate Belle Chasse, Louisiana, Tulane University Museum of Natural History.

Rohlf, F. J. (2000). NTSYSpc: Numerical Taxonomy System. Setauket, NY, Exeter Publishing, LTd.

Rohlf, F. J. (2004). tpsDig, digitize landmarks and outlines, Department of Ecology and Evolution, State University of New York at Stony Brook.

Sanders, R. and D. Lee. (2003). "Trees of Miami Interactive Key." from http://www.virtualherbarium.org/treepuzzle/navikey/navikey.html.

Scora, R. W. (1965). "New taxa in the genus *Monarda* (Labiatae)." Madroño **18**: 119-122.

Scora, R. W. (1967). "Interspecific relationships in the genus *Monarda* (Labiatae)." University of California Publications in Botany **41**: 1-71.

Shinners (1953). Field and Laboratory **21**(2).

Sneath, P. H. A. and R. R. Sokal (1973). Numerical taxonomy; the principles and practice of numerical classification. San Francisco,, W. H. Freeman.

Sokal, R. R. and T. J. Crovello (1970). "BIOLOGICAL SPECIES CONCEPT - A CRITICAL EVALUATION." American Naturalist **104**(936): 127-&.

Swofford, D. L. (2002). PAUP* 4.0b10 Phylogenetic Analysis Using Parsimony (*and other methods). Sunderland, Massachusetts, Sinauer Associates.

The International Plant Names Index. (2004). from http://www.ipni.org/.

The New York Botanical Garden. (2007). "Index Herbariorum: A Global Directory of Public Herbaria and Associated Staff." from http://sciweb.nybg.org/science2/IndexHerbariorum.asp.

The Polistes Corporation. (2011). "Discover Life." from http://www.discoverlife.org.

Turner, B. L. (1994). "Taxonomic treatment of *Monarda* (Lamiaceae) for Texas and Mexico." Phytologia **77**(1): 56-79.

Ward, D. E. and R. Spellenberg (1984). "Chromosome counts from New Mexico and Mexico." Phytologia **56**: 55-60.

Waterfall, U. T. (1950). "Some Additions to the Oklahoma Flora." Rhodora **52**.

Watson, L. and M. Dalwitz (1992). The families of flowering plants: descriptions, illustrations, identification, and information retrieval.

Weiblen, G. and N. Deacon. (2003). "Interactive key to the woody plants of Minnesota." from http://geo.cbs.umn.edu/treekey/navikey.html.

Whitten, W. M. (1981). "POLLINATION ECOLOGY OF MONARDA-DIDYMA, MONARDA-CLINOPODIA, AND HYBRIDS (LAMIACEAE) IN THE SOUTHERN APPALACHIAN MOUNTAINS." American Journal of Botany **68**(3): 435-442.

Wilson, E. O. (2003). "The encyclopedia of life." Trends in Ecology & Evolution **18**(2): 77-80.

Wunderlin, R. and B. Hansen. (2008). "Atlas of Florida Vascular Plants." from http://www.plantatlas.usf.edu.

Yamada, K., T. Murata, et al. (2010). "A lipase inhibitor monoterpene and monoterpene glycosides from Monarda punctata." Phytochemistry **71**(16): 1884-1891.

Zhilyakova, E. T., O. O. Novikov, et al. (2009). "Study of Monarda Fistulosa Essential Oil as a Prospective Antiseborrheic Agent." Bulletin of Experimental Biology and Medicine **148**(4): 612-614.