Variables affecting DNA preservation in archival plant specimens[1]

Kurt M. Neubig,[2,3] W. Mark Whitten,[2] J. Richard Abbott,[4] Savannah Elliott,[2] Douglas E. Soltis,[2,5] and Pamela S. Soltis[2]

ABSTRACT

Although the use of plant DNA in scientific research is now decades old now, we still know very little about the best methods of DNA preservation. A few studies have addressed aspects of DNA quality and preservation, but a broad sense of the quality of DNA in herbarium specimens and tissues specifically preserved for DNA usage is still lacking. This article reviews the basic concepts of DNA preservation, factors affecting DNA in herbarium specimens, optimal methods for DNA extraction, and storage. To address lingering questions about the nature of DNA quality in archival plant specimens, we also evaluated ~2000 samples from herbarium specimens, as well as silica-dried and frozen tissues specifically preserved for DNA usage. For herbarium specimens, we used materials spanning much of angiosperm phylogenetic diversity to ascertain general trends of DNA degradation over time and to assess whether different clades had different rates of "expiration." Our results indicate different rates of DNA degradation, but for most samples, no matter the taxonomic group, we were unlikely to recover high-quality DNA after 30–40 years. Nonetheless, given rapid technological advances and changes in DNA sequencing methods, even herbarium specimens with highly degraded DNA may still be of use in molecular analyses. Additional herbarium specimens were sampled for two different collection sets with drastically different curation histories but of approximately the same age. This analysis showed a very marked difference in DNA quality between the two sets: the well-curated specimens had excellent-quality DNA while the poorly curated samples had low-quality DNA. For frozen tissues, virtually all samples had excellent quality, whether storage was at -20° or -80°C and whether tissue was pulverized or intact. For silica-dried tissues, the results were much more heterogeneous, depending on the storage vessel. Samples stored in vessels with poor seals yielded lower-quality DNA. To address the long-term viability of frozen DNA extracts, we compared a set of 7–12-year-old DNA extracts with new extracts of the same original silica-dried tissues and with fresh, greenhouse-collected tissues of the same original material; these comparisons indicated less degradation in the extracts than in the silica-preserved samples, although the differences were subtle. We also found that 15-year-old photo-bleached, silica-dried samples still had small amounts of high-molecular-weight DNA. The long-term preservation of DNA in archival samples remains problematic, but we can best preserve DNA by limiting the factors that degrade it. Although the botanical community has been preserving tissues and DNA extracts for a limited timespan, we can infer some basic conclusions from this and other studies. Recommended best practices are to freeze tissues and extracts at as low a temperature as possible (e.g., -80°C), but if that is not possible or practical, room temperature storage of tissues with silica in tightly sealed containers is a viable alternative, at least for the short term.

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[2] Florida Museum of Natural History, University of Florida, P.O. Box 117800, Gainesville, FL 32611-7800, U.S.A.

[3] author for correspondence: kneubig@flmnh.ufl.edu

[4] Missouri Botanical Garden, P.O. Box 299, St. Louis, Missouri, 63166-0299, U.S.A.

[5] Department of Biology, University of Florida, P.O. Box 118526, Gainesville, FL 32611-8526, U.S.A.

INTRODUCTION AND REVIEW

Advances in DNA sequencing technology have revolutionized the fields of plant evolutionary biology and systematics during the last 30 years, but methods for collecting and preserving plant herbarium specimens have changed little since the time of Linnaeus. Early molecular phylogenetic work in the 1980s usually relied upon extraction of DNA from fresh material from exemplar taxa, but as the difficulty and cost of DNA sequencing dropped, botanists sought to expand taxon sampling to many species that were not in cultivation. Attempts to extract DNA from herbarium specimens usually resulted in degraded DNA, which was still suitable in many cases for many types of analyses. Botanists experimented with various methods of preserving tissue in the field to supplement herbarium specimens. The simplest technique to preserve DNA was rapid, gentle drying (Doyle & Dickson, 1987), but Chase and Hills (1991) reported difficulties in extracting usable DNA from dried tissues of Malpighiaceae and Orchidaceae. They realized that rapid desiccation of tissues (<24 hr) was critical to DNA preservation and demonstrated that tissues dried in fine-grain silica gel yielded high-quality DNA across a wide range of taxa. Similar techniques (e.g., CTAB-NaCl gel; FTA paper) were also demonstrated to preserve DNA by rapidly removing water from tissue. These techniques are now routinely used to supplement standard herbarium collections, with minimal added cost and space requirements. With the emphasis on molecular data in plant systematics, these supplementary preserved tissue samples are important, just as their matching herbarium specimens are.

Although methods for archival storage of herbarium specimens are standardized, there is no commonly accepted standard method for storage of the matching tissue samples. Cryogenic liquid nitrogen storage facilities are accepted as best practice for storage of DNA extracts and tissues, but many institutions do not currently have costly cryogenic facilities (although many larger institutions currently accept samples for cryogenic storage; see Endara et al., this volume). Nearly every plant systematics lab has hundreds to thousands of Ziploc® bags or vials containing silica-dried tissue, largely uncurated, linked to herbarium specimens. What should we do with the thousands of samples stored in this manner? How long can we store them, and what are the best conditions for storage for high yields of good-quality DNA over time? How quickly does DNA degrade in these dried samples, and what is the least expensive, most effective way to store them? Are there simple, relatively low-cost storage methods that might increase the lifespan of the DNA these dried samples contain?

This paper will focus on DNA preservation in plants and is divided into six parts: 1) a review of conditions affecting DNA preservation in herbarium specimens; 2) a review of methods for archiving tissues/DNA supplementary to herbarium specimens; 3) a review of DNA extraction methods for plant tissues 4) a review of tissue/DNA storage; 5) a review of what is known of tissue/DNA storage at different temperatures; and 6) a new comparison of DNA extracted from sets of tissue sample stored for varying lengths of time and under different conditions, with the goal of revealin storage variables that affect DNA quality ove time.

1. HERBARIUM SPECIMENS AS SOURCES C DNA

DNA from herbarium specimens - The phi osophical debate of using herbarium spec mens as a DNA resource has been discuss (Metsger, 1999; Miller, 1999; Mueller, 199

Wood et al., 1999). Policies governing the use of herbarium specimens as a DNA resource have been contentious, but it is now a widely accepted practice, given some limitations. Predicting whether a given specimen will yield high-quality DNA is often subjective and often depends upon unrecorded details about how the specimen was pressed and stored. Factors that affect DNA quality in herbarium specimens are briefly outlined as follows.

Specimen Preparation – If properly dried plant tissues are ideal for DNA preservation, then well-prepared herbarium specimens alone might be an excellent source of archival DNA. Herbarium specimens have become an invaluable resource for systematists and phylogeneticists since dried herbarium specimens were first investigated for their utility as DNA sources (Liston et al., 1990; Savolainen et al., 1995; Bridson and Forman, 1998). Unfortunately, many factors during the preparation and storage of a herbarium specimen may result in highly degraded DNA. A plant specimen is collected and dried in a plant press, usually within a sheet of newspaper between sheets of blotter paper and cardboard. The drying conditions are critical to the quality of DNA that will remain in the pressed specimen. DNA degradation (due to decomposition of the plant material itself) can occur in specimens that dry too slowly; degradation can also occur if drying temperatures are too high. Field methods for plant drying using forced air electric heaters (Blanco et al., 2006), propane burners (Mori, 2011), or solar collectors (Sinnott, 1983) are methods for moving warm (60-100°C) air through the press and drying the tissues to crispness within 12-24 hours. Field work in remote, wet habitats may make field drying impractical, and botanists may resort to field pressing specimens and then soaking them in alcohol or formalin for transport prior to drying (Mori, 2011). Such preservatives protect specimens against decomposition, but they destroy DNA present in tissues. Such field-pickled specimens almost never yield usable DNA after drying and mounting. As discussed elsewhere, tissues stored in aqueous ethanol have shown moderate to strong degradation of DNA quality (Adams and Baker, 2011), so it is not surprising that DNA degradation occurs in freshly collected specimens exposed to dilute alcohols for weeks.

Length of storage in acidic newspaper – Specimens are eventually mounted on archival paper, but in most (underfunded) herbaria, specimens often remain in yellowing newspaper for months or years before being mounted and accessioned. Newspaper is highly acidic and probably contributes to DNA degradation, especially in specimens stored for long periods. Best practice should include pressing specimens in archival, acid-free paper, but we are unaware of vendors that sell acid-free paper for plant pressing. Specimens should be removed from newspaper and mounted on archival paper as soon as possible after drying.

Specimen age – Early studies showed that age of herbarium specimens was a major limiting factor in obtaining high-quality DNA (Savolainen et al., 1995). Most workers assumed that greenness of tissue was associated with high-molecular-weight (HMW) DNA. However, studies reveal that greenness is only loosely correlated with DNA quality, and that age, in combination with the specimen curation history, is a more important factor in estimating quality of DNA (Erkens et al., 2008).

Using 454 sequences of amplicons from nuclear, plastid, and mitochondrial regions, Staats et al. (2011) measured the damage to DNA in herbarium specimens. They compared fresh, recently dried specimens and those up to 114 years old. They concluded that over

95% of DNA is irretrievably damaged during the plant drying process, with only about 1% of amplifiable copies remaining in old herbarium specimens. They observed increased levels of C to T /G to A transitions in plastid DNA of old herbarium specimens as compared to recently dried or fresh tissues. They concluded that ambient humidity in herbarium storage allows for rehydration of DNA that leads to hydrolytic DNA damage over time. While demonstrating that older herbarium specimens can provide sequenceable DNA in spite of damage, the authors advocated for supplemental collection of tissues in silica gel for modern collections.

Humidity – Ambient humidity during specimen storage is probably one of the most important conditions affecting specimens, although controlled studies are limited (Adams, 2011). Most herbaria attempt to keep humidity below 50% to help control pests, but smaller herbaria in tropical areas may not have air conditioning. Also, during transport, specimens will typically be exposed to temperatures and humidity well above standard curation norms for several days or even weeks.

Pest control chemicals and treatments – Herbaria occasionally use chemicals to control insect pests. Pyrethroid insecticides, paradichlorobenzene and naphthalene have no gross adverse effects on DNA quality (Neubig, pers. obs. at FLAS). Vikane (sulfuryl fluoride)/ chloropicrin, used for building/collection fumigation) is not harmful to herbarium DNA (Whitten et al., 1999). Microwave ovens have been used for both initial specimen drying (Bacci et al., 1985) and for control of pest infestations (Hill, 1983; Philbrick, 1984), but because microwaves act by heating tissues, their use should probably be avoided. The deleterious effect of microwaves on DNA is apparently small, although noticeable (Lander et al., 2013).

Oxidation – While the oxidative effect of ambient air is well known (Daniel, 1995), storage of herbarium specimens in reduced-oxygen environments is impractical except for extremely rare historical objects. It has been suggested that DNA isolated from herbarium specimens degrades more rapidly than DNA isolated from fresh tissue (Jansen et al., 1999). In our experience, after many years of using herbarium-extracted DNA, we have no evidence to support this claim, especially if DNAs are stored in TE (Tris-EDTA; see below) buffer.

2. Supplementary Collections Specifically for DNA Preservation

Staats et al. (2011) compared DNA damage in fresh, newly dried, and ca. 100-year-old herbarium specimens. They assessed strand breaks and other sorts of
polymerase non-bypassable damage by quantitative real-time PCR and concluded that most of the DNA damage was caused by heating during the specimen drying process and not by aging during specimen storage. Given that herbarium drying techniques are unlikely to change in the near future, their results demonstrate the necessity to preserve supplementary samples specifically for DNA preservation. We concur with Gaudel and Rouhan (2013) that supplementary material for DNA preservation should be collected along with all new plant vouchers. Given the high cost of herbarium specimen collection and curation, specimen value can be greatly enhanced at minimal additional cost by supplementing the specimen with tissues preserved specifically for DNA extraction.

Storage of flash-frozen fresh tissues in cryogenic banks is ideal but is not feasible for most field projects. Various methods of tissue preservation have been proposed to minimize

DNA degradation over time (Nagy, 2010). The primary causes of DNA degradation are high humidity, light (especially sunlight or fluorescent lights that leak significant levels of ultraviolet wavelengths), oxidation, low pH, endogenous DNases, and exposure to chemical "preservatives" that can alter or destroy DNA. Most preservation methods remove water from tissues and/or buffer cell contents against DNA degradation.

Silica gel – Silica gel has been the most commonly used desiccant to preserve tissues for DNA usage (Chase and Hills, 1991). The most important variables affecting the rate of tissue desiccation are 1) particle size of silica gel; 2) the size/surface area of tissue pieces; and 3) the ratio of tissue to silica gel. Smaller grades of silica gel have greater surface area and therefore dehydrate tissues more rapidly; large beads of silica gel perform poorly compared to finer grades (i.e., 150-200 mesh). Tissues should be torn or cut into very small pieces before being placed into silica gel. Succulents or CAM plants can close their stomata when placed in silica gel; unless the tissues are cut into thin strips, they can take weeks to dehydrate. The weight of silica used should be at least 10 times the amount of tissue. Silica gel often includes colored indicator beads that change color when the silica is saturated with water. Cobalt chloride indicator changes from blue to pink; methyl violet changes from orange to green; iron (III) salts change from orange to clear. Silica gel that has become saturated with water can be regenerated by heating at 120°C for several hours in an oven or by microwaving. Reuse of silica gel carries the risk of cross-contamination of samples with small tissue fragments or pollen, and the use of silica gel is not without disadvantages. Silica gel is potentially hazardous, and inhaling the dust (especially from fine grades) carries risk of silicosis. The blue cobalt chloride indicator is a carcinogen and is being replaced by iron (III) indicators (e.g., Sorbead Orange®) or methyl violet indicators. The cost of silica gel has increased dramatically in recent years, especially in grades sold by scientific vendors. Cheaper alternatives that work just as well are sold as desiccants for flower drying by florists (e.g., http://www.deltaadsorbents.com/). Silica gel works well with thin tissues, but tissues with thick cuticles or abundant mucilage or secondary compounds may dry slowly.

Many botanists use small Ziploc™ polyethylene bags to store tissues in silica gel. Although convenient, such bags do not seal tightly, and the contents quickly become saturated with water, depending upon relative humidity. To slow the hydration of these bags, we place bundles of bags in larger bags used for food storage (see Appendix 1 for further detail); these food preservation bags can be heat-sealed after evacuation of air. Such vacuum-sealed bags can then be stored in a freezer or in a cool, dark space.

NaCl – Granular sodium chloride is an alternative to silica gel that is both cheaper and readily available around the world (Carrió and Rosselló, 2013). Using NaCl provides significant advantages in remote tropical regions. Silica gel desiccates tissues faster than NaCl (Carrió and Rosselló, 2013), but salt may be an acceptable alternative for most uses. The long-term stability of DNA in salt-dried tissues (relative to silica gel) is unknown.

NaCl-CTAB – Succulent or mucilaginous plants are slow to desiccate in silica gel. An alternative strategy is to use a saturated gel composed of NaCl and cetyltrimethylammonium bromide (CTAB) (Rogstad, 1992). The components for this preservative can be carried in the field as a dry powder and hydrated prior to use, in order to form the gel. This colloidal gel is extremely thick, and tissues should be sliced into thin sections or (if possible) vacuum-infiltrated.

FTA paper – An alternative to drying tissues is the use of FTA (FTA® is an acronym for fast technology for analysis of nucleic acids; Whatman, Inc., Clifton, NJ) paper (Lin et al., 2000; Smith and Burgoyne, 2004; Mbogori et al., 2006; Rajendram et al., 2006). FTA paper is thick, adsorbent paper impregnated with buffers and chemical preservatives that retard DNA degradation. Tissues are squeezed or abraded, and the plant juice is adsorbed onto the paper, followed by air-drying. The paper can be stored at room temperature or in a freezer. Samples are cut from the paper for DNA extraction. This is a rapid and space-conservative method, but the quantities of DNA preserved may be relatively small (compared to tissue preservation) unless large pieces of paper are used. Commercially available FTA paper can be relatively expensive compared to silica gel. But a cheap and similar alternative can be made very easily (1 g SDS, 1 ml EDTA at 0.5M, 3 ml Tris at 1 M, add water to 50 ml and mix, soak solution onto filter paper, then dry) for a small fraction of the cost (Klemchin, 2008). These samples, like all others, should be kept in a cool, dry, dark, oxygen-poor location.

RNAlater – RNAlater is a commercial medium for preserving "all" nucleic acids within a tissue (Mutter et al., 2004), including DNA as well as RNA. Its high cost (ca. $1/ml) makes it an expensive alternative to other methods unless RNA preservation is required. Long-term stability of DNA at room temperature is not well studied, and freezer storage is recommended.

Alcohols – Simple alcohols are frequently used as DNA preservatives for animal tissues, but they have not been effective in plants. Insects in particular are frequently preserved in 100% ethanol, with several changes of alcohol needed to remove water and dehydrate tissues. Usable DNA may even be extracted from the alcohol preservative fluids of insect specimens (Shokrolla et al., 2010). Short-term storage (less than a year) of plant tissues in almost any alcohol can yield high-quality DNA (Flournoy et al., 1996). However, long-term storage of many years yields highly degraded DNA, at least in spinach (Adams and Baker, 2011). Although isopropanol is the best out of a suite of different alcohols examined, it is still mediocre at best (Adams and Baker, 2011). Plant tissues to be used in developmental or structural studies are frequently fixed (as spirit collections) in a formalin-glacial acetic acid-ethanol mixture (FAA) that fixes cellular contents (Simmons, 1995). This mixture is highly acidic and hence destructive to DNA (Doyle and Dickson, 1987; Pyle and Adams, 1989). However, extractions from formalin-fixed and paraffin-embedded human tissues have yielded high-quality DNA (Shi et al., 2004). Such success is probably attributable to the use of buffered formalin that is rapidly removed after fixation (rather than long-term storage as for plant tissues). There is some evidence that ethanol pretreatment might be useful in some applications. Soaking tissues in high ethanol concentrations (70% or higher) and then putting them in silica yields higher quantities ol DNA, probably due to the rapid removal ol water (Akinnagbe et al., 2011). Studies by Adams et al. (1999) showed that some plant (Brassicaceae, Poaceae) have potent DNAses that are not inactivated by standard DN extraction protocols, resulting in degrade DNA. Pretreatment of fresh tissue with ethanol prior to extraction increases DNA yields perhaps due to inactivation of DNases (Adams et al., 1999).

Acetone – Acetone is a superior preservativ to ethanol for insect tissues (Fukatsu, 1999). We have not found any literature on the preservation of plant tissues in acetone, but the flammability, volatility, and toxicity of acetone make it an unlikely candidate for wide use.

3. Methods for DNA Extraction from Plants

Tissue grinding – The first step in preparation for DNA extraction of fresh or dried tissue is the disruption of the cell wall. With dried tissue, this is most effectively done using beads (glass, zirconia, steel, etc.) in tubes (we use thick-walled plastic 2-ml tubes with gasketed screw caps) to create a fine powder from the tissue. There are many "bead beater" style machines available; they make extraction processes more streamlined and efficient and can be used for 96-well plate formats. However, such instruments may be relatively expensive ($600-$16,000; http://www.biospec.com/laboratory_cell_disrupters/), and so cheaper alternatives, such as reciprocating saws (Alexander et al., 2006) or electric drills (Zhang and Stewart, 2000), have been proposed.

The use of mortar and pestle to hand-grind tissue is effective for fresh or dried samples, but is very time consuming. Many older protocols call for the addition of liquid nitrogen at this stage of hand pulverization (Gawel and Jarret, 1991). Liquid nitrogen pulverization has multiple uses: one is to make fresh tissues very brittle and more easily ground into smaller pieces, and the second is to retard enzymatic or oxidative degradation until the addition of hot extraction buffer. For silica-dried tissues, grinding in liquid nitrogen serves little purpose, except perhaps to aid the physical grinding of tissues.

Extraction protocols – The most widely used plant DNA extraction is the "modified CTAB method" (Doyle and Doyle, 1987) that uses CTAB (a detergent) combined with NaCl and buffers to disrupt organellar membranes and dissolve DNA. A chloroform liquid-liquid extraction is used to remove lipoidal compounds, and DNA is precipitated from the aqueous phase by addition of isopropanol or ethanol. A basic protocol is presented in Appendix 2. The basic CTAB extraction works well with a majority of plant taxa, but the great variation in plant secondary chemistry results in failures for various taxa. There are numerous published variant protocols to overcome these problems created by secondary chemicals. Examples include:

- In *Drosera*, there is a recipe that uses sorbitol, Tris-HCl, EDTA, and sodium bisulfite (Bekesiova et al., 1999).
- In *Saccharum*, there is a recipe more or less similar to a "basic CTAB" solution, but with polyethylene glycol instead of CTAB (Honeycutt et al., 1992).
- For Proteaceae, there are suggestions for modifying CTAB concentration, or the number of chloroform/isoamyl alcohol washes (Maguire et al., 1994).
- For Cactaceae, including additives like sorbitol in the CTAB buffer and additional chloroform washes remove inhibitory compounds (Tel-Zur et al., 1999).
- For algae, because of the complex mix of unusual polysaccharides, DNA extraction can be problematic and may require special pre-treatment of the tissue to remove secondary compounds. Polyvinylpyrrolidone (PVP) can be added to the CTAB buffer (Maeda et al., 2013)</style><style face="italic" font="default" size="100%">Saccharina</style></title><secondary-title>Journal of Applied Phycology</secondary-title></titles><periodical><-

full-title>Journal of Applied Phycology</full-title></periodical><dates><year>2012</year></dates><urls></urls><electronic-resource-num>10.1007/s10811-012-9868-3</electronic-resource-num></record></Cite></EndNote>.

- For *Ipomoea*, including multiple washes with chloroform removes inhibitory compounds (Kim and Hamada, 2005).
- For *Dalbergia*, adding PVP binds the phenolic compounds, a high molar concentration of NaCl inhibits co-precipitation of polysaccharides and DNA, and LiCl removes RNA by selective precipitation (Ribeiro and Lovato, 2007).
- A generalized extraction protocol for fungi and plants that avoids use of chloroform has also been proposed (Mahuku, 2004).
- For the diverse secondary compounds found in many rosids, a modified CTAB-based protocol was also developed (Soltis et al., 1991).

Various protocols have been developed to remove undesirable polysaccharides in DNA samples (Do and Adams, 1991; Jobes et al., 1995; Porebski et al., 1997). Essentially, these protocols suggest silica column purification (discussed below) or the use of PVP in the extraction buffer to bind to polysaccharides or polyphenolic compounds, thus removing them from the solution prior to DNA precipitation. For taxa with strong mucilaginous compounds, a 3X CTAB protocol is recommended with repeated chloroform extractions, followed by a second precipitation of DNA after treatment with RNase (Cota-Sánchez et al., 2006). For taxa with abundant latex, extraction of etiolated tissues may reduce the amount of secondary metabolites relative to DNA (Michiels et al., 2003). Because of the degraded nature of ancient DNA, extractions are sensitive to loss and contamination (Rohland and Hofreiter, 2007; Särkinen et al., 2012).

Beta-mercaptoethanol is often added to CTAB extractions; it is a strong reducing agent that can remove tannins and other polyphenols often present in the crude plant extract. It is an irritant with a very strong odor, so its inclusion should be avoided unless it is demonstrated to be beneficial.

DNA extraction methods from plants, animals, and other eukaryotic organisms are reviewed by Knebelsberger and Stoger (2012). Binding DNA to magnetic beads followed by washing is a technique amenable to automation and high-throughput sequencing utilized in DNA barcoding (Rudi et al., 1997; Levison et al., 1998; Oster et al., 2001; Palecek and Fojta, 2007). The resulting DNA is very pure, but yield is relatively low, and the technique is not oriented towards archival museum storage. Other high-throughput methods utilize silica-containing filters, hereafter referred to as silica columns (Whitlock et al., 2008).

The CTAB method involves one to several liquid phase extractions with chloroform/isoamyl alcohol (24:1) that are very effective in removing polar secondary compounds that interfere with DNA precipitation. Unfortunately, chloroform is carcinogenic and toxic and involves added expense for disposal. Various commercial plant DNA extraction kits (Qiagen DNeasy, Invitrogen ChargeSwitch, Nucleospin) utilize proprietary reagents combined with silica membrane columns, magnetic beads, or anion exchange resins to avoid the use and hazard of chloroform. Särkinen et al. (2012) compared the most commonly used commercial kits to several variants of CTAB extraction, measuring DNA yield, purity, and PCR amplification from the extracted DNA.

They noted that (especially for herbarium specimens) total quantity of DNA extracted is not as important as the purity of the resulting DNA and the ability of the DNA to yield amplicons. Their and other comparative studies showed that for optimal PCR amplification of various DNA loci, a CTAB extraction combined with silica column binding purification gave the best results (Csaikl et al., 1998; Rohland and Hofreiter, 2007; Särkinen et al., 2012).

Telle and Thines (2008) exhaustively compared 19 different extraction methods or kits and 15 different polymerases, measuring their ability to amplify a ~620-bp oomycete (plant pathogen) mitochondrial fragment from herbarium specimens up to 129 years old. Their results were complex, but demonstrated that several of the commercial DNA extraction kits (Geneclean Kit for Ancient DNA, Bio 101; Genelute Plant Genomic DNA kit, Sigma; innuPREP Plant DNA Kit, Analytikjena; DNeasy Plant Mini Kit, Qiagen; Invisorb Spin Plant Mini Kit, Invitek; E.N.Z.A. Forensic DNA Isolation Kit, VWR) outperformed basic CTAB + silica column extractions as measured by the amplification of 300-600-bp amplicons. They also demonstrated that choice of polymerase was crucial to successful amplification. They did not sequence the amplicons, so DNA damage could not be compared.

Activation of DNases during extraction – Proteinase K is routinely used in extraction of animal tissues; the enzyme not only degrades structural proteins but also inactivates proteinases that digest DNA (Knebelsberger and Stoger, 2012). Proteinase K is not inactivated by chelating reagents such as EDTA or detergents such as SDS and is active over a wide range of pH (4-12.5). Adams et al. (1999) showed that some taxa (Poaceae, Brassicaceae) exhibit rapid degradation of DNA during extraction in normal protocols from both fresh or silica-dried tissues. They hypothesized the degradation was caused by exceptionally stable DNases that could tolerate desiccation and that consumed DNA during the extraction process. They showed that addition of proteinase K during the initial incubation stage of DNA extraction likewise destroys any endonucleases, resulting in high yields of HMW DNA. Other workers have noted the beneficial effects of proteinase K in extraction buffers (Crowe et al., 1991; Zhang and Stewart, 2000).

4. Archival Storage of Plant Tissues or Extracts to Maximize Quality

Should we store tissue samples or just DNA extracts? Given that we cannot anticipate all future uses of archival specimens, it makes sense to preserve portions in their most natural form (leaves, flowers, seeds), because these contain not only DNA but also all the other biomolecules that survive drying. Anchordquy (2007) notes the increasing importance of epigenetics and suggests that archival storage methods should include preservation of other biomolecules in addition to DNA. However, if DNA degrades inside intact tissues during archival storage, then DNA should be extracted for archival storage. If space and curation facilities allow, storage of both tissues and extracted DNAs seems optimal.

5. Storage Temperature and Room-Temperature Alternatives

Storage of tissues or DNA at liquid nitrogen temperatures (-196°C) is optimal because degradation is minimized relative to all other storage techniques (Lee et al., 2010). The high quality of preservation comes at a relatively high cost due to initial cost of the Dewar tanks and the specialized cryogenic vials and labels that must be used, combined with the perpetual costs of liquid nitrogen. Mechanical freezers (-60° to -80°C) are an alternative but are relatively expensive, and mechanical failure must be anticipated for archival storage. Storage in -20°C freezers is much more common; some large herbaria (e.g., Missouri Botanical Garden) have walk-in freezers for storage of vouchered tissue samples. Commercial food freezers are suitable for specimen storage as long as they are not frost-free; the periodic thawing in frost-free freezers is harmful to extracted DNA and presumably to tissues and specimens as well (Surzycki, 2000).

Methods for storing DNA or tissue extracts at room temperature include FTA paper (mentioned above) and vitrification of DNA in trehalose [e.g., Qiasafe tubes (Qiagen, Inc.) or Gentegra (IntegenX, Inc.); Trehalose works by binding to DNA and stabilizing its structure (Zhu et al., 2007)]. Ivanova and Kuzmina (2013) compared Biomatrica DNAstable plates, homemade trehalose plates, and polyvinyl alcohol (PVA) plates for room-temperature and freezer preservation of insect DNA. They measured successful amplification and sequencing following various storage conditions up to 4 years old. Overall, the dry storage media (trehalose, Biomatrica, or PVA) provided sufficient protection for short-term storage of DNA at room temperature, thus enabling shipment and exchange of DNA extracts and PCR products between DNA barcoding facilities (Knebelsberger and Stoger, 2012). Although trehalose might be sufficient for short-term storage, they recommend Biomatrica and Tris-buffered PVA for long-term storage and for sample exchange with tropical countries. Desiccants should be used to minimize exposure to humidity. Temperature is a crucial factor for DNA quality, which has to be considered especially for long-term storage. Some have found that short-term DNA storage is best at 4°C or long-term at -70°C or less. Others have concluded that DNA is best stored in trehalose, either at room temperature or at -80°C (Smith and Morin, 2005). However, Smith and Morin (2005) focused on extracted DNA and not storage of tissues, which behave differently because of the matrix of cellular contents. It is premature to advocate transition to DNA storage at room temperature, and that these storage methods should be viewed as adjuncts to archival freezer storage of tissues or DNAs.

Frippiat (2011) compared stability of human DNA stored at room temperature in Gentegra matrix vs. Qiasafe, using DNA extracted by phenol/chloroform vs. a magnetic bead protocol. Reduction in amplification was shown in the samples extracted with magnetic beads, suggesting that specific DNA isolation protocols are important in these anhydrous preservation methods.

Although many researchers resuspend DNA extracts in water, many references emphasize the beneficial effects of TE buffer (10 mM Tris-HCl, 1 mM EDTA, pH 8.0) for long-term storage of DNA. DNA is more stable under high pH and in the absence of metal ions that catalyze degradation. TE buffer provides a slightly alkaline environment, and EDTA is a chelating agent that binds metal ions (Surzycki, 2000; Anchordoquy and Molina, 2007).

6. What questions remain about plant DNA resources, curation, and long-term storage?

Given the above review, some aspects of DNA curation, and storage are clear, but many questions remain.

A. How is DNA quality related to methods of herbarium specimen curation (e.g., do higher temperature and humidity negatively affect DNA quality in herbarium specimens)? In a broad su of taxa, are there any plant groups that have consistently good or bad DNA quality in herbarium specimens (i.e., might certain families be particularly prone to DNA degradation)?

B. What are the age limits of herbarium specimens that give "high-quality" DNA? Does this vary among different clades (families/genera)? Does tissue succulence play a role in DNA degradation in herbarium specimens (i.e., does the added water of thick tissues make DNA preservation poorer than in thin-leaved samples)?

C. How is storage of tissues in silica affected by type of storage vessel? How is DNA quality affected in tissues stored in silica vs. freezers?

D. How does DNA quality compare in DNA extracts stored at -20°C vs. silica-dried tissues stored at room temperature?

E. What are the effects of light on DNA quality of silica-dried tissues (i.e., effects of photobleaching)?

Here we present results of experi-ents designed to address these questions.

[ATERIALS AND METHODS

uring discussions of DNA and herbarium ecimens, we realized that collectively we ıve sets of hundreds of herbarium specimens .d/or specimens dried in silica gel collect- up to 30 years ago that might facilitate a rendipitous experiment on the effects of ecimen preparation and curation on DNA eservation. These specimens were collected : a variety of phylogenetic or floristic proj-:s, but their curation history is known in fficient detail for us to make correlations between DNA quality, age, and specimen curation (Appendix 4). To examine the relative importance of such effects, we extracted DNA from these sets of specimens and used gel electrophoresis as a rough estimate of DNA quality among samples. We did not test amplification or sequencing success from these DNAs.

<u>A. Effects of herbarium specimen curation on DNA quality</u>: To address the impact of different herbarium curation variables (archival mounting paper, ambient temperature and humidity), we used two similar sets of taxa collected for Florida floristic studies from about the same time period (7-21 years old) but stored under different conditions. The first data set was collected to document the flora of the White Oak Plantation, Nassau Co., Florida. These specimens (n = 461, mean age of 13.6 years) were pressed carefully over gentle forced air, immediately mounted on archival herbarium paper, and stored in pest-free cabinets in an air-conditioned lab, under low humidity (ca. 45% RH) at cool temperatures (<20°C) for the lifetime of the collection.

The second set of specimens, hereafter referred to as the "Abbott collection" (n = 192, mean age 17.6 years), was collected by Richard Abbott and has been stored unmounted in the original newspapers and has never been mounted on archival paper. The collection was moved cross-country several times (Florida, California, Illinois, Missouri, Florida). Until recently, the specimens were not consistently in air-conditioned environments, thus were periodically subject to ambient humidity and temperature.

<u>B. Effects of herbarium specimen age and leaf succulence on DNA quality</u>: To determine if DNA degradation rates in herbarium specimens might vary among families or genera, we examined specimens of various ages of phylogenetically disparate families from specimens

with the same curation history: *Asimina* (n = 128, Annonaceae), *Mikania* (n = 334, Asteraceae), Polygalaceae (n = 355), Hibisceae (n = 330, Malvaceae), and *Portulaca* (n = 40, Portulacaceae).

C. Effect of silica drying and freezing on DNA preservation: We examined DNA quality in various tissues that had been stored with the specific intent of preserving DNA. Specimen sets included tissues dried in silica gel and then stored at room temperature (usually in the dark) for up to 20 years in falcon tubes (transparent 50-ml polypropylene centrifuge tubes with opaque blue caps) (n = 63), glass specimen jars (n = 20), and Ziploc® bags (n = 91). Unfortunately, no tissues older than this could be located, because this method of tissue storage only came into use in the early 1990s (Chase and Hills, 1991). We also analyzed various tissues stored for up to 24 years in -20°C (n = 20) or -80°C (n = 38) freezers to assess the effects of low temperatures on DNA quality.

D. Comparison of DNA preservation of orchid leaf samples in room temperature silica-dried tissues vs. DNA extracts frozen at -20°C for 7-12 years: Silica-dried samples (n = 11) were stored at room temperature for 7-12 years with a replicate of DNA extracts from the matching samples. Fresh tissues of the same silica-dried accessions were recollected from greenhouse-grown material at the present day (i.e., 2013) for comparison.

E. Effect of photobleaching: Orchid leaf tissues (n = 8) were stored in falcon tubes and exposed to ambient light (both indirect sunlight and fluorescent light) on a laboratory shelf for 15 years. These tubes seal tightly with little air infiltration. These samples are not directly compared to other DNA resources; they simply represent the demonstrable effect of light on tissues.

Extraction protocol – All samples were ground in a bead beater mill in 2-ml screwcap vials using glass beads. Extractions utilized a modified CTAB protocol (Doyle and Doyle, 1987); details are presented in Appendix 2. Because of the large number of samples, the DNAs were simply precipitated with isopropanol followed by two washes of the pellet with 70% ethanol. Neither RNase treatment nor silica column cleaning was performed prior to electrophoresis.

Electrophoresis – Because of cost and time considerations, we did perform exhaustive spectrophotometric analyses (e.g., Nanodrop, Qubit) or more sophisticated methods of nucleic acid analysis (e.g., Bioanalyzer). All total genomic DNAs were electrophoresed on 1.5% agarose gels using ethidium bromide and two size standards (a 100-bp hyperladder IV and lambda DNA digested with *Eco*RI and *Hin-d*III) run at 150 volts for ~30 minutes or 2 cm migration of loading dye (whichever was achieved first); details are in Appendix 3. Gels were photographed using a Canon A650IS camera. Gel images were analyzed using Photoshop software for basic image cropping and rotation. GelAnalyzer2010 was then used to produce a two-dimensional graph of absorbance vs. fragment length (http://www.gelanalyzer.com/).

Analysis – We regard the pattern of DNA fragment length revealed through gel electrophoresis as roughly indicative of overall DNA quality and extent of degradation. High-quality total DNA extracts have a strong peak of very HMW (>23 kbp), with relatively few low-molecular-weight fragments. Highly degraded DNA has no HMW fragments, with smears of fragments below 1000 bp. Based on the relative intensity of absorbance at high-, medium-, and low-molecular-weight regions of each trace (Fig. 1), we constructed 24 categories of DNA trace quality, ranging from highest to lowest quality (Fig. 2). We subjectively scored each sample's electrophoretic trace and placed it into one of these quality categories. These quality scores were used to compare samples in the data analyses.

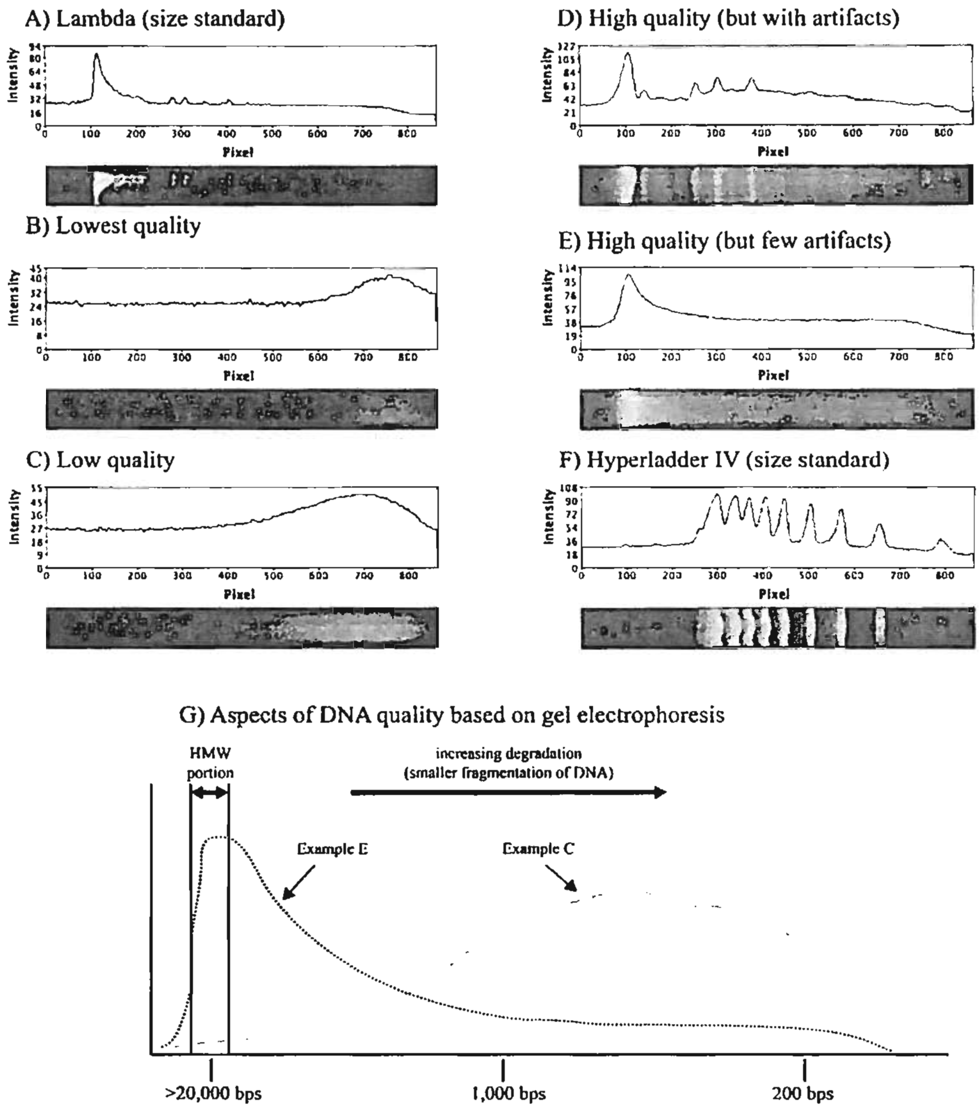


Figure 1. Electrophoretic profiles of exemplar samples demonstrating: A) Upper size limit. B) Lowest quality sample (except for a sample with no discernible DNA) with a low peak in the low-molecular-weight region indicating intense degradation. C) Another low quality sample, but with a broader smear with slightly higher molecular weight. D) High quality DNA with a HMW band, but peak artifacts at lower molecular weight (presumably ribosomal RNA). E) High-quality sample with a HMW peak and very little low-molecular-weight DNA, indicating little degradation. F) Size standard hyper ladder showing peaks at 100-bp intervals from 1000 bp at left to 200 bp at right. Peak height is correlated with overall fluorescence and is not an absolute measurement of DNA.

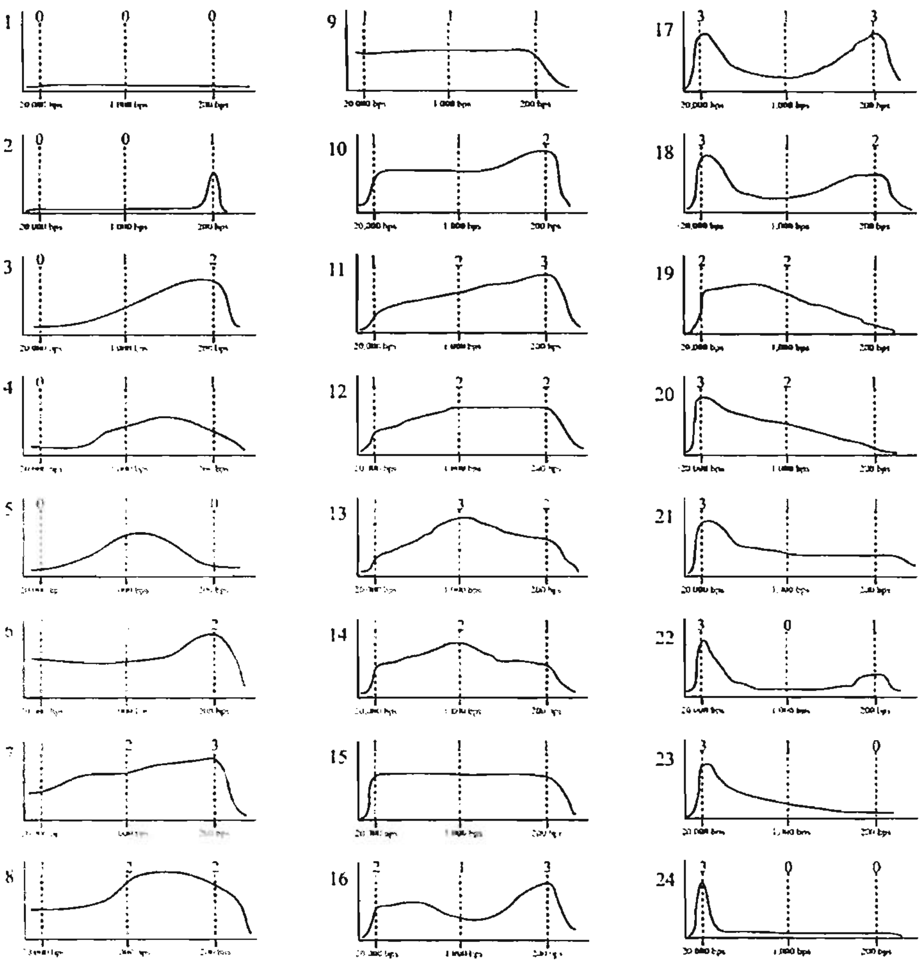


Figure 2. Character states of DNA quality as delimited by four aspects in gel electrophoresis imaging. The first aspect is the pre ence of a peak within the HMW region as indicated by Figure 1. The second, third, and fourth aspects are the relati fluorescence at the HMW, 1 kb, and 200 bp portions, respectively, of the total DNA extracts. The lowest-quality samp is exemplified by image 1; the highest-quality is exemplified by image 24.

Results

For this study, we define "high-quality" DNA as a sample containing a relatively large amount of HMW fragments. Likewise, "degraded" DNA implies that there is relatively little HMW DNA with a majority of low-molecular-weight DNA. Our results are contingent upon the premise of DNA degradation shifting HMW DNA to low molecular weight (Fig. 1G) and are consistent with the examples of degradation presented by Adan and Sharma (2010).

A) Comparison of the extracts from the tw differentially curated herbaria (White O Plantation vs. Abbott) (Fig. 3) demonstrat that method of curation has a large effect DNA quality. The White Oak Plantati samples had 89% of the samples with HM bands, whereas the Abbott samples had or 16% of samples with HMW bands.

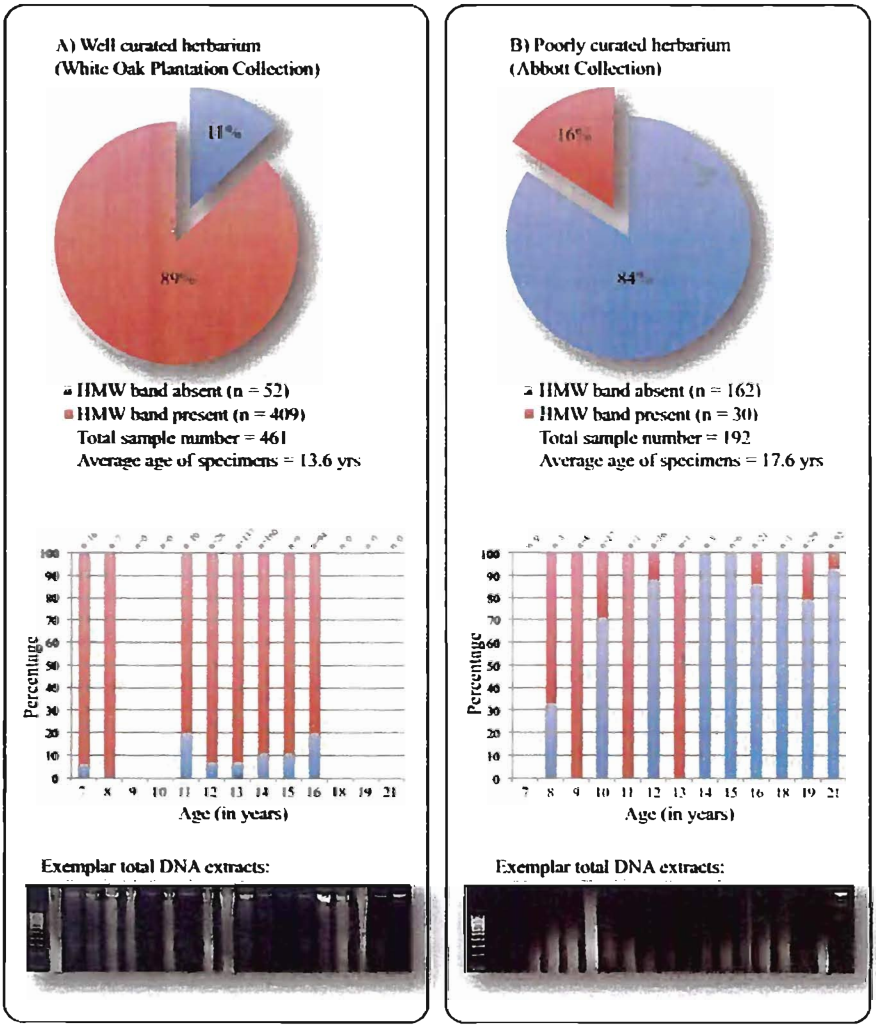
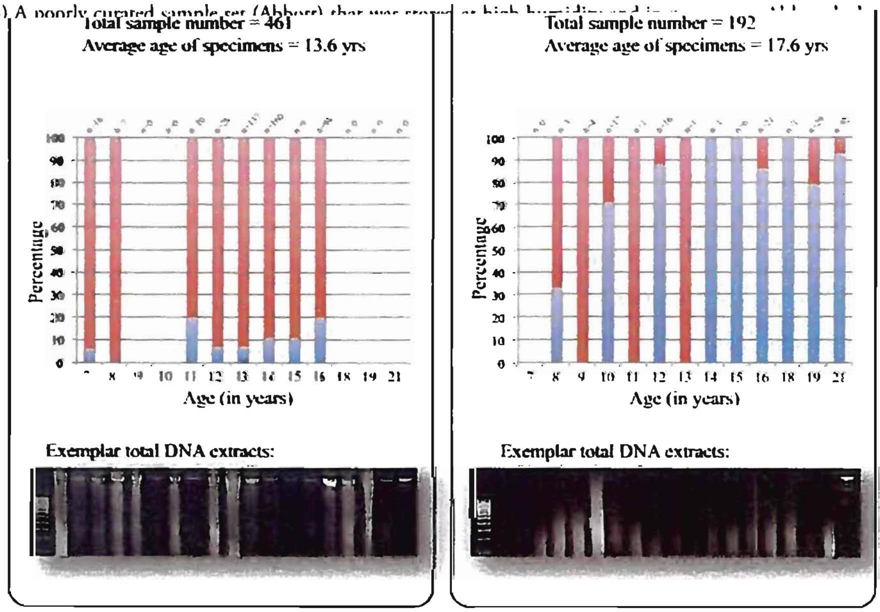
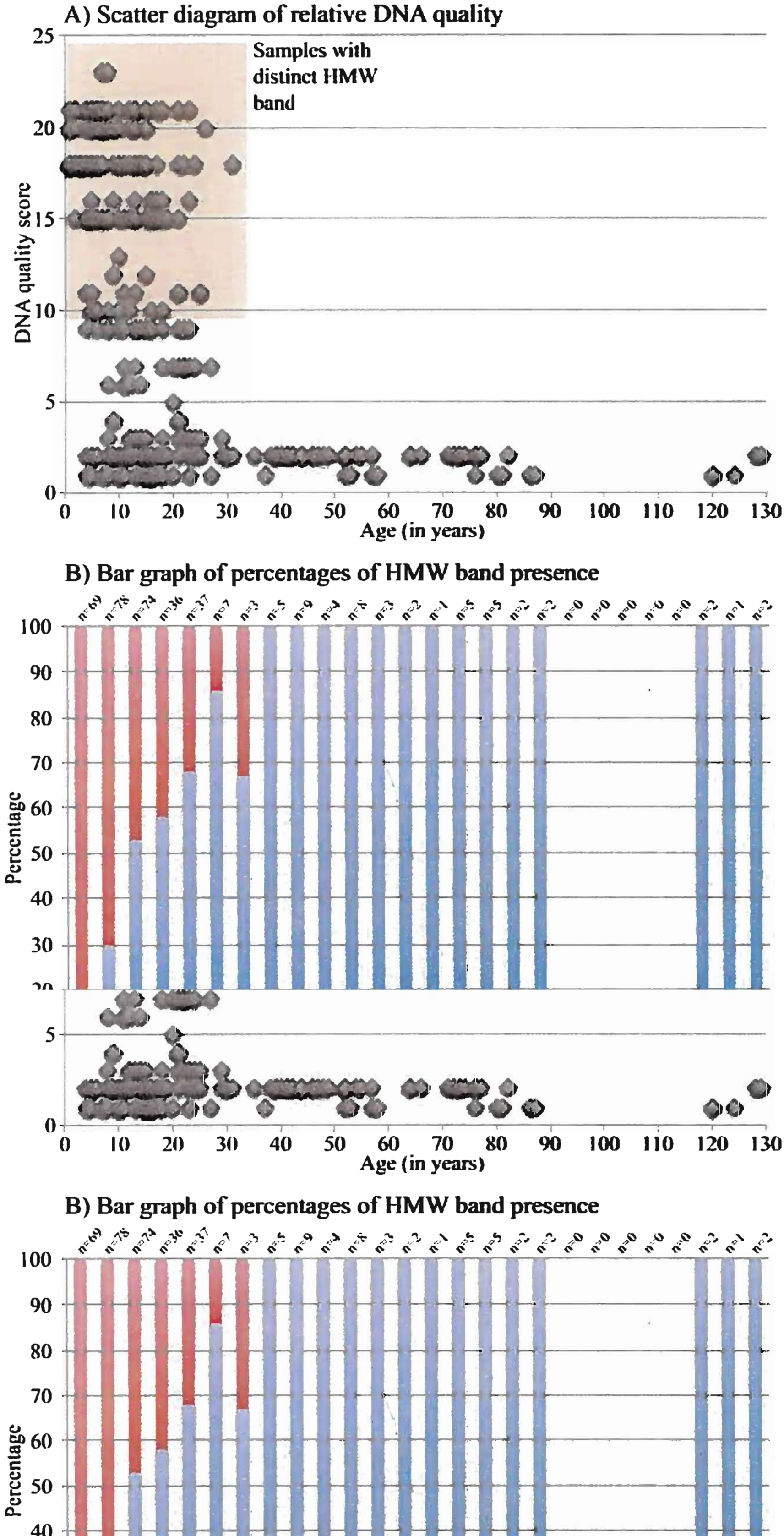
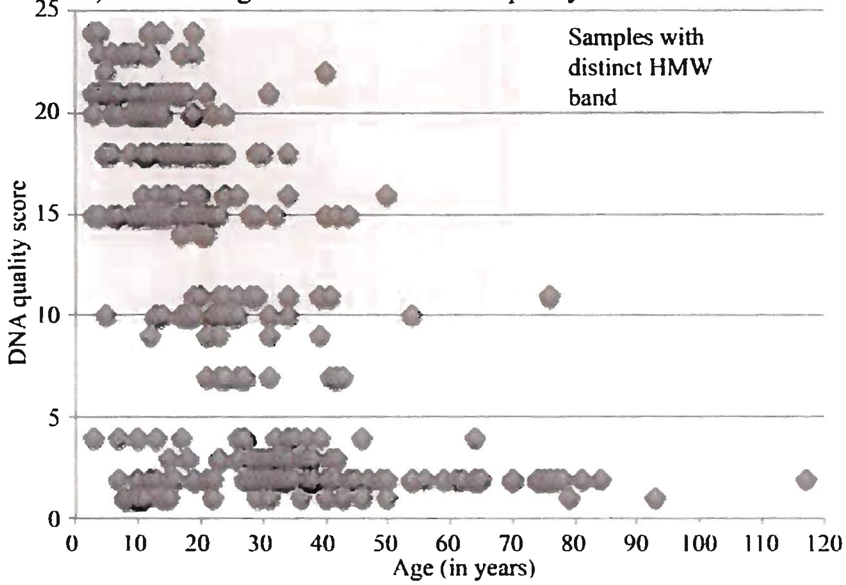


Figure 3. A comparison of the presence of HMW DNA in various herbarium collections to ascertain the influence of herbarium sample curation on DNA quality. A) A well-curated sample set (White Oak Plantation) that was stored at low humidity. B) A poorly curated sample set (Abbott) that was stored at high humidity and in ...

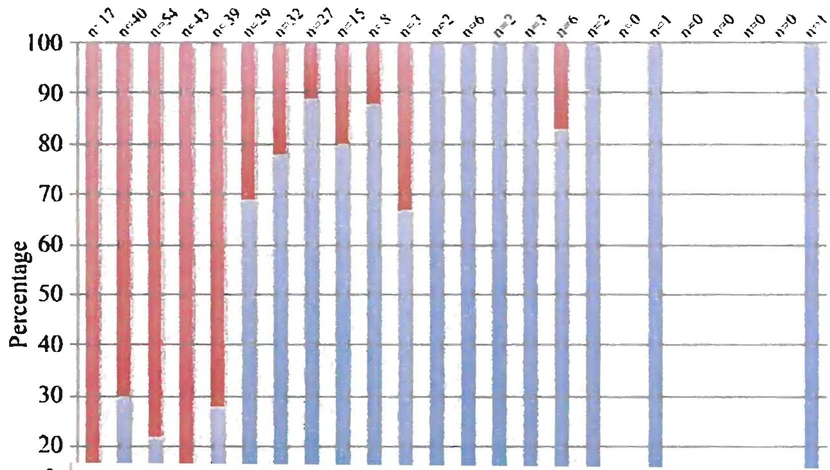

Total sample number = 461
Average age of specimens = 13.6 yrs
Percentage
Age (in years)
Exemplar total DNA extracts:
Total sample number = 192
Average age of specimens = 17.6 yrs
Percentage
Age (in years)
Exemplar total DNA extracts:

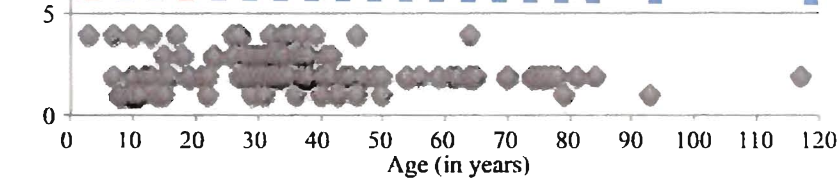

A) Scatter diagram of relative DNA quality
Samples with distinct HMW band
DNA quality score
Age (in years)
B) Bar graph of percentages of HMW band presence
Percentage

A) Scatter diagram of relative DNA quality

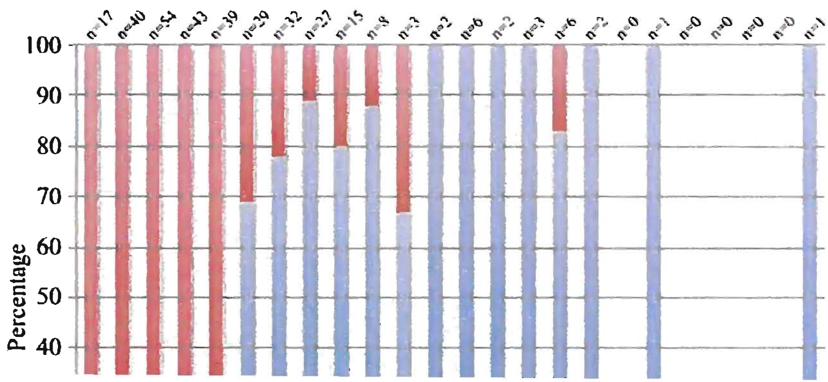


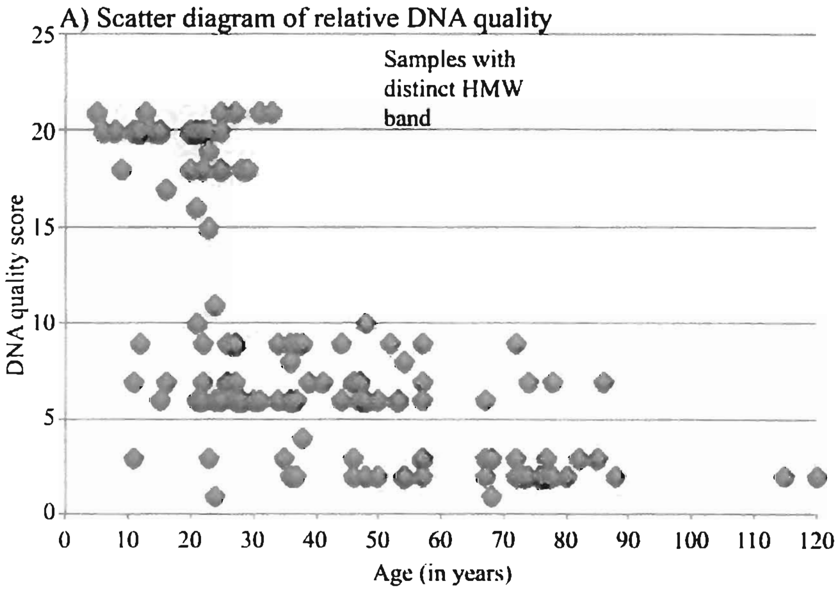
B) Bar graph of percentages of HMW band presence

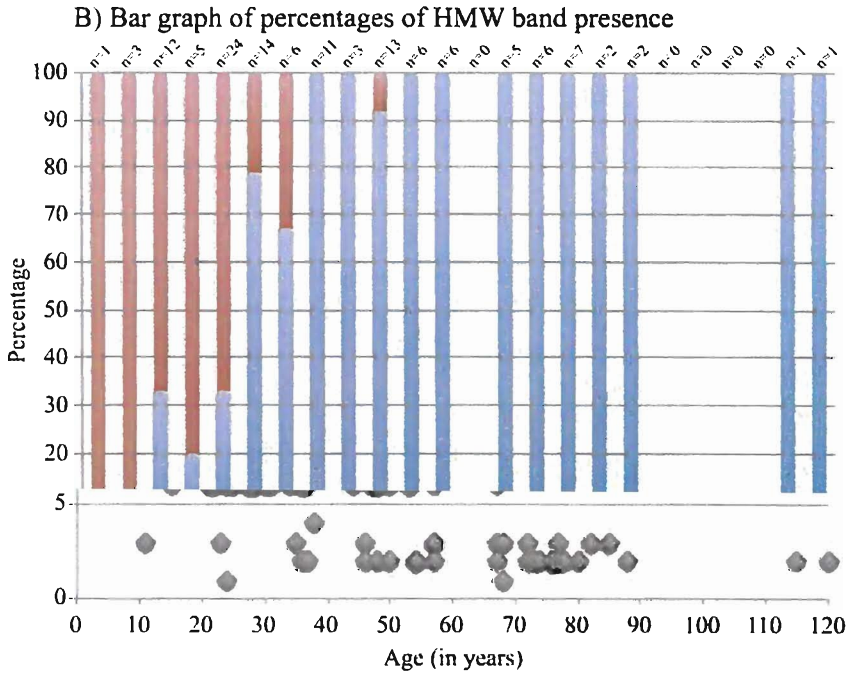


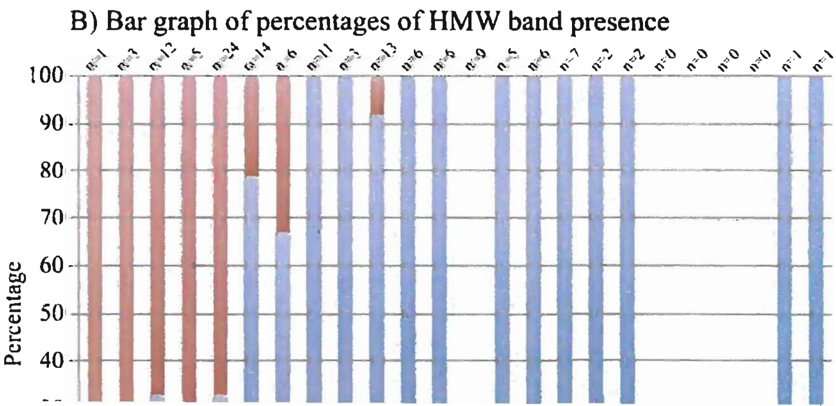


B) Bar graph of percentages of HMW band presence

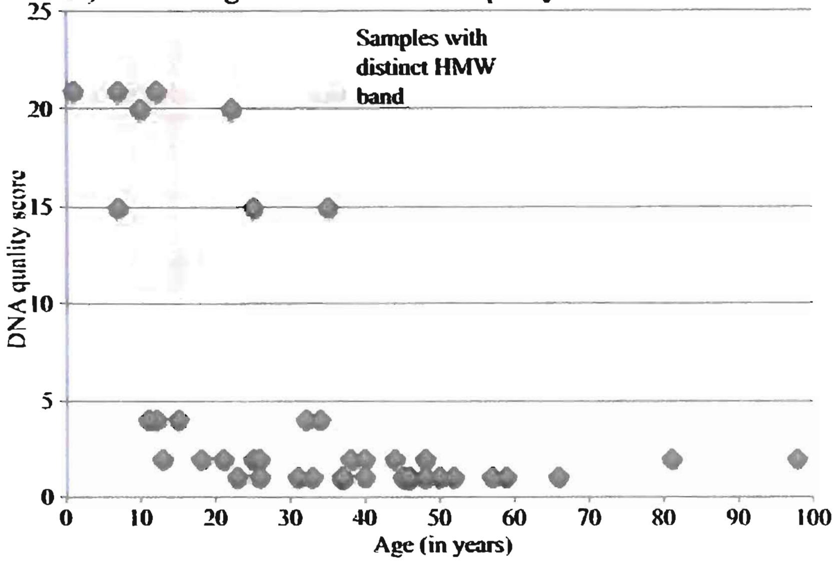



A) Scatter diagram of relative DNA quality
Samples with distinct HMW band
DNA quality score
0
5
10
15
20
25
0 10 20 30 40 50 60 70 80 90 100 110 120
Age (in years)

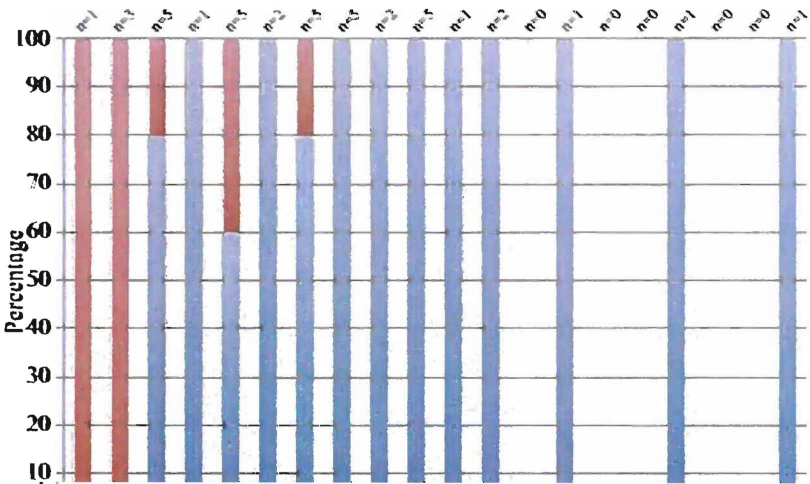

B) Bar graph of percentages of HMW band presence
Percentage
100
90
80
70
60
50
40
30
20
5
0
0 10 20 30 40 50 60 70 80 90 100 110 120
Age (in years)

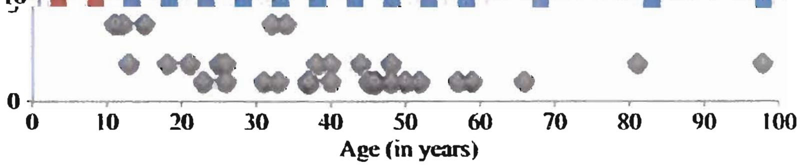

B) Bar graph of percentages of HMW band presence
Percentage
100
90
80
70
60
50
40

A) Scatter diagram of relative DNA quality

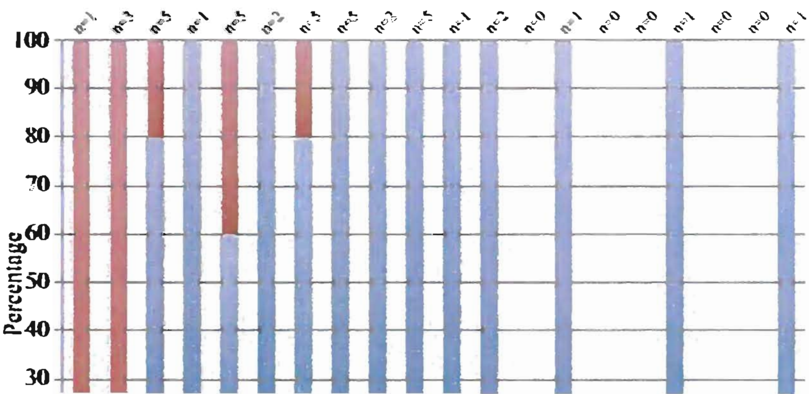


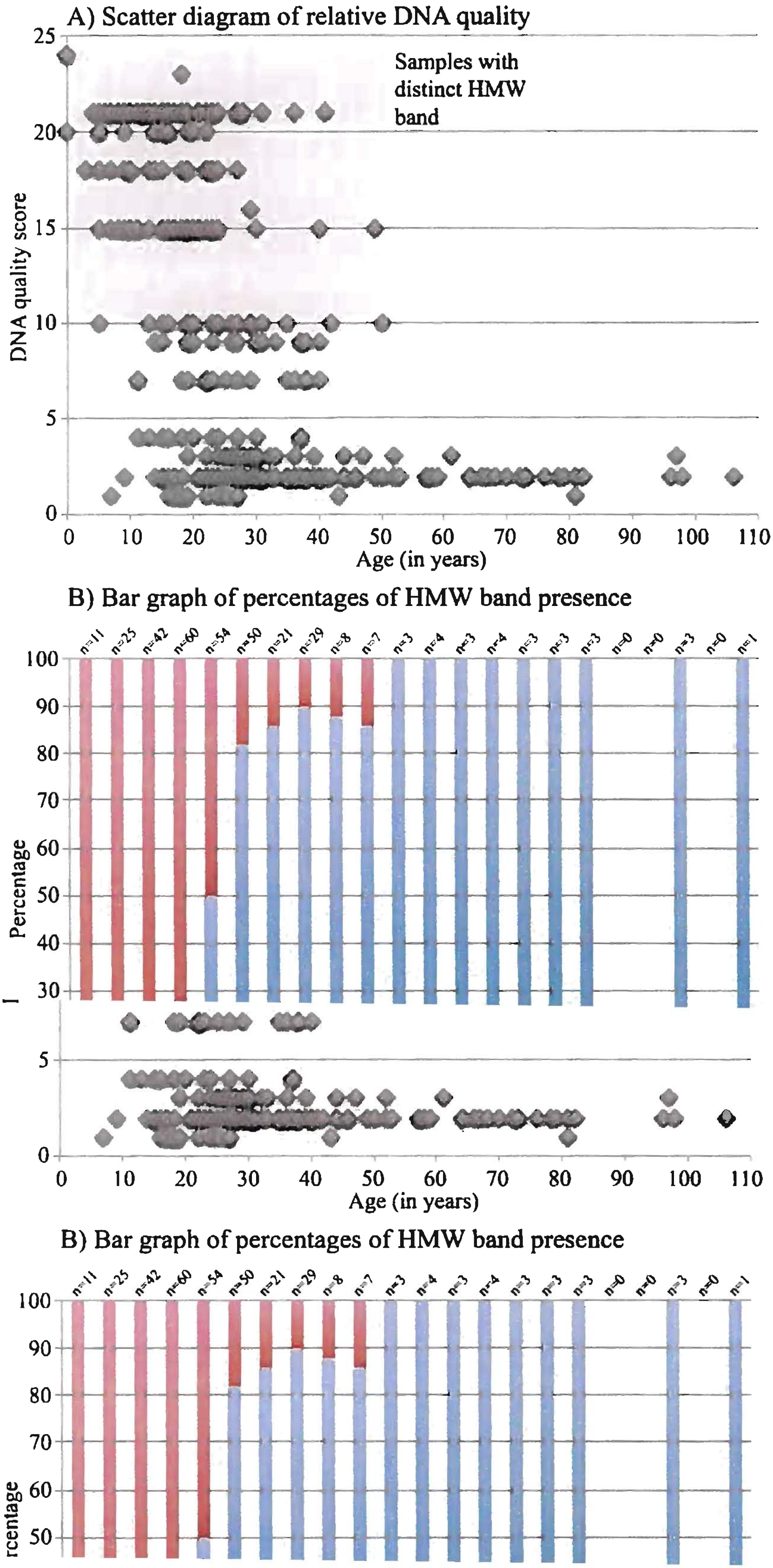
B) Bar graph of percentages of HMW band presence



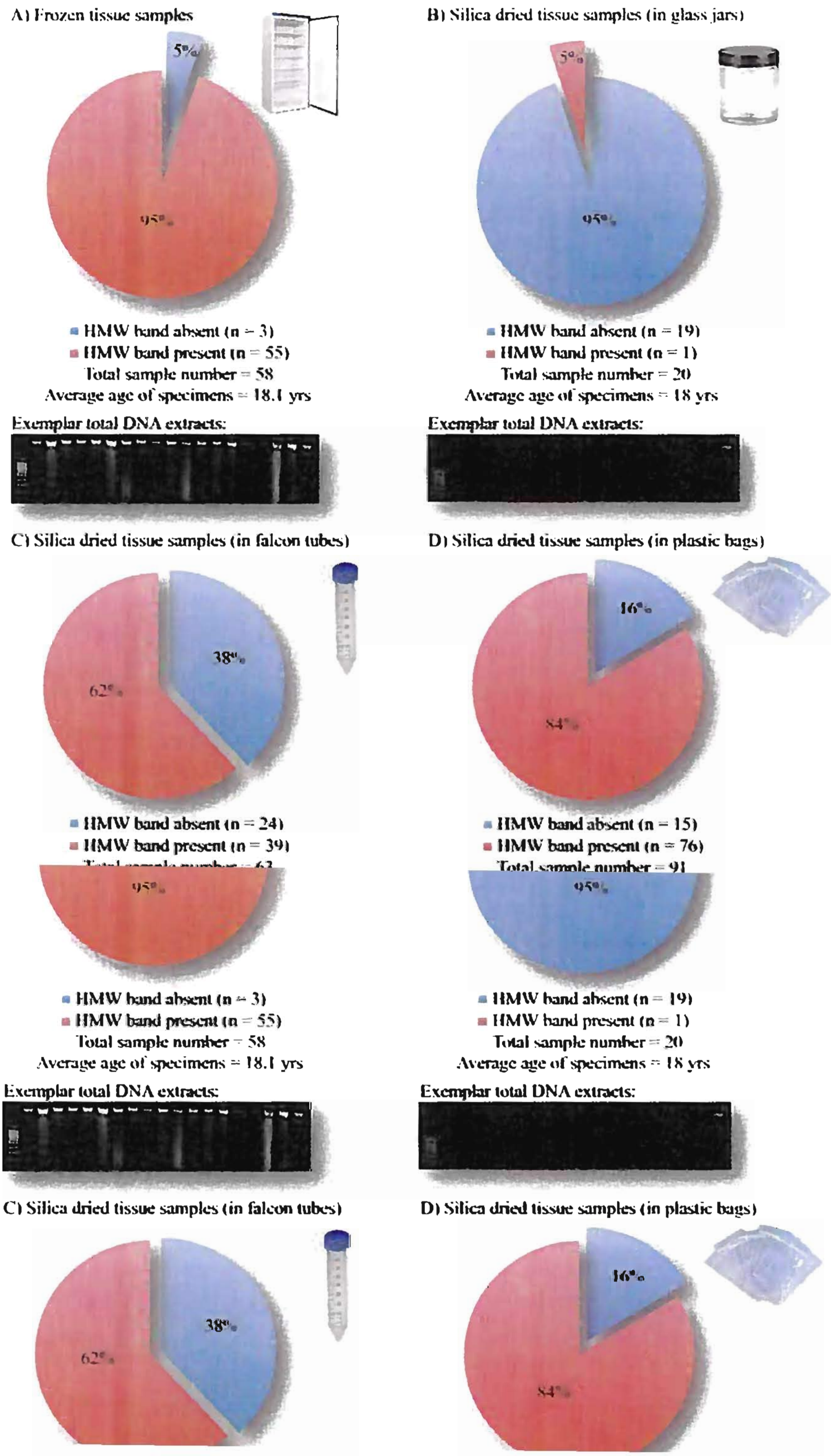


B) Bar graph of percentages of HMW band presence




A) Scatter diagram of relative DNA quality
Samples with distinct HMW band
DNA quality score
Age (in years)
B) Bar graph of percentages of HMW band presence
n=11 n=25 n=42 n=60 n=54 n=50 n=21 n=29 n=8 n=7 n=3 n=4 n=3 n=4 n=3 n=3 n=3 n=0 n=0 n=3 n=0 n=1
Percentage

C) Frozen tissues gave consistently high-quality DNA (Fig. 9A), regardless of age. However, silica-dried tissues yielded extracts of widely varying DNA quality (Fig. 9B-D), suggesting that storage conditions of the silica-dried tissues might greatly affect long-term DNA quality.



D) Figure 10 shows DNA extracts for a set of 11 orchid samples. The bottom row shows extracts from fresh tissue, the top row shows DNA extracts made from freshly silica-dried tissues 7-12 years ago (the total DNAs have been stored at -20°C since extraction), and the middle row shows recent re-extractions of the same 7-12-year-old silica-dried tissues, illustrating a comparison of the first and second rows showing degradation of these samples over time.

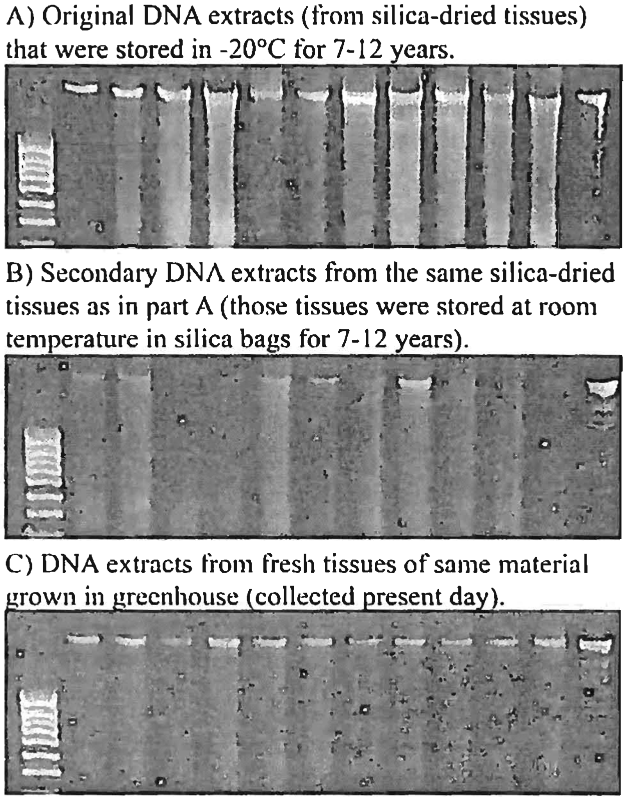
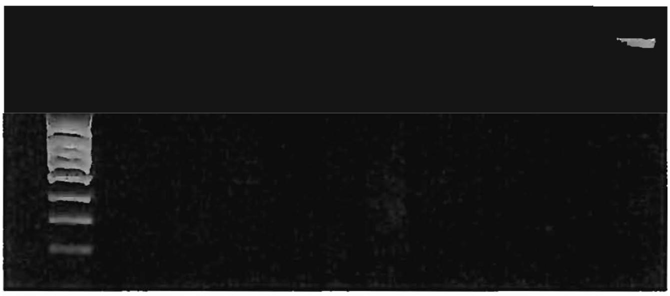


Figure 10. Comparison of A) original extracted DNA from silica-dried samples stored at-20°C, B) secondary extractions from the same silica-dried samples in present day, and C) freshly collected samples from greenhouse-grown living plant collection in present day. Size standards are in in lanes 1 and 13 (hyperladder IV and lambda digest, respectively), identical sample replicates are in lanes 2-12.

E) In Figure 11, the effects of photobleaching in silica-dried samples are depicted. Although very little DNA was recovered from these samples, some of them still had some HMW DNA.

A) Exemplar photobleached sample

B) Electrophoretic gel image of photobleached samples



B) Electrophoretic gel image of photobleached samples

DISCUSSION

DNA measurements can be made by various means. Spectrophotometric analyses of DNA solutions measure the absorbance ratio at 260 vs. 280 nm; the ratio is indicative of the purity of the DNA (i.e., 1.8 for pure DNA) (Manchester, 1995). DNA-specific spectrophotometers include NanoVue UV-spectrophotometer (GE Healthcare), Nanodrop, and Qubit. These technologies assess DNA quantity, but not quality. So, low-quality samples can have high masses of DNA, and vice versa. Assays to measure damage to DNA strands generally involve sequencing of the DNA, usually through next-generation methods (Godden et al., 2012; Bi et al., 2013)K.</author><author>Linderoth, T.</author><author>Vanderpool, D.</author><author>Good, J. M.</author><author>Nielsen, R.</author><author>Moritz, C.</author></authors></contributors><titles><title>Unlocking the vault: next-generation museum population genomics</title><secondary-title>Molecular Ecology</secondary-title></titles><periodical><full-title>Molecular Ecology</full-title></periodical><pages>6018-6032</pages><volume>22</volume><dates><year>2013</year></dates><urls></urls></record></Cite></EndNote>.

Many studies have used PCR as a measure of DNA quantity and quality. DNA quality is estimated by simple success/failure ratios and the length of the target amplicon, with the assumption that higher-quality DNA is capable of yielding higher-molecular-weight amplicons (Erkens et al., 2008; Adams and Sharma, 2010; Särkinen et al., 2012; Ivanova and Kuzmina, 2013). Real-time PCR has also been applied as a means of more precisely quantifying DNA quality (Cankar et al., 2006). However, there are at least several potential problems with using PCR as a gauge of template quality. The first potential problem is primer mismatch; if a primer does not match the template appropriately, a product will not be generated, thus giving a false negative for DNA quality. The second potential problem is inhibition; because PCR is a relatively sensitive enzymatic reaction, secondary compounds, when present within a total DNA extract, commonly inhibit PCR, also giving a false negative for DNA quality.

Highly accurate analyses of fragment length are provided by instruments such as the Bioanalyzer (Agilent Technologies, Inc.). However, the Bioanalyzer only analyzes fragments up to 17 kb, whereas HMW DNA tends to be >20 kb (Panaro et al., 2000), so it is severely limited for assessing high-quality DNA. A quicker and somewhat less precise method of assessing DNA quality through a proportionate measure of fragment length is by gel electrophoresis; the gel image provides a semi-quantitative assessment of DNA fragment size and abundance. We used gel electrophoresis to estimate DNA quality because it is relatively cheap and rapid.

Pertinent variables affecting DNA quality that were addressed in our study include herbarium specimen curation conditions, taxonomic variation versus time, leaf succulence and DNA preservation, silica storage, freezer storage, DNA extract storage, and photobleaching, as follows.

A) Effects of herbarium specimen curation on DNA quality

The comparison of the White Oak Plantation and Abbott collections showed different patterns in DNA quality. With these two sets of data, we attempted to eliminate as many variables as possible, such as inconsistency in collection process, by having a limited number of collectors for each set. Taxonomic biases were minimized because both sets represent the same north Florida flora, although sample size and taxon sampling are not identical. The main variables between the two data sets were the environmental conditions during storage. Whereas the White Oak collection was mounted immediately after pressing and drying and then stored under very tightly controlled temperature and humidity, the Abbott collection has been stored in boxes and the original newspapers. Interestingly, this collection also sat in hot moving trucks (often exceeding 60°C) moving across the country from Florida to California, back to Florida, then to Illinois, then to Missouri, then ultimately back to Florida (all in this 21-year period with an average specimen age of 17.6 years). This collection was not stored under ideal conditions of low humidity. In the course of this collection's history, the specimens were subject to multiple pests. Most notably, while in California, one bundle of specimens became home to a small family of field mice, who chewed through the newspapers holding the specimens.

Not surprisingly, the two sets are strikingly different in DNA quality. Whereas the White Oak Plantation specimens included 89% of specimens with HMW DNA, only 16% of the Abbott collection had HMW DNA. Further, although these two data sets do differ slightly in age [the White Oak Plantation is an average of 13.6 years (7-16 years), while the Abbott collection is an average of 17.6 years (8-21 years)], all of the specimen ages are less than that of the typical thresholds of samples that give HMW DNA (see Figs. 4-8 and following section), if collection methods are standardized. These data demonstrate that the quality of collection and storage of herbarium specimens strongly affects DNA quality, at least for specimens 15-21 years old.

B) Effects of herbarium specimen age and leaf succulence on DNA quality

DNA quality in herbarium specimens is loosely correlated with specimen age. Although high-quality samples are exclusively found in younger specimens, low-quality samples can be found throughout the age distribution, even in recently collected specimens.

Effect of succulence on DNA preservation We selected subsets of herbarium specimens with different tissue thicknesses and rates of drying. Samples of *Asimina*, Hibisceae, and *Mikania* are typically thin-leaved, whereas those of *Portulaca* are succulent. Polygalaceae are usually thin-leaved, but more variable. Results showed that thin-leaved taxa generally have higher quality DNA than do thick-leaved or succulent specimens. Although a 35-year-old sample of *Portulaca* showed relatively high-quality DNA, most *Portulaca* samples of high quality were less than 15 years old. This is relatively young compared to the other taxonomic groups examined. This is consistent with Chase and Hills (1991), who showed low DNA yields in succulent herbarium specimens of orchids. Our own work on herbarium specimens of orchid taxa shows similar results in DNA quality of succulent versus thin-leaved orchid tissues (Neubig and Whitten, pers. obs.).

Taxon-specific variation in DNA preservation – Does DNA survive better in some families or genera than others? Aside from the effect of succulence causing slow drying, our uncontrolled data are not sufficient to demonstrate any clear correlations between taxonomic group and DNA preservation. Adams et al. (1999) reported rapid DNA degradation in some Poaceae and Brassicaceae, and they hypothesized that robust DNases degraded DNA rapidly in fresh and herbarium tissues. These effects may be restricted to relatively few taxa. We have sampled many taxa from Poaceae both in this study and others, and the vast majority of samples yield good-quality DNA (within a reasonable age limitation of 30 years or less). In contrast, Melastomataceae exhibit very poor DNA preservation in herbarium specimens, even in recent collections. Our work on Melastomataceae (especially in tribe Miconieae) consistently shows low success rates of extractions from herbarium specimens, despite being relatively thin-leaved (Neubig, pers. obs.; Bécquer-Granados et al., 2003). The cause of this degradation in Melastomataceae is unclear. High success rates of extraction and amplification from old herbarium specimens of xeric Melanthiaceae, such as *Schoenocaulon*, led Zomlefer (2006) to speculate that physiological adaptations to xeric habitats might result in better DNA preservation than in mesic plants, but we are unaware of controlled studies.

C) Effect of silica drying and freezing on DNA preservation

We analyzed 58 samples of tissues that had been frozen (-20° or -80°C) for at least 10 years (Fig. 9). The samples are phylogenetically diverse and variable in preparation (pulverized or intact tissue). Almost all yielded extremely good-quality DNA. This is somewhat at odds with Smith and Morin (2005), who found significant degradation of samples stored at -20°C versus colder temperatures.

We presume that nearly all the silica-dried tissues initially contained high-quality DNA, because most of the samples used had been originally preserved for molecular laboratory use (i.e., plastid restriction site analysis, or PCR-based procedures). The great range of quality present in the ca. 20-year-old samples must be due to storage variables. The most obvious is the seal of the container. Specimens stored in tightly sealed containers (i.e., falcon tubes), often with an excess of silica gel, appeared to have higher-quality DNA. Loosely sealed specimen jars (such as jars used for spirit collections in herbaria) are very poorly sealed against air infiltration, and thus humidity. Small Ziploc® bags are not airtight, and the silica will eventually equilibrate with atmospheric humidity. But, most of our samples from Ziploc® bags were triple sealed in airtight polypropylene boxes with silicone gaskets. So not surprisingly, the Ziploc® bags performed the best (Fig. 9D) because of the extra measures of protection taken, rather than the innate nature of Ziploc® bags.

D) Comparison of DNA preservation of orchid leaf samples stored in room temperature as silica-dried tissues vs. DNA extracts frozen at -20°C for 7-12 years

Comparison of DNA quality in Figure 10 shows that storage of DNA extracts (stored in TE at -20°C for 7-12 years) is superior to new extracts of silica-dried leaves stored at room temperature, sealed in containers in the dark, but without additional silica to absorb ambient moisture. Nevertheless, most of the silica-dried tissues retained some HMW DNA. The freshly collected tissues all exhibit relatively uniform and strong HMW DNA as expected. Therefore, we can conclude that ambient moisture, and potentially temperature, are the dominant contributing factors to DNA degradation in the silica-dried tissue samples.

E. Effect of photobleaching

Silica-dried tissues that have been stored in transparent containers (plastic bags or falcon tubes) are subject to the deleterious effects of light over long periods (Sinha and Häder, 2002). Such tissues exposed to light usually lose their green pigmentation. However, this bleaching does not necessarily affect HMW DNA. This reiterates the findings of Erkens et al. (2008), who correlated DNA quality with herbarium specimen color. They found a weak correlation with specimen "greenness" when compared to DNA quality. Nevertheless, we recommend storage of tissues in the dark.

Conclusions

The wide variety of morphology and life history of organisms makes DNA and tissue preservation a complex topic (Seutin et al., 1990; Kilpatrick, 2002; Mitchell and Takacs-Vesbach, 2008; Zimmermann et al., 2008). Although very limited, these data indicate that best practice is to freeze tissues and DNA samples for maximum quality preservation at the lowest temperatures possible. Although cryogenic tissue banks that curate samples for archival storage are becoming more common (Corthals and Desalle, 2005; Hodkinson et al., 2007; Gemeinholzer et al., 2011; Endara et al., this volume; Godden and Soltis, this volume), they are still expensive for small institutions and are impractical for short term lab work where samples need to be accessed frequently.

Although the ability of next-generation sequencing technologies to produce useful data from fragmented DNA will undoubtedly increase, we should not use this technology as an excuse to abandon collection/curation methods that maximize DNA quality. Highly intact and undamaged DNA will always be preferred over degraded DNA of uncertain quality. We recommend that all herbarium collections should be supplemented with tissues dried in silica gel (or FTA paper, or both). If institutional resources permit, an aliquot of these tissues should be stored at the lowest temperature possible. If liquid nitrogen storage is not available, we recommend vacuum-packing of dried tissues as a low-cost alternative to minimize degradation over time. This procedure has been suggested before (Nagy, 2010), but we have tested this method over the past 10 years (see Appendix 1) and find it to be an effective way to preserve DNA quality in tissues, yet still have them readily available for active use in the laboratory.

The emergence of room temperature storage methods such as trehalose vitrification or FTA paper is encouraging, but the available data do not justify using these methods to replace cryogenic banks and silica-dried tissues at present. They are useful supplements, but cannot be considered archival.

Although this and other studies have shown that DNA degrades over time in herbarium specimens (Erkens et al., 2008; Adams and Sharma, 2010; Adams, 2011), it is clear that we can retard degradation by optimizing the environmental conditions in which the specimens are stored. From the herbarium curator's perspective, we strongly recommend minimizing the length of time specimens are stored in acidic newspaper. Although specimen mounting backlogs are usually the result of budget constraints, herbarium curators should realize that leaving specimens in acidic newspapers is one of the greatest threats to specimen quality, analogous to dermestid beetles, on a molecular level.

Archival storage is expensive in terms of money, space, and time. Institutions need to set priorities to decide what to preserve and at what quality. Is it really necessary to store all DNA for eternity? If we store a sample on FTA paper or vitrified in trehalose that will be good for 200 years, is that good enough, or do we need to store everything in liquid nitrogen? How do we prioritize sample storage vs. cost? What are the effects of various storage techniques on DNA damage (i.e., "nicking", etc.)? Although liquid nitrogen storage is superior, relatively inexpensive methods can be used to improve the storage conditions of specimens and tissues, drastically slowing the rate of DNA degradation. With global extinction rates rising rapidly, our herbaria will soon contain the only remains of many extinct species or extirpated populations. The DNA in these specimens contains the majority of the information on the species that we can leave to future generations. Anything we can do to minimize the loss of this information should be encouraged.

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Appendix 1. Vacuum bag storage for plant tissue preservation

In our combined efforts of storing plant tissues for many years, we have been concerned with the storage of plant tissues to maximally preserve DNA quality.
Over the course of the past 10 years we have used vacuum bags from the commercial food preservation industry with good success. Silica-dried tissues stored in these bags have routinely yielded high quality DNA (sample size of >5,000 ranging in age from 1-10 years old). As indicated in this paper, even silica-dried tissues that are exposed to ambient light, atmosphere and moisture quickly degrade in DNA quality. Storage in vacuum-sealed bags minimizes moisture and oxygen uptake in stored specimens.

A. Sample preparation
Ensure that each sample is labeled for future reference (ideally with a miniaturized copy of the label of the corresponding herbarium voucher). Although we routinely prefer to keep tissues in their original polyethylene collection bags with silica in those individual collection bags, paper envelopes can be used if they are acid-free and archival quality. Bundle the samples into groups that will conveniently fit inside the storage bags.

If storing at room temperature, we recommend including a small mesh bag of indicating silica gel in each vacuum bag. The indicator allows visual inspection of each vacuum bag for moisture infiltration over time; if the indicator shows the presence of moisture, the bag can be opened to replace the silica gel and resealed. We prefer a mesh bag for indicator because it allows maximal exchange with any tissues in the vacuum bag.

B. Vacuum and sealing
Although many commercial vacuum food preservation kits are available, we have used FoodSaver® brand with satisfactory results. This apparatus pumps air out of the vacuum bag and uses heat to melt and seal the ends. It is preferable to choose a vacuum bag product with the thickest available plastic to minimize air infiltration and durability. Because the effects of hydration of silica at very low temperatures are not well known, it is not preferable to use silica in vacuum bags that are to be stored in freezers at low temperatures. This has the added benefit of reducing bulk in bags and taking less room in the freezer.

C. Storage
Freezers provide optimal storage conditions. If storing at room temperature, it is preferable to keep the bags in a cool dark place because sunlight and fluorescent lights are damaging to DNA. Opaque plastic storage bins or even cardboard boxes should be used to minimize exposure to light.

Appendix 2. DNA extraction protocol for plant tissue adapted from Doyle, J.J. and J.L. Doyle (1987).

Reagents and equipment: CTAB (cetyl trimethylammonium bromide) buffer (1 M Tris, pH 8.0, 20 ml; 0.25 M EDTA, pH 8.0, 20 ml; NaCl, 16.4 g; CTAB, 4.0 g; water, to 200 ml); proteinase K, 1g/ml stock; chloroform/isoamyl alcohol 24:1; 3 M sodium acetate, pH 4.8; 100% isopropanol; 70% ethanol; Tris-EDTA buffer (TE), pH 8.5 (10 mM Tris, 1 mM EDTA); microcentrifuge; 2.0 ml tubes with gasket screwcap; disposable pipettes; mortar and pestle, or beater tube and glass beads; heating block, prewarmed to 50-55 C; nitrile gloves; fume hood (for chloroform steps).

A. Tissue pulverization and extraction
Using Bead Beater:
1. Place 5-6 glass beads into beater tube; tough tissues may require use of steel or zirconia beads. Add 50-100 mg dried tissue. Grind in beater for 1-2 minutes or until tissue is reduced to a fine powder.
2. Add 2-5 µl of Proteinase K and 1.2 ml CTAB buffer. Vortex.

Or, using Pestle and Mortar:
1. Place 50-100 mg fresh tissue in mortar (about 1.0 cm square of petal or leaf tissue, or equivalent amount of dried tissue; too much tissue can reduce yield). Add 1.2 ml CTAB buffer and 2-5 µl of Proteinase K.

2. Grind tissue with mortar and pestle until tissue is completely homogenized (ignore tough fibers). Transfer 1.2 ml to a labeled 2.0 ml tube; vortex.
3. Incubate tube at 50°C in the heating block for at least 2 hours (heating too long may result in degraded DNA). Shake occasionally during incubation.
4. In fume hood, add 500 µl of chloroform/isoamyl alcohol, and vortex lightly until a milky suspension is obtained.
5. Centrifuge at 10,000 rpm for 4 minutes to separate phases. The chloroform layer is on the bottom; the aqueous layer (containing DNA) is on top.
6. Using 1000 µl pipet, carefully remove 750 µl of the aqueous (top) layer and transfer to a new labeled tube. Avoid sucking up any of the chloroform layer or debris. Discard the chloroform and homogenate into the waste bottle. (The chloroform extraction can be repeated if necessary.)

B. DNA precipitation

1. Add 3 M sodium acetate to the aqueous phase according to the following formula: volume aqueous phase in µl X 0.04 (e.g., 750 x 0.04 = 30 µl). Add 100% isopropanol according to the formula: volume aqueous phase in µl X 0.65 (e.g., 780 x 0.65 = ca. 510 µl). Rock tube gently to mix; continue until layers are completely mixed. Occasionally, you will see DNA strands precipitate at this point (especially with floral tissue). Many protocols recommend leaving tube in -20 C freezer overnight; this is generally not necessary, although it might help precipitate very dilute small fragments.
2. Centrifuge at maximum speed (13,000 g) for 20 minutes. After centrifuging, a pellet of DNA should be visible in the bottom of the tube.
3. Carefully pour off the alcohol without disturbing pellet. Wash pellet with 1 ml 70% ethanol; close cap and invert tube to wash the internal surface of tube. Carefully pour off ethanol (don't lose pellet; centrifuge again if pellet is loose). Repeat ethanol wash (if pellet is large and mucilaginous, allow to stand in 70% EtOH for 30 minutes with occasional agitation). Drain tube on clean Kimwipe, and use the 100 µl pipet to remove any excess ethanol. We have found that drying the pellet under heat is unnecessary; often, the dried pellet is more difficult to resuspend. The residual amounts of ethanol do not seem to interfere with PCR, and the wet pellets resuspend much more rapidly.
4. Resuspend DNA pellet in 200 µl of 1X Tris-EDTA buffer (TE). Incubate at 65 C for 15 minutes to assure resuspension of DNA; finger-flick until pellet is dissolved. Store in fridge at 4 C, or in freezer for long-term storage. Resuspending DNA in water is not recommended, because DNA is most stable under basic conditions.

C. Silica column cleaning of total DNA

The total DNA extract from the above procedure is often clean enough for routine PCR, but often still contains many impurities that can interfere with downstream applications. There are various methods for cleaning DNA, but one of the most commonly used involves binding the DNA to a silica matrix in a special tube with chaeoptropic salts, washing the impurities away with buffered isopropanol, and then eluting the cleaned DNA with basic TE buffer. DNA purification columns and reagents are sold by various vendors including Qiagen, Promega, and Axygen. The columns (or their 96 well format equivalent) are relatively expensive (ca. $1 each), and are the most expensive component in DNA extraction. To save cost, Siddappa et al. (2007) demonstrated that the columns can be cleaned and regenerated by washing and storage in dilute HCl; the acid destroys residual DNA on the columns. An alternative method of column cleaning bypasses the DNA precipitation step; this method is especially useful for weak or degraded samples where risk of losing the pellet is high. This alternative method begins after chloroform extraction (step A above):

B. Direct column cleaning without DNA precipitation

1. After centrifugation, remove 750 µl of aqueous

layer and place in separate labeled tube.

2. Add 750 µl of binding buffer (Qiagen buffer PB or equivalent); vortex to mix.
3. Add 2 µl of phenol red indicator. [This pH indicator is yellow below pH 6.8, and pink above pH 8.2; in order for DNA to bind to the silica column, the pH of the mixture must be slightly acidic (yellow)]. The initial color of the aqueous extract should be pink.
4. Add 10 µl of 3M sodium acetate; mix and note change of color. Continue to add 10 µl aliquots of sodium acetate until the color of the tube changes from pink to yellow. When it is yellow, then proceed to the next step.
5. Transfer 750 µl of mixture to clean silica spin column; spin for 30 seconds at high speed to push solution through the column. Discard flowthrough; DNA is bound to the silica matrix in the column.
6. Add remaining mixture to spin column and spin through column. Discard flowthrough.
7. Add 750 µl of wash buffer (Qiagen buffer PE or equivalent). Spin for 30 seconds to push through column; discard flowthrough. Repeat this wash if desired.
8. Spin empty column for 2 minutes at high speed to remove all traces of wash buffer.
9. Transfer spin column to a clean 1.5 ml Eppendorf tube. Add 100-200 µl of 1X TE buffer, pH 8.0 (The high pH of the buffer allows the cleaned DNA to be released from the silica matrix). Optional: warm in heating block for several minutes.
10. Centrifuge column at 6000 rpm (high speed may cause hinge to break on Eppendorf). The clean DNA is in the bottom of the collecting tube. Step 9 can be repeated to remove residual DNA, and the aliquots pooled.

Appendix 3. Agarose gel electrophoresis protocol. N.B.: Ethidium bromide (EtBr) is hazardous and potentially mutagenic. Always wear nitrile gloves when handling EtBr solutions, gels, buffers, and anything that has contacted these. Use proper disposal techniques. Visualizing EtBr requires intense UV light; wear appropriate eye protection when visualizing DNA samples.

Reagents and equipment: 1X Sodium Boric Acid buffer (Brody et al., 2004; sodium hydroxide pellets, boric acid (powder), and water); 250 ml flask; agarose, molecular biology grade; gel rig; 1-10 µl pipeter and tips; dams and combs (for casting gel); ethidium bromide solution, 1%; strip of parafilm; loading dye; pipeter and tips; DNA samples.

A. Prepare sodium boric acid buffer (SBA) 20X stock.

1. Make a 0.2 M sodium hydroxide (NaOH) solution by adding 4 g of NaOH to 500 ml water; stir to dissolve.
2. Make a 1.0 M boric acid solution by adding 30 g boric acid to 500 ml water.
3. Adjust pH of NaOH solution to 8.0 by adding boric acid solution to NaOH solution approximately 1:1.
4. Use 50ml of the 20X stock solution and bring to 1000 ml with water to make a 1 X working solution for use in making gels and electrophoresis.

B. Prepare agarose gel.

1. Place gel rig in manufacturer's mold and insert combs as needed.
2. To create a 1.5% gel, measure 1.5 x the volume of buffer in grams of agarose (e.g., pour 75 ml of buffer into flask and weigh 1.13 g of agarose on balance). Pour agarose and buffer into flask and swirl to suspend agarose.
3. Heat flask in microwave just until it begins to boil (ca. 1.5 min); watch carefully to avoid explosive boiling.
4. When dissolved, add 2.0 µl of EtBr solution to flask. Swirl carefully to mix. Cool flask under running tap water until warm to the touch, but still liquid (hot agarose will cause the gel rig to warp and leak).
5. Pour agar solution into gel tray. Allow gel to cool undisturbed until solid (ca. 15 min.)

C. Loading the DNA samples in the agarose gel.

1. Place tray with gel into electrophoresis rig. Add 1X SBA buffer as needed to barely submerge gel. Carefully remove the combs.
2. Cut a strip of parafilm and press corners down onto tray. Pipet 5 µl droplets of loading dye

onto the parafilm (one drop per sample) and 5 μl of DNA solution to drop of loading dye. Change tip after each sample to avoid contamination.

3. Set pipeter to 10 μl. Draw up sample into pipeter; load carefully into well (avoid puncturing bottom of well). Repeat for all samples. Place lid on gel rig and turn on power supply; power should read 150 volts. Allow to run for 10-30 minutes, noting migration of bromphenol blue dye front. Turn off power source and remove lid.

5. Carefully remove gel tray, draining off excess buffer without letting gel slide off the tray. Place tray on UV transilluminator. Turn on UV viewer and examine; photograph as needed.

Appendix 4. Vouchers and assessed DNA quality. Each specimen includes the following information in this order: taxon, voucher information (herbarium), year of collection, age of specimen at time of extraction, HMW presence, peak at >20,000 bp region, peak at 1000 bp region, and peak at 200 bp region.

A) White Oak Plantation Collection data set from herbarium specimens: *Elytraria caroliniensis* (J.F. Gmel.) Pers. (Acanthaceae), *Rider 258* (FLAS), 2000, 13, 1, 3, 1, 2; *Ruellia caroliniensis* (J.F. Gmel.) Steud. (Acanthaceae), *Rider 95* (FLAS), 1999, 14, 1, 3, 1, 2; *Sambucus canadensis* L. (Adoxaceae), *Mercurio & Wagamon 85* (FLAS), 1997, 16, 1, 3, 2, 1; *Viburnum* L. (Adoxaceae), *Rider 87* (FLAS), 1999, 14, 1, 3, 1, 1; *Viburnum obovatum* Walter (Adoxaceae), *Mercurio & Wagamon 138* (FLAS), 1997, 16, 1, 3, 2, 1; *Viburnum obovatum* Walter (Adoxaceae), *Rider 37* (FLAS), 1999, 14, 1, 3, 1, 1; *Sagittaria graminea* Michx. (Alismataceae), *Rider 3* (FLAS), 1998, 15, 1, 3, 1, 1; *Sagittaria lancifolia* L. (Alismataceae), *Rider 84* (FLAS), 1999, 14, 1, 3, 1, 1; *Liquidambar styraciflua* L. (Altingiaceae), *Rider 32* (FLAS), 1999, 14, 1, 3, 2, 1; *Alternanthera philoxeroides* (Mart.) Griseb. (Amaranthaceae), *Rider 243* (FLAS), 2000, 13, 1, 3, 1, 2; *Amaranthus australis* (A. Gray) J.D. Sauer (Amaranthaceae), *Rider 267* (FLAS), 2000, 13, 1, 3, 1, 2; *Hymenocallis crassifolia* Herb. (Amaryllidaceae), *Rider 225* (FLAS), 2000, 13, 1, 3, 1, 2; *Zephyranthes atamasco* (L.) Herb. (Amaryllidaceae), *Rider 50* (FLAS), 1999, 14, 1, 3, 1, 1; *Rhus copallinum* L. (Anacardiaceae), *Rider 281* (FLAS), 2000, 13, 0, 0, 0, 1; *Rhus copallinum* L. (Anacardiaceae), *Rider 139* (FLAS), 1999, 14, 1, 1, 1, 2; *Toxicodendron radicans* (L.) Kuntze (Anacardiaceae), *Rider 192* (FLAS), 2000, 13, 1, 1, 1, 2; *Toxicodendron pubescens* Mill. (Anacardiaceae), *Rider 193* (FLAS), 2000, 13, 1, 1, 1, 2; *Asimina incana* (W. Bartram) Exell (Annonaceae), *Rider 60* (FLAS), 1999, 14, 1, 3, 1, 2; *Cicuta mexicana* J.M. Coult. & Rose (Apiaceae), *Rider 137* (FLAS), 1999, 14, 1, 3, 1, 2; *Cicuta mexicana* J.M. Coult. & Rose (Apiaceae), *Rider 132* (FLAS), 1999, 14, 1, 3, 1, 2; *Eryngium baldwinii* Spreng. (Apiaceae), *Mercurio & Wagamon 10* (FLAS), 1997, 16, 1, 3, 1, 1; *Eryngium baldwinii* Spreng. (Apiaceae), *Proenza 429* (FLAS), 2006, 7, 1, 3, 1, 2; *Eryngium baldwinii* Spreng. (Apiaceae), *Rider 254* (FLAS), 2000, 13, 1, 3, 1, 2; *Eryngium yuccifolium* Michx. (Apiaceae), *Rider 127* (FLAS), 1999, 14, 1, 2, 1, 3; *Oxypolis filiformis* (Walter) Britton (Apiaceae), *Rider 161* (FLAS), 1999, 14, 1, 3, 1, 2; *Ptilimnium capillaceum* (Michx.) Raf. (Apiaceae), *Rider 115* (FLAS), 1999, 14, 1, 3, 1, 2; *Asclepias connivens* Baldwin ex Elliott (Apocynaceae), *Rider 151* (FLAS), 1999, 14, 1, 3, 1, 1; *Asclepias lanceolata* Walter (Apocynaceae), *Rider 108* (FLAS), 1999, 14, 1, 3, 1, 1; *Asclepias michauxii* Decne. (Apocynaceae), *Rider 229* (FLAS), 2000, 13, 1, 3, 1, 1; *Asclepias perennis* Walter (Apocynaceae), *Rider 105* (FLAS), 1999, 14, 1, 3, 1, 1; *Ilex cassine* L. (Aquifoliaceae), *Rider 351* (FLAS), 2001, 12, 1, 3, 1, 2; *Ilex glabra* (L.) A. Gray (Aquifoliaceae), *Mercurio & Wagamon 104* (FLAS), 1997, 16, 1, 3, 1, 2; *Ilex glabra* (L.) A. Gray (Aquifoliaceae), *Mercurio & Wagamon 2* (FLAS), 1997, 16, 1, 3, 1, 2; *Ilex myrtifolia* Walter (Aquifoliaceae), *Rider 5* (FLAS), 1998, 15, 1, 3, 1, 2; *Ilex opaca* Aiton (Aquifoliaceae), *Rider 182* (FLAS), 2000, 13, 1, 3, 1, 2; *Ilex vomitoria* Aiton (Aquifoliaceae), *Rider 188* (FLAS), 2000, 13, 1, 3, 1, 2; *Colocasia esculenta* (L.) Schott (Araceae), *Rider 388* (FLAS), 2002, 11, 1, 3, 1, 1; *Peltandra virginica* (L.) Schott (Araceae), *Rider 259* (FLAS), 2000, 13, 1, 3, 2, 1; *Aralia spinosa* L. (Araliaceae), *Rider 221* (FLAS), 2000, 13, 1, 3, 1, 2; *Hydrocotyle umbellata* L. (Araliaceae), *Mercurio & Wagamon 73* (FLAS), 1997, 16, 1, 3, 1, 2; *Sabal minor* (Jacq.) Pers. (Arecaceae), *Rider 270* (FLAS), 2000, 13, 1, 3, 2, 1; *Sabal palmetto* (Walter) Lodd. ex Schult. & Schult. f. (Arecaceae), *Rider 269* (FLAS), 2000, 13, 1, 3, 2, 1; *Serenoa repens* (W. Bartram) Small (Arecaceae), *Rider 274* (FLAS), 2000, 13, 1, 3, 2, 1; *Washingtonia robusta* H. Wendl. (Arecaceae), *Rider 273* (FLAS), 2000, 13, 1, 3, 1, 2; *Yucca aloifolia* L. (Asparagaceae), *Rider 372* (FLAS), 2001, 12, 1, 3, 1, 2; *Yucca gloriosa* L. (Asparagaceae), *Rider 328* (FLAS), 2000, 13, 1, 3, 1, 2; *Arnoglossum ovatum* (Walter) H. Rob. (Asteraceae), *Rider 330* (FLAS), 2000, 13, 1, 3, 1, 2; *Baccharis glomeruliflora* Pers. (Asteraceae), *Rider 180* (FLAS), 1999, 14, 1, 3, 1, 2; *Baccharis halimifolia* L. (Asteraceae), *Rider 04* (FLAS), 1998, 15, 1, 3, 1, 2; *Balduina uniflora* Nutt. (Asteraceae), *Rider 157* (FLAS), 1999, 14, 1, 3, 1, 2; *Bidens alba* (L.) DC. (Asteraceae), *Rider 160* (FLAS), 1999, 14, 1, 3, 1, 1; *Bidens mitis* (Michx.) Sherff (Asteraceae), *Mercurio & Wagamon 162* (FLAS), 1997, 16, 1, 3, 1, 1; *Bigelowia nudata* (Michx.) DC. (Asteraceae), *Rider 167* (FLAS), 1999, 14, 0, 0, 0, 0; *Carphephorus corymbosus* (Nutt.) Torr. & A. Gray (Asteraceae), *Rider 323* (FLAS), 2000, 13, 1, 3, 1, 2; *Carphephorus odoratissimus* (J.F. Gmel.) H.J.-C. Hebert (Asteraceae), *Rider 295* (FLAS), 2000, 13, 1, 3, 1, 2; *Chaptalia tomentosa* Vent. (Asteraceae), *Rider 16* (FLAS), 1999, 14, 1, 3, 1, 0; *Cirsium horridulum* Michx. (Asteraceae), *Rider 66* (FLAS), 1999, 14, 1, 3, 1, 2; *Cirsium nuttallii* DC. (Asteraceae), *Rider 217* (FLAS), 2000, 13, 1, 3, 1, 1; *Conoclinium coelestinum* (L.) DC. (Asteraceae), *Rider 173* (FLAS), 1999, 14, 1, 3, 1, 2; *Coreopsis gladiata* Walter (Asteraceae), *Rider 170* (FLAS), 1999, 14, 1, 3, 1, 2; *Coreopsis gladiata* Walter (Asteraceae), *Rider 376* (FLAS), 2001, 12, 1, 3, 1, 2; *Coreopsis gladiata* Walter (Asteraceae), *Rider 381* (FLAS), 2001, 12, 1, 3, 1, 2; *Coreopsis gladiata* Walter (Asteraceae), *Rider 379* (FLAS), 2001, 12, 1, 3, 1, 2; *Coreopsis nudata*

Nutt. (Asteraceae), *Rider 104* (FLAS), 1999, 14, 1, 3, 2, 1; *Elephantopus mollis* Kunth (Asteraceae), *Rider 333* (FLAS), 2000, 13, 1, 3, 1, 3; *Elephantopus elatus* Bertol. (Asteraceae), *Rider 310* (FLAS), 2000, 13, 1, 3, 1, 2; *Elephantopus nudatus* A. Gray (Asteraceae), *Rider 321* (FLAS), 2000, 13, 1, 3, 1, 1; *Erigeron vernus* (L.) Torr. & A. Gray (Asteraceae), *Rider 55* (FLAS), 1999, 14, 1, 3, 1, 1; *Eupatorium capillifolium* (Lam.) Small ex Porter & Britton (Asteraceae), *Mercurio & Wagamon 80* (FLAS), 1997, 16, 1, 2, 1, 3; *Eupatorium leucolepis* (DC.) Torr. & A. Gray (Asteraceae), *Rider 296* (FLAS), 2000, 13, 1, 2, 1, 3; *Eupatorium rotundifolium* L. (Asteraceae), *Rider 268* (FLAS), 2000, 13, 1, 3, 1, 2; *Eupatorium rotundifolium* L. (Asteraceae), *Mercurio & Wagamon 97* (FLAS), 1997, 16, 1, 2, 1, 3; *Eupatorium rotundifolium* L. (Asteraceae), *Mercurio & Wagamon 79* (FLAS), 1997, 16, 1, 2, 1, 3; *Euthamia caroliniana* (L.) Greene ex Porter & Britton (Asteraceae), *Rider 378* (FLAS), 2001, 12, 1, 3, 1, 1; *Gamochaeta pensylvanica* (Willd.) Cabrera (Asteraceae), *Rider 233* (FLAS), 2000, 13, 1, 3, 1, 2; *Helenium autumnale* L. (Asteraceae), *Mercurio & Wagamon 33* (FLAS), 1997, 16, 1, 3, 2, 1; *Helenium pinnatifidum* (Schwein. ex Nutt.) Rydb. (Asteraceae), *Rider 53* (FLAS), 1999, 14, 1, 3, 2, 1; *Krigia virginica* (L.) Willd. (Asteraceae), *Rider 204* (FLAS), 2000, 13, 1, 3, 1, 3; *Liatris chapmanii* Torr. & A. Gray (Asteraceae), *Rider 344* (FLAS), 2000, 13, 1, 3, 1, 1; *Liatris gracilis* Pursh (Asteraceae), *Rider 343* (FLAS), 2000, 13, 1, 3, 1, 2; *Liatris pauciflora* Pursh (Asteraceae), *Rider 348* (FLAS), 2000, 13, 1, 3, 1, 2; *Liatris spicata* (L.) Willd. (Asteraceae), *Rider 338* (FLAS), 2000, 13, 1, 3, 2, 1; *Liatris spicata* (L.) Willd. (Asteraceae), *Rider 168* (FLAS), 1999, 14, 1, 3, 1, 1; *Marshallia tenuifolia* Raf. (Asteraceae), *Rider 154* (FLAS), 1999, 14, 1, 3, 1, 1; *Marshallia tenuifolia* Raf. (Asteraceae), *Mercurio & Wagamon 98* (FLAS), 1997, 16, 1, 3, 2, 1; *Mikania scandens* (L.) Willd. (Asteraceae), *Rider 172* (FLAS), 1999, 14, 1, 3, 1, 1; *Mikania scandens* (L.) Willd. (Asteraceae), *Mercurio & Wagamon 66* (FLAS), 1997, 16, 1, 2, 1, 3; *Oclemena reticulata* (Pursh) G.L. Nesom (Asteraceae), *Rider 81* (FLAS), 1999, 14, 1, 3, 1, 2; *Pityopsis graminifolia* (Michx.) Nutt. (Asteraceae), *Rider 174* (FLAS), 1999, 14, 1, 3, 2, 1; *Pluchea foetida* (L.) DC. (Asteraceae), *Rider 282* (FLAS), 2000, 13, 1, 3, 2, 1; *Pluchea odorata* (L.) Cass. (Asteraceae), *Rider 327* (FLAS), 2000, 13, 1, 3, 1, 2; *Pluchea baccharis* (Mill.) Pruski (Asteraceae), *Rider 253* (FLAS), 2000, 13, 0, 1, 2, 1; *Pluchea baccharis* (Mill.) Pruski (Asteraceae), *Mercurio & Wagamon 3* (FLAS), 1997, 16, 1, 2, 1, 3; *Pterocaulon pycnostachyum* (Michx.) Elliott (Asteraceae), *Rider 93* (FLAS), 1999, 14, 1, 3, 2, 1; *Pterocaulon virgatum* (L.) DC. (Asteraceae), *Mercurio & Wagamon 81* (FLAS), 1997, 16, 1, 3, 2, 1; *Pyrrhopappus carolinianus* (Walter) DC. (Asteraceae), *Rider 143* (FLAS), 1999, 14, 1, 3, 2, 1; *Rudbeckia fulgida* Aiton (Asteraceae), *Rider 124* (FLAS), 1999, 14, 1, 3, 2, 1; *Solidago canadensis* L. (Asteraceae), *Rider 345* (FLAS), 2000, 13, 1, 3, 1, 1; *Solidago fistulosa* Mill. (Asteraceae), *Rider 324* (FLAS), 2000, 13, 1, 3, 2, 1; *Solidago odora subsp. chapmanii* (A. Gray) Semple (Asteraceae), *Rider 304* (FLAS), 2000, 13, 1, 3, 1, 1; *Solidago* L. (Asteraceae), *Mercurio & Wagamon 56* (FLAS), 1997, 16, 1, 2, 1, 3; *Solidago stricta* Aiton (Asteraceae), *Rider 377* (FLAS), 2001, 12, 1, 3, 1, 1; *Sonchus asper* (L.) Hill (Asteraceae), *Proenza 427* (FLAS), 2006, 7, 1, 3, 1, 1; *Sonchus asper* (L.) Hill (Asteraceae), *Rider 213* (FLAS), 2000, 13, 1, 3, 1, 1; *Sonchus oleraceus* L. (Asteraceae), *Rider 232* (FLAS), 2000, 13, 1, 3, 1, 1; *Symphyotrichum adnatum* (Nutt.) G.L. Nesom (Asteraceae), *Rider 09* (FLAS), 1998, 15, 1, 3, 1, 2; *Ampelaster carolinianus* (Walter) G.L. Nesom (Asteraceae), *Mercurio & Wagamon 43* (FLAS), 1997, 16, 1, 2, 1, 3; *Symphyotrichum dumosum* (L.) G.L. Nesom (Asteraceae), *Rider 382* (FLAS), 2001, 12, 1, 3, 1, 2; *Taraxacum officinale* F.H. Wigg. (Asteraceae), *Rider 18* (FLAS), 1999, 14, 1, 3, 1, 1; *Vernonia angustifolia* Michx. (Asteraceae), *Rider 147* (FLAS), 1999, 14, 1, 3, 1, 1; *Vernonia noveboracensis* (L.) Michx. (Asteraceae), *Rider 314* (FLAS), 2000, 13, 1, 3, 1, 1; *Youngia japonica* (L.) DC. (Asteraceae), *Rider 20* (FLAS), 1999, 14, 1, 3, 1, 1; *Azolla caroliniana* Willd. (Azollaceae), *Proenza 415* (FLAS), 2005, 8, 1, 3, 1, 1; *Carpinus caroliniana* Walter (Betulaceae), *Rider 31'* (FLAS), 1999, 14, 1, 3, 1, 1; *Bignonia capreolata* L. (Bignoniaceae), *Rider 57* (FLAS), 1999, 14, 1, 3, 1, 1; *Campsis radicans* (L.) Bureau (Bignoniaceae), *Rider 250* (FLAS), 2000, 13, 1, 3, 1, 1; *Campsis radicans* (L.) Bureau (Bignoniaceae), *Rider 249* (FLAS), 2000, 13, 1, 3, 1, 1; *Catalpa bignonioides* Walter (Bignoniaceae), *Rider 364* (FLAS), 2001, 12, 1, 3, 1, 1; *Lepidium campestre* (L.) W.T. Aiton (Brassicaceae), *Rider 231* (FLAS), 2000, 13, 1, 3, 1, 1; *Tillandsia bartramii* Elliott (Bromeliaceae), *Rider 15* (FLAS), 1999, 14, 1, 3, 1, 1; *Tillandsia usneoides* (L.) L. (Bromeliaceae), *Rider 238* (FLAS), 2000, 13, 0, 1, 1, 2; *Lobelia floridana* Chapm. (Campanulaceae), *Rider 88* (FLAS), 1999, 14, 1, 3, 1, 1; *Lobelia glandulosa* Walter (Campanulaceae), *Rider 179* (FLAS), 1999, 14, 1, 3, 1, 1; *Lobelia* L. (Campanulaceae), *Rider 2* (FLAS), 1998, 15, 1, 3, 1, 1; *Lobelia* L. (Campanulaceae), *Mercurio & Wagamon 30* (FLAS), 1997, 16, 1, 3, 1, 1; *Wahlenbergia marginata* (Thunb.) A. DC. (Campanulaceae), *Rider 239* (FLAS), 2000, 13, 1, 3, 1, 1; *Wahlenbergia marginata* (Thunb.) A. DC. (Campanulaceae), *Mercurio & Wagamon 72* (FLAS), 1997, 16, 1, 3, 1, 1; *Celtis laevigata* Willd. (Cannabaceae), *Rider 129* (FLAS), 1999, 14, 1, 3, 2, 1; *Canna flaccida* Salisb. (Cannaceae), *Rider 109* (FLAS), 1999, 14, 0, 1, 1, 2; *Lonicera japonica* Thunb. (Caprifoliaceae), *Rider 371* (FLAS), 2001, 12, 1, 3, 1, 2; *Lonicera sempervirens* L. (Caprifoliaceae), *Rider 195* (FLAS), 2000, 13, 1, 3, 1, 1; *Helianthemum nashii* Britton (Cistaceae), *Rider 209* (FLAS), 2000, 13, 1, 3, 1, 1; *Clethra alnifolia* L. (Clethraceae), *Mercurio & Wagamon 54* (FLAS), 1997, 16, 1, 3, 1, 1; *Commelina diffusa* Burm. f. (Commelinaceae), *Rider 134* (FLAS), 1999, 14, 1, 3, 2, 1; *Commelina diffusa* Burm. f. (Commelinaceae), *Mercurio & Wagamon 123* (FLAS), 1997, 16, 0, 1, 1, 2; *Calystegia sepium* (L.) R. Br. (Convolvulaceae), *Mercurio & Wagamon 21* (FLAS), 1997, 16, 1, 3, 1, 1; *Calystegia sepium* (L.) R. Br. (Convolvulaceae), *Rider 82* (FLAS), 1999, 14, 1, 3, 1, 1; *Cuscuta compacta* Juss. ex Choisy (Convolvulaceae), *Rider 260* (FLAS), 2000, 13, 1, 3, 1, 1; *Ipomoea cordatotriloba* Dennst. (Convolvulaceae), *Rider 334* (FLAS), 2000, 13, 1, 3, 1, 1; *Cornus florida* L. (Cornaceae), *Rider 38* (FLAS), 1999, 14, 1, 2, 3, 1; *Cornus foemina* Mill. (Cornaceae), *Mercurio & Wagamon 125* (FLAS), 1997, 16, 1, 3, 1, 1; *Juniperus virginiana* L. (Cupressaceae), *Rider 236* (FLAS), 2000, 13, 1, 3, 1, 1; *Taxodium distichum var. imbricatum* (Nutt.) Croom (Cupressaceae), *Rider 216* (FLAS), 2000, 13, 1, 3, 1, 2; *Taxodium distichum* (L.) Rich. (Cupressaceae), *Mercurio & Wagamon 22* (FLAS), 1997, 16, 0, 1, 1, 2; *Carex complanata* Torr. & Hook. (Cyperaceae), *Proenza 432* (FLAS), 2006, 7, 1, 3, 2, 1; *Carex glaucescens* Elliott (Cyperaceae), *Mercurio & Wagamon 76* (FLAS), 1997, 16, 1, 3, 1, 2; *Carex glaucescens* Elliott (Cyperaceae), *Rider 308* (FLAS), 2000, 13, 1, 3, 1, 2; *Carex louisianica* L.H. Bailey (Cyperaceae), *Proenza 440* (FLAS), 2006, 7, 1, 3, 2, 1; *Carex lupulina* Muhl. ex Willd. (Cyperaceae), *Rider 241* (FLAS), 2000, 13, 1, 3, 2, 1; *Carex* L. (Cyperaceae), *Proenza 441* (FLAS), 2006, 7, 1, 3, 1, 1; *Carex stipata* Muhl. ex Willd. (Cyperaceae), *Rider 210* (FLAS), 2000, 13, 1, 3, 1, 2; *Cladium jamaicense* Crantz (Cyperaceae), *Rider 153* (FLAS), 1999, 14, 1, 3, 1, 1; *Cyperus alternifolius* L. (Cyperaceae), *Mercurio & Wagamon 70* (FLAS), 1997, 16, 1, 1, 1, 2; *Cyperus croceus* Vahl (Cyperaceae), *Rider 275* (FLAS), 2000, 13, 1, 3, 1, 2; *Cyperus involucratus* Rottb. (Cyperaceae), *Rider 276* (FLAS), 2000, 13, 1, 3, 1, 2; *Cyperus odoratus* L. (Cyperaceae), *Rider 305* (FLAS), 2000, 13, 1, 3, 1, 2; *Eleocharis vivipara* Link (Cyperaceae), *Proenza 418* (FLAS), 2005, 8, 1, 3, 1, 2; *Fuirena pumila* (Torr.) Spreng. (Cyperaceae), *Rider 322* (FLAS), 2000, 13, 1, 3, 1, 2; *Rhynchospora careyana* Fernald (Cyperaceae), *Mercurio & Wagamon 119* (FLAS), 1997, 16, 1, 3, 1, 2; *Rhynchospora cephalantha* A. Gray (Cyperaceae), *Mercurio & Wagamon 113* (FLAS), 1997, 16, 0, 1, 1, 2; *Rhynchospora colorata* (L.) H. Pfeiff. (Cyperaceae), *Rider 76* (FLAS), 1999, 14, 1, 3, 1, 2; *Rhynchospora inundata* (Oakes) Fernald (Cyperaceae), *Rider 309* (FLAS), 2000, 13, 1, 3, 1, 2; *Rhynchospora latifolia* (Baldwin) W.W. Thomas (Cyperaceae), *Rider 99* (FLAS), 1999, 14, 1, 3, 1, 2; *Rhynchospora* Vahl (Cyperaceae), *Proenza 433* (FLAS), 2006, 7, 1, 3, 1, 2; *Rhynchospora tracyi* Britton (Cyperaceae), *Rider 318* (FLAS), 2000, 13, 1, 3, 1, 2; *Scirpus cyperinus* (L.) Kunth (Cyperaceae), *Rider 292* (FLAS), 2000, 13, 1, 3, 1, 2; *Schoenoplectus pungens var. pungens* (Cyperaceae), *Rider 315* (FLAS), 2000, 13, 1, 3, 1, 2; *Cyrilla racemiflora* L. (Cyrillaceae), *Rider 116* (FLAS), 1999, 14, 0, 1, 1, 1; *Drosera brevifolia* Pursh (Droseraceae), *Rider 63* (FLAS), 1999, 14, 0, 0, 0, 0; *Drosera capillaris* Poir. (Droseraceae), *Rider 103* (FLAS), 1999, 14, 0, 1, 1, 1; *Diospyros virginiana* L. (Ebenaceae), *Rider 89* (FLAS), 1999, 14, 1, 1, 1, 1; *Diospyros virginiana* L. (Ebenaceae), *Rider 90* (FLAS), 1999, 14, 1, 3, 2, 1; *Bejaria racemosa* Vent. (Ericaceae), *Mercurio & Wagamon 19* (FLAS), 1997, 16, 0, 0, 1, 1; *Kalmia hirsuta* Walter (Ericaceae), *Mercurio & Wagamon 90* (FLAS), 1997, 16, 0, 1, 1, 1; *Lyonia lucida* (Lam.) K. Koch (Ericaceae), *Mercurio & Wagamon 16* (FLAS), 1997, 16, 1, 1, 1, 1; *Lyonia lucida* (Lam.) K. Koch (Ericaceae), *Rider 35* (FLAS), 1999, 14, 1, 3, 1, 1; *Rhododendron canescens* (Michx.) Sweet (Ericaceae), *Rider 44* (FLAS), 1999, 14, 1, 3, 1, 1; *Vaccinium corymbosum* L. (Ericaceae), *Rider 26* (FLAS), 1999, 14, 1, 3, 1, 1; *Vaccinium corymbosum* L. (Ericaceae), *Mercurio & Wagamon 96* (FLAS), 1997, 16, 1, 2, 1, 3; *Vaccinium corymbosum* L. (Ericaceae), *Mercurio & Wagamon 141* (FLAS), 1997, 16, 1, 2, 1, 3; *Eriocaulon decangulare* L. (Eriocaulaceae), *Rider 264* (FLAS), 2000, 13, 1, 3, 1, 2; *Lachnocaulon anceps* (Walter) Morong (Eriocaulaceae), *Rider 235* (FLAS), 2000, 13, 1, 3, 1, 2; *Lachnocaulon* Kunth (Eriocaulaceae), *Mercurio & Wagamon 14* (FLAS), 1997, 16, 1, 3, 1, 1; *Cnidoscolus urens* (L.) Arthur (Euphorbiaceae), *Mercurio & Wagamon 71* (FLAS), 1997, 16, 1, 3, 2, 1; *Sapium sebiferum* (L.) Roxb. (Euphorbiaceae), *Mercurio & Wagamon 39* (FLAS), 1997, 16, 0, 1, 1, 1; *Sapium sebiferum* (L.) Roxb. (Euphorbiaceae), *Rider 8* (FLAS), 1998, 15, 1, 1, 1, 1; *Stillingia sylvatica* Garden ex L. (Euphorbiaceae), *Rider 117* (FLAS), 1999, 14, 0, 1, 2, 3; *Amorpha fruticosa* L. (Fabaceae), *Mercurio & Wagamon 25* (FLAS), 1997, 16, 1, 1, 1, 2; *Amorpha fruticosa* L. (Fabaceae), *Rider 74* (FLAS), 1999, 14, 1, 3, 1, 2; *Baptisia* Vent. (Fabaceae), *Rider 54* (FLAS), 1999, 14, 1, 3, 1, 1; *Centrosema virginianum* (L.) Benth. (Fabaceae), *Rider 126* (FLAS), 1999, 14, 1, 3, 1, 1; *Cercis canadensis* L. (Fabaceae), *Rider 42* (FLAS), 1999, 14, 1, 3, 1, 1; *Cercis canadensis* L. (Fabaceae), *Mercurio & Wagamon 147* (FLAS), 1997, 16, 1, 1, 1, 1; *Crotalaria rotundifolia* J.F. Gmel. (Fabaceae), *Rider 61* (FLAS), 1999, 14, 1, 3, 1, 1; *Crotalaria spectabilis* Roth (Fabaceae), *Rider 1* (FLAS), 1998, 15, 1, 1, 1, 1; *Dalea carnea* (Michx.) Poir. (Fabaceae), *Rider 150* (FLAS), 1999, 14, 1, 3, 1, 1; *Erythrina herbacea* L. (Fabaceae), *Rider 247* (FLAS), 2000, 13, 1, 3, 1, 1; *Galactia elliottii* Nutt. (Fabaceae), *Mercurio & Wagamon 83* (FLAS), 1997, 16, 1, 3, 1, 1; *Mimosa quadrivalvis* L. (Fabaceae), *Rider 101* (FLAS), 1999, 14, 1, 3, 1, 1; *Senna obtusifolia* (L.) H.S. Irwin & Barneby (Fabaceae), *Mercurio & Wagamon 77* (FLAS), 1997, 16, 1, 3, 1, 1; *Sesbania punicea* (Cav.) Benth. (Fabaceae), *Rider 79* (FLAS), 1999, 14, 1, 3, 1, 1; *Tephrosia florida* (F. Dietr.) C.E. Wood (Fabaceae), *Rider 252* (FLAS), 2000, 13, 1, 3, 1, 1; *Tephrosia florida* (F. Dietr.) C.E. Wood (Fabaceae), *Mercurio & Wagamon 82* (FLAS), 1997, 16, 1, 3, 1, 1; *Trifolium repens* L. (Fabaceae), *Rider 142* (FLAS), 1999, 14, 1, 3, 1, 1; *Trifolium repens* L. (Fabaceae), *Proenza 436* (FLAS), 2006, 7, 1, 3, 1, 1; *Vachellia farnesiana* (L.) Wight & Arn. (Fabaceae), *Mercurio & Wagamon 42* (FLAS), 1997, 16, 1, 3, 2, 1; *Acacia pinetorum* F.J. Herm. (Fabaceae), *Rider 6* (FLAS), 1998, 15, 1, 3, 2, 1; *Vicia acutifolia* Elliott (Fabaceae), *Rider 59* (FLAS), 1999, 14, 1, 3, 1, 1; *Wisteria frutescens* (L.) Poir. (Fabaceae), *Rider 73* (FLAS), 1999, 14, 1, 2, 1, 3; *Wisteria sinensis* (Sims) Sweet (Fabaceae), *Rider 49* (FLAS), 1999, 14, 1, 3, 1, 2; *Quercus acutissima* Carruth. (Fagaceae), *Rider 366* (FLAS), 2001, 12, 1, 2, 1, 3; *Quercus alba* L. (Fagaceae), *Rider 164* (FLAS), 1999, 14, 1, 3, 2, 1; *Quercus incana* W. Bartram (Fagaceae), *Rider 245* (FLAS), 2000, 13, 1, 2, 2, 1; *Quercus laevis* Walter (Fagaceae), *Mercurio & Wagamon 74* (FLAS), 1997, 16, 1, 2, 2, 1; *Quercus laurifolia* Michx. (Fagaceae), *Mercurio & Wagamon 87* (FLAS), 1997, 16, 1, 2, 2, 1; *Quercus margarettiae* (Ashe) Small (Fagaceae), *Mercurio & Wagamon 68* (FLAS), 1997, 16, 1, 1, 1, 2; *Quercus marilandica* Münchh. (Fagaceae), *Rider 244* (FLAS), 2000, 13, 1, 3, 1, 1; *Quercus marilandica* Münchh. (Fagaceae), *Mercurio & Wagamon 132* (FLAS), 1997, 16, 0, 0, 1, 2; *Quercus marilandica* Münchh. (Fagaceae), *Rider 288* (FLAS), 2000, 13, 1, 2, 2, 1; *Quercus michauxii* Nutt. (Fagaceae), *Mercurio & Wagamon 151* (FLAS), 1997, 16, 1, 2, 1, 3; *Quercus minima* (Sarg.) Small (Fagaceae), *Rider 339* (FLAS), 2000, 13, 1, 1, 1, 1; *Quercus nigra* L. (Fagaceae), *Mercurio & Wagamon 84* (FLAS), 1997, 16, 0, 1, 1, 2; *Quercus shumardii* Buckley (Fagaceae), *Rider 176* (FLAS), 1999, 14, 1, 3, 2, 1; *Quercus* L. (Fagaceae), *Mercurio & Wagamon 139* (FLAS), 1997, 16, 1, 3, 1, 1; *Quercus virginiana* Mill. (Fagaceae), *Rider 183* (FLAS), 2000, 13, 1, 3, 2, 1; *Gelsemium sempervirens* (L.) J. St.-Hil. (Gelsemiaceae), *Rider 13* (FLAS), 1999, 14, 0, 0, 0, 0; *Sabatia decandra* (Walter) R.M. Harper (Gentianaceae), *Rider 152* (FLAS), 1999, 14, 1, 3, 1, 1; *Sabatia decandra* (Walter) R.M. Harper (Gentianaceae), *Mercurio & Wagamon 92* (FLAS), 1997, 16, 1, 3, 1, 1; *Sabatia brevifolia* Raf. (Gentianaceae), *Rider 162* (FLAS), 1999, 14, 1, 3, 1, 1; *Sabatia campanulata* (L.) Torr. (Gentianaceae), *Rider 119* (FLAS), 1999, 14, 1, 3, 1, 1; *Sabatia dodecandra* (L.) Britton, Sterns & Poggenb. (Gentianaceae), *Rider 131* (FLAS), 1999, 14, 1, 3, 1, 1; *Geranium carolinianum* L. (Geraniaceae), *Rider 358* (FLAS), 2001, 12, 1, 3, 2, 1; *Lachnanthes caroliniana* (Lam.) Dandy (Haemodoraceae), *Rider 144* (FLAS), 1999, 14, 1, 3, 2, 1; *Lachnanthes caroliniana* (Lam.) Dandy (Haemodoraceae), *Mercurio & Wagamon 148* (FLAS), 1997, 16, 1, 3, 1, 3;

Myriophyllum aquaticum (Vell.) Verdc. (Haloragaceae), *Rider 391* (FLAS), 2002, 11, 0, 1, 2, 3; *Proserpinaca pectinata* Lam. (Haloragaceae), *Proenza 431* (FLAS), 2006, 7, 1, 3, 1, 1; *Najas guadalupensis* (Spreng.) Magnus (Hydrocharitaceae), *Proenza 416* (FLAS), 2005, 8, 1, 2, 1, 3; *Hypericum cistifolium* Lam. (Hypericaceae), *Mercurio & Wagamon 99* (FLAS), 1997, 16, 1, 1, 1, 1; *Hypericum cistifolium* Lam. (Hypericaceae), *Rider 290* (FLAS), 2000, 13, 1, 3, 1, 1; *Hypericum fasciculatum* Lam. (Hypericaceae), *Rider 199* (FLAS), 2000, 13, 1, 3, 1, 1; *Hypericum gentianoides* (L.) Britton, Sterns & Poggenb. (Hypericaceae), *Rider 159* (FLAS), 1999, 14, 1, 3, 1, 2; *Hypericum hypericoides* (L.) Crantz (Hypericaceae), *Rider 302* (FLAS), 2000, 13, 1, 3, 1, 1; *Hypericum microsepalum* (Torr. & A. Gray) A. Gray ex S. Watson (Hypericaceae), *Rider 198* (FLAS), 2000, 13, 1, 3, 1, 1; *Hypericum setosum* L. (Hypericaceae), *Rider 287* (FLAS), 2000, 13, 1, 3, 2, 1; *Hypericum tetrapetalum* Lam. (Hypericaceae), *Rider 196* (FLAS), 2000, 13, 1, 3, 1, 1; *Hypoxis juncea* Sm. (Hypoxidaceae), *Rider 200* (FLAS), 2000, 13, 1, 3, 1, 2; *Hypoxis juncea* Sm. (Hypoxidaceae), *Proenza 424* (FLAS), 2006, 7, 1, 3, 1, 2; *Iris virginica* L. (Iridaceae), *Rider 40* (FLAS), 1999, 14, 1, 3, 1, 2; *Sisyrinchium atlanticum* E.P. Bicknell (Iridaceae), *Rider 56* (FLAS), 1999, 14, 1, 3, 1, 2; *Sisyrinchium rosulatum* E.P. Bicknell (Iridaceae), *Rider 223* (FLAS), 2000, 13, 1, 3, 1, 2; *Itea virginica* L. (Iteaceae), *Mercurio & Wagamon 63* (FLAS), 1997, 16, 1, 3, 2, 1; *Carya glabra* (Mill.) Sweet (Juglandaceae), *Rider 370* (FLAS), 2001, 12, 1, 3, 1, 1; *Carya illinoinensis* (Wangenh.) K. Koch (Juglandaceae), *Rider 78* (FLAS), 1999, 14, 1, 2, 1, 3; *Juncus effusus* L. (Juncaceae), *Rider 21* (FLAS), 1999, 14, 1, 3, 1, 2; *Juncus polycephalus* Michx. (Juncaceae), *Rider 266* (FLAS), 2000, 13, 1, 3, 1, 2; *Juncus* L. (Juncaceae), *Mercurio & Wagamon 91* (FLAS), 1997, 16, 0, 1, 1, 2; *Juncus* L. (Juncaceae), *Mercurio & Wagamon 111* (FLAS), 1997, 16, 1, 2, 1, 3; *Callicarpa americana* L. (Lamiaceae), *Mercurio & Wagamon 40* (FLAS), 1997, 16, 1, 3, 1, 1; *Hyptis alata* Shinners (Lamiaceae), *Rider 141* (FLAS), 1999, 14, 1, 3, 1, 1; *Hyptis mutabilis* (Rich.) Briq. (Lamiaceae), *Mercurio & Wagamon 27* (FLAS), 1997, 16, 1, 3, 1, 1; *Hyptis mutabilis* (Rich.) Briq. (Lamiaceae), *Rider 326* (FLAS), 2000, 13, 1, 3, 1, 1; *Physostegia purpurea* (Walter) S.F. Blake (Lamiaceae), *Rider 100* (FLAS), 1999, 14, 1, 3, 1, 1; *Physostegia* Benth. (Lamiaceae), *Rider 112* (FLAS), 1999, 14, 1, 3, 1, 1; *Rosmarinus officinalis* L. (Lamiaceae), *Rider 397* (FLAS), 2002, 11, 1, 1, 1, 1; *Salvia lyrata* L. (Lamiaceae), *Rider 207* (FLAS), 2000, 13, 1, 3, 2, 1; *Salvia lyrata* L. (Lamiaceae), *Rider 64* (FLAS), 1999, 14, 0, 0, 0, 0; *Scutellaria arenicola* Small (Lamiaceae), *Rider 98* (FLAS), 1999, 14, 1, 3, 1, 1; *Teucrium canadense* L. (Lamiaceae), *Rider 135* (FLAS), 1999, 14, 1, 3, 1, 1; *Teucrium canadense* L. (Lamiaceae), *Mercurio & Wagamon 75* (FLAS), 1997, 16, 1, 3, 1, 1; *Trichostema dichotomum* L. (Lamiaceae), *Rider 335* (FLAS), 2000, 13, 1, 3, 1, 1; *Cinnamomum camphora* (L.) J. Presl (Lauraceae), *Rider 75* (FLAS), 1999, 14, 1, 3, 2, 1; *Persea borbonia* (L.) Spreng. (Lauraceae), *Rider 383* (FLAS), 2001, 12, 1, 3, 0, 0; *Persea borbonia* (L.) Spreng. (Lauraceae), *Rider 219* (FLAS), 2000, 13, 1, 3, 1, 1; *Persea palustris* (Raf.) Sarg. (Lauraceae), *Rider 396* (FLAS), 2002, 11, 1, 3, 1, 1; *Sassafras albidum* (Nutt.) Nees (Lauraceae), *Rider 140* (FLAS), 1999, 14, 1, 3, 0, 0; *Pinguicula caerulea* Walter (Lentibulariaceae), *Rider 201* (FLAS), 2000, 13, 1, 3, 1, 1; *Pinguicula lutea* Walter (Lentibulariaceae), *Rider 45* (FLAS), 1999, 14, 1, 3, 1, 1; *Pinguicula pumila* Michx. (Lentibulariaceae), *Rider 10* (FLAS), 1999, 14, 1, 3, 1, 1; *Pinguicula pumila* Michx. (Lentibulariaceae), *Proenza 439* (FLAS), 2006, 7, 1, 3, 1, 1; *Pinguicula pumila* Michx. (Lentibulariaceae), *Rider 394* (FLAS), 2002, 11, 0, 0, 0, 0; *Utricularia gibba* L. (Lentibulariaceae), *Rider 375* (FLAS), 2001, 12, 1, 3, 1, 1; *Utricularia breviscapa* Wright ex Griseb. (Lentibulariaceae), *Rider 22* (FLAS), 1999, 14, 0, 1, 1, 1; *Utricularia subulata* L. (Lentibulariaceae), *Rider 47* (FLAS), 1999, 14, 1, 3, 1, 1; *Lilium catesbaei* Walter (Liliaceae), *Rider 163* (FLAS), 1999, 14, 0, 0, 0, 1; *Lycopodiella alopecuroides* (L.) Cranfill (Lycopodiaceae), *Rider 387* (FLAS), 2002, 11, 1, 3, 1, 1; *Lycopodiella alopecuroides* (L.) Cranfill (Lycopodiaceae), *Mercurio & Wagamon 95* (FLAS), 1997, 16, 1, 3, 1, 1; *Lythrum lineare* L. (Lythraceae), *Mercurio & Wagamon 120* (FLAS), 1997, 16, 0, 1, 1, 2; *Magnolia grandiflora* L. (Magnoliaceae), *Rider 123* (FLAS), 1999, 14, 1, 1, 1, 1; *Magnolia virginiana* L. (Magnoliaceae), *Rider 107* (FLAS), 1999, 14, 1, 3, 1, 1; *Hibiscus aculeatus* Walter (Malvaceae), *Rider 125* (FLAS), 1999, 14, 0, 1, 1, 2; *Hibiscus moscheutos* L. (Malvaceae), *Rider 114* (FLAS), 1999, 14, 1, 2, 2, 1; *Kosteletzkya pentacarpa* (L.) Ledeb. (Malvaceae), *Rider 138* (FLAS), 1999, 14, 1, 3, 1, 1; *Pavonia hastata* Cav. (Malvaceae), *Rider 149* (FLAS), 1999, 14, 1, 3, 2, 1; *Zigadenus densus* (Desr.) Fernald (Melanthiaceae), *Rider 86* (FLAS), 1999, 14, 1, 3, 1, 2; *Rhexia alifanus* Walter (Melastomataceae), *Rider 118* (FLAS), 1999, 14, 0, 0, 0, 0; *Rhexia cubensis* Griseb. (Melastomataceae), *Rider 279* (FLAS), 2000, 13, 1, 0, 1, 2; *Rhexia lutea* Walter (Melastomataceae), *Rider 365* (FLAS), 2001, 12, 0, 0, 0, 0; *Rhexia mariana* L. (Melastomataceae), *Rider 121* (FLAS), 1999, 14, 1, 1, 1, 1; *Rhexia nashii* Small (Melastomataceae), *Rider 284* (FLAS), 2000, 13, 1, 2, 1, 3; *Rhexia petiolata* Walter (Melastomataceae), *Rider 313* (FLAS), 2000, 13, 1, 1, 1, 1; *Limnobium spongia* (Bosc) Rich. ex Steud. (Menyanthaceae), *Mercurio & Wagamon 88* (FLAS), 1997, 16, 0, 0, 1, 2; *Morus rubra* L. (Moraceae), *Mercurio & Wagamon 135* (FLAS), 1997, 16, 1, 3, 1, 1; *Musa acuminata* Colla (Musaceae), *Rider 278* (FLAS), 2000, 13, 0, 1, 1, 2; *Morella cerifera* (L.) Small (Myricaceae), *Rider 7* (FLAS), 1998, 15, 1, 3, 2, 1; *Myrica heterophylla* Raf. (Myricaceae), *Rider 392* (FLAS), 2002, 11, 1, 1, 1, 1; *Aletris lutea* Small (Nartheciaceae), *Rider 97* (FLAS), 1999, 14, 1, 2, 1, 3; *Aletris obovata* Nash ex Small (Nartheciaceae), *Rider 106* (FLAS), 1999, 14, 0, 0, 0, 1; *Nymphaea odorata* Aiton (Nymphaeaceae), *Rider 373* (FLAS), 2001, 12, 1, 1, 1, 1; *Nyssa ogeche* W. Bartram ex Marshall (Nyssaceae), *Mercurio & Wagamon 58* (FLAS), 1997, 16, 0, 1, 2, 3; *Nyssa sylvatica* Marshall (Nyssaceae), *Rider 220* (FLAS), 2000, 13, 0, 0, 0, 1; *Chionanthus virginicus* L. (Oleaceae), *Rider 68* (FLAS), 1999, 14, 1, 3, 1, 1; *Fraxinus caroliniana* Mill. (Oleaceae), *Rider 72* (FLAS), 1999, 14, 1, 3, 1, 1; *Fraxinus caroliniana* Mill. (Oleaceae), *Mercurio & Wagamon 24* (FLAS), 1997, 16, 1, 3, 2, 1; *Fraxinus pennsylvanica* Marshall (Oleaceae), *Mercurio & Wagamon 158* (FLAS), 1997, 16, 1, 3, 1, 1; *Ligustrum japonicum* Thunb. (Oleaceae), *Rider 214* (FLAS), 2000, 13, 1, 3, 2, 1; *Ludwigia leptocarpa* (Nutt.) H. Hara (Onagraceae), *Proenza 417* (FLAS), 2005, 8, 1, 3, 2, 1; *Ludwigia maritima* R.M. Harper (Onagraceae), *Rider 280* (FLAS), 2000, 13, 1, 3, 1, 1; *Ludwigia peruviana* (L.) H. Hara (Onagraceae), *Rider 171* (FLAS), 1999, 14, 1, 2, 1, 3; *Ludwigia* L. (Onagraceae), *Mercurio & Wagamon 100* (FLAS), 1997, 16, 0, 1, 1, 1; *Ludwigia virgata* Michx. (Onagraceae), *Rider 128* (FLAS), 1999, 14, 1, 1, 1, 1; *Oenothera laciniata* Hill (Onagraceae), *Rider 65* (FLAS), 1999, 14, 1, 1, 1, 1; *Calopogon multiflorus* Lindl. (Orchidaceae), *Rider 360* (FLAS), 2001, 12, 1, 3, 1, 2; *Calopogon pallidus* Chapm. (Orchidaceae), *Rider 362* (FLAS), 2001, 12, 1, 3, 1, 2; *Calopogon tuberosus* (L.) Britton, Sterns & Poggenb. (Orchidaceae), *Rider 99* (FLAS), 1999, 14, 1, 3, 1, 2; *Cleistes divaricata* (L.) Ames (Orchidaceae), *Rider 102* (FLAS), 1999, 14, 1, 3, 2, 1; *Corallorhiza wisteriana* Conrad (Orchidaceae), *Rider 353* (FLAS), 2001, 12, 1, 3, 1, 2; *Platanthera ciliaris* (L.) Lindl. (Orchidaceae), *Rider 158* (FLAS), 1999, 14, 1, 3, 2, 1; *Spiranthes praecox* (Walter) S. Watson (Orchidaceae), *Rider 67* (FLAS), 1999, 14, 1, 3, 2, 1; *Spiranthes vernalis* Engelm. & A. Gray (Orchidaceae), *Rider 91* (FLAS), 1999, 14, 1, 3, 1, 2; *Zeuxine strateumatica* (L.) Schltr. (Orchidaceae), *Rider 11* (FLAS), 1999, 14, 1, 3, 1, 2; *Agalinis aphylla* (Nutt.) Raf. (Orobanchaceae), *Rider 347* (FLAS), 2000, 13, 1, 3, 2, 1; *Agalinis fasciculata* (Elliott) Raf. (Orobanchaceae), *Rider 342* (FLAS), 2000, 13, 1, 3, 2, 1; *Agalinis fasciculata* (Elliott) Raf. (Orobanchaceae), *Rider 169* (FLAS), 1999, 14, 1, 3, 2, 1; *Agalinis setacea* (J.F. Gmel.) Raf. (Orobanchaceae), *Rider 349* (FLAS), 2000, 13, 1, 3, 1, 1; *Oxalis corniculata* L. (Oxalidaceae), *Rider 208* (FLAS), 2000, 13, 0, 1, 2, 3; *Phyllanthus urinaria* L. (Phyllanthaceae), *Rider 291* (FLAS), 2000, 13, 0, 1, 1, 1; *Phytolacca americana* L. (Phytolaccaceae), *Mercurio & Wagamon 41* (FLAS), 1997, 16, 1, 3, 1, 1; *Pinus clausa* (Chapm. ex Engelm.) Sarg. (Pinaceae), *Mercurio & Wagamon 69* (FLAS), 1997, 16, 0, 0, 0, 0; *Pinus elliottii* Engelm. (Pinaceae), *Mercurio & Wagamon 145* (FLAS), 1997, 16, 0, 0, 0, 1; *Pinus glabra* Walter (Pinaceae), *Rider 43* (FLAS), 1999, 14, 0, 1, 1, 2; *Pinus palustris* Mill. (Pinaceae), *Rider 356* (FLAS), 2001, 12, 1, 3, 1, 2; *Pinus serotina* Michx. (Pinaceae), *Rider 384* (FLAS), 2001, 12, 1, 3, 1, 2; *Pinus taeda* L. (Pinaceae), *Rider 33* (FLAS), 1999, 14, 1, 3, 1, 2; *Bacopa caroliniana* (Walter) B.L. Rob. (Plantaginaceae), *Rider 145* (FLAS), 1999, 14, 1, 3, 1, 1; *Bacopa monnieri* (L.) Wettst. (Plantaginaceae), *Mercurio & Wagamon 102* (FLAS), 1997, 16, 1, 3, 1, 1; *Linaria canadensis* (L.) Dum. Cours. (Plantaginaceae), *Rider 29* (FLAS), 1999, 14, 1, 3, 2, 1; *Mecardonia acuminata* (Walter) Small (Plantaginaceae), *Rider 71* (FLAS), 1999, 14, 1, 3, 1, 3; *Mecardonia acuminata* (Walter) Small (Plantaginaceae), *Proenza 438* (FLAS), 2006, 7, 1, 3, 1, 1; *Plantago lanceolata* L. (Plantaginaceae), *Rider 212* (FLAS), 2000, 13, 1, 3, 1, 0; *Plantago major* L. (Plantaginaceae), *Rider 41* (FLAS), 1999, 14, 1, 3, 1, 1; *Plantago virginica* L. (Plantaginaceae), *Rider 205* (FLAS), 2000, 13, 1, 2, 3, 1; *Platanus occidentalis* L. (Platanaceae), *Rider 77* (FLAS), 1999, 14, 1, 2, 1, 3; *Andropogon glomeratus* (Walter) Britton, Sterns & Poggenb. (Poaceae), *Rider 178* (FLAS), 1999, 14, 1, 3, 1, 2; *Arundinaria gigantea* (Walter) Muhl. (Poaceae), *Rider 197* (FLAS), 2000, 13, 1, 3, 1, 2; *Arundinaria gigantea* (Walter) Muhl. (Poaceae), *Rider 194* (FLAS), 2000, 13, 1, 3, 1, 2; *Arundo donax* L. (Poaceae), *Proenza 425* (FLAS), 2005, 8, 1, 3, 1, 2; *Chasmanthium laxum* (L.) H.O. Yates (Poaceae), *Mercurio & Wagamon 115* (FLAS), 1997, 16, 1, 3, 1, 2; *Chasmanthium laxum* (L.) H.O. Yates (Poaceae), *Mercurio & Wagamon 137* (FLAS), 1997, 16, 1, 3, 1, 1; *Chasmanthium nitidum* (Baldwin ex Elliott) H.O. Yates (Poaceae), *Mercurio & Wagamon 112* (FLAS), 1997, 16, 1, 3, 1, 1; *Cladium jamaicense* Crantz (Poaceae), *Mercurio & Wagamon 26a* (FLAS), 1997, 16, 1, 3, 1, 2; *Ctenium aromaticum* (Walter) Alph. Wood (Poaceae), *Rider 94* (FLAS), 1999, 14, 1, 3, 1, 2; *Ctenium aromaticum* (Walter) Alph. Wood (Poaceae), *Mercurio & Wagamon 78* (FLAS), 1997, 16, 1, 3, 1, 2; *Dichanthelium commutatum* (Schult.) Gould (Poaceae), *Mercurio & Wagamon 107* (FLAS), 1997, 16, 1, 3, 1, 1; *Dichanthelium sphaerocarpon* var. *floridanum* (Vasey) Davidse (Poaceae), *Mercurio & Wagamon 106* (FLAS), 1997, 16, 1, 3, 1, 1; *Dichanthelium scabriusculum* (Elliott) Gould & C.A. Clark (Poaceae), *Proenza 426* (FLAS), 2005, 8, 1, 3, 1, 2; *Dichanthelium scabriusculum* (Elliott) Gould & C.A. Clark (Poaceae), *Mercurio & Wagamon 117* (FLAS), 1997, 16, 1, 3, 1, 1; *Dichanthelium scabriusculum* (Elliott) Gould & C.A. Clark (Poaceae), *Mercurio & Wagamon 116* (FLAS), 1997, 16, 1, 3, 1, 1; *Dichanthelium dichotomum* var. *unciphyllum* (Trin.) Davidse (Poaceae), *Proenza 434* (FLAS), 2006, 7, 1, 3, 1, 1; *Digitaria ciliaris* (Retz.) Koeler (Poaceae), *Rider 307* (FLAS), 2000, 13, 1, 3, 1, 2; *Imperata cylindrica* (L.) Raeusch. (Poaceae), *Proenza 430* (FLAS), 2006, 7, 1, 3, 1, 2; *Lolium perenne* L. (Poaceae), *Rider 230* (FLAS), 2000, 13, 1, 3, 1, 2; *Paspalum notatum* Alain ex Flüggé (Poaceae), *Rider 227* (FLAS), 2000, 13, 1, 3, 1, 2; *Paspalum praecox* Walter (Poaceae), *Rider 226* (FLAS), 2000, 13, 1, 3, 0, 0; *Paspalum urvillei* Steud. (Poaceae), *Rider 285* (FLAS), 2000, 13, 1, 3, 1, 2; *Paspalum urvillei* Steud. (Poaceae), *Proenza 419* (FLAS), 2005, 8, 1, 3, 1, 2; *Cenchrus purpureus* (Schumach.) Morrone (Poaceae), *Rider 272* (FLAS), 2000, 13, 1, 3, 1, 2; *Polypogon monspeliensis* (L.) Desf. (Poaceae), *Rider 203* (FLAS), 2000, 13, 1, 3, 1, 2; *Polypogon monspeliensis* (L.) Desf. (Poaceae), *Proenza 437* (FLAS), 2006, 7, 0, 0, 0, 0; *Saccharum giganteum* (Walter) Pers. (Poaceae), *Rider 175* (FLAS), 1999, 14, 1, 3, 1, 2; *Setaria parviflora* (Poir.) Kerguélen (Poaceae), *Rider 263* (FLAS), 2000, 13, 1, 3, 1, 2; *Setaria parviflora* (Poir.) Kerguélen (Poaceae), *Mercurio & Wagamon 142* (FLAS), 1997, 16, 1, 3, 1, 1; *Sorghastrum elliottii* (C. Mohr) Nash (Poaceae), *Rider 337* (FLAS), 2000, 13, 1, 3, 1, 2; *Tripsacum dactyloides* (L.) L. (Poaceae), *Rider 242* (FLAS), 2000, 13, 1, 3, 1, 2; *Tripsacum dactyloides* var. *floridanum* (Porter ex Vasey) Beal (Poaceae), *Rider 248* (FLAS), 2000, 13, 1, 3, 1, 2; *Zizaniopsis miliacea* (Michx.) Döll & Asch. (Poaceae), *Rider 165* (FLAS), 1999, 14, 1, 3, 1, 2; *Zizaniopsis miliacea* (Michx.) Döll & Asch. (Poaceae), *Rider 166* (FLAS), 1999, 14, 1, 3, 1, 2; *Phlox floridana* Benth. (Polemoniaceae), *Rider 69* (FLAS), 1999, 14, 0, 0, 0, 0; *Polygala cruciata* L. (Polygalaceae), *Rider 369* (FLAS), 2001, 12, 0, 0, 0, 0; *Polygala cymosa* Walter (Polygalaceae), *Rider 368* (FLAS), 2001, 12, 1, 3, 1, 2; *Polygala lutea* L. (Polygalaceae), *Rider 51* (FLAS), 1999, 14, 1, 3, 1, 1; *Polygala lutea* L. (Polygalaceae), *Mercurio & Wagamon 15* (FLAS), 1997, 16, 1, 3, 1, 1; *Polygala nana* (Michx.) DC. (Polygalaceae), *Rider 23* (FLAS), 1999, 14, 0, 1, 1, 1; *Polygala ramosa* Elliott (Polygalaceae), *Rider 146* (FLAS), 1999, 14, 1, 3, 1, 1; *Polygala ramosa* Elliott (Polygalaceae), *Rider 120* (FLAS), 1999, 14, 1, 3, 1, 1; *Polygala rugelii* Shuttlew. ex Chapm. (Polygalaceae), *Rider 62* (FLAS), 1999, 14, 0, 1, 1, 1; *Pleopeltis polypodioides* (L.) E.G. Andrews & Windham (Polypodiaceae), *Rider 386* (FLAS), 2002, 11, 1, 3, 1, 2; *Pontederia cordata* L. (Pontederiaceae), *Rider 80* (FLAS), 1999, 14, 1, 2, 1, 3; *Samolus floribundus* Kunth (Primulaceae), *Proenza 435* (FLAS), 2006, 7, 1, 3, 1, 1; *Clematis crispa* L. (Ranunculaceae), *Mercurio & Wagamon 103* (FLAS), 1997, 16, 1, 1, 1, 1; *Clematis crispa* L. (Ranunculaceae), *Rider 83* (FLAS), 1999, 14, 1, 3, 1, 1; *Ranunculus hispidus* Michx. (Ranunculaceae), *Rider 234* (FLAS), 2000, 13, 1, 3, 1, 1; *Eriobotrya japonica* (Thunb.) Lindl. (Rosaceae), *Rider 187* (FLAS), 2000, 13, 1, 3, 2, 1; *Photinia pyrifolia* (Lam.) K.R. Robertson & J.B. Phipps (Rosaceae), *Rider 185* (FLAS), 2000, 13, 1, 2, 1, 3; *Photinia pyrifolia* (Lam.) K.R. Robertson & J.B. Phipps (Rosaceae), *Rider 27*

(FLAS), 1999, 14, 1, 3, 2, 1; *Prunus americana* Marshall (Rosaceae), *Rider 352* (FLAS), 2001, 12, 1, 1, 1, 2; *Prunus serotina* Ehrh. (Rosaceae), *Rider 190* (FLAS), 2000, 13, 1, 2, 3, 1; *Prunus serotina* Ehrh. (Rosaceae), *Mercurio & Wagamon 67* (FLAS), 1997, 16, 1, 3, 2, 1; *Pyrus calleryana* Decne. (Rosaceae), *Rider 354* (FLAS), 2001, 12, 1, 1, 1, 3; *Rosa laevigata* Michx. (Rosaceae), *Rider 34* (FLAS), 1999, 14, 1, 1, 1, 3; *Rosa palustris* Marshall (Rosaceae), *Rider 85* (FLAS), 1999, 14, 1, 3, 2, 1; *Rosa palustris* Marshall (Rosaceae), *Rider 385* (FLAS), 2002, 11, 1, 3, 2, 1; *Rubus cuneifolius* Pursh (Rosaceae), *Rider 246* (FLAS), 2000, 13, 1, 3, 2, 1; *Rubus trivialis* Michx. (Rosaceae), *Rider 25* (FLAS), 1999, 14, 1, 2, 1, 3; *Cephalanthus occidentalis* L. (Rubiaceae), *Mercurio & Wagamon 35* (FLAS), 1997, 16, 0, 1, 2, 3; *Diodia virginiana* L. (Rubiaceae), *Rider 316* (FLAS), 2000, 13, 1, 3, 1, 1; *Hedyotis procumbens* (J.F. Gmel.) Fosberg (Rubiaceae), *Rider 355* (FLAS), 2001, 12, 1, 3, 2, 1; *Mitchella repens* L. (Rubiaceae), *Rider 181* (FLAS), 2000, 13, 1, 3, 2, 1; *Populus deltoides* W. Bartram ex Marshall (Salicaceae), *Rider 215* (FLAS), 2000, 13, 1, 3, 2, 1; *Salix babylonica* L. (Salicaceae), *Rider 277* (FLAS), 2000, 13, 1, 1, 2, 3; *Salix caroliniana* Michx. (Salicaceae), *Mercurio & Wagamon 118* (FLAS), 1997, 16, 1, 1, 1, 1; *Salix nigra* Marshall (Salicaceae), *Rider 48* (FLAS), 1999, 14, 1, 3, 2, 1; *Phoradendron leucarpum* (Raf.) Reveal & M.C. Johnst. (Santalaceae), *Rider 350* (FLAS), 2001, 12, 1, 2, 1, 3; *Acer rubrum* L. (Sapindaceae), *Rider 19* (FLAS), 1999, 14, 1, 3, 1, 2; *Sarracenia minor* Walter (Sarraceniaceae), *Rider 206* (FLAS), 2000, 13, 1, 3, 2, 1; *Sarracenia minor* Walter (Sarraceniaceae), *Mercurio & Wagamon 93* (FLAS), 1997, 16, 1, 3, 2, 1; *Saururus cernuus* L. (Saururaceae), *Rider 96* (FLAS), 1999, 14, 1, 3, 2, 1; *Illicium floridanum* J. Ellis (Schisandraceae), *Rider 177* (FLAS), 1999, 14, 1, 3, 2, 1; *Smilax bona-nox* L. (Smilacaceae), *Rider 390* (FLAS), 2002, 11, 1, 3, 1, 2; *Smilax glauca* Walter (Smilacaceae), *Rider 251* (FLAS), 2000, 13, 1, 3, 1, 2; *Smilax laurifolia* L. (Smilacaceae), *Rider 28* (FLAS), 1999, 14, 1, 2, 1, 3; *Smilax* L. (Smilacaceae), *Mercurio & Wagamon 160* (FLAS), 1997, 16, 1, 3, 1, 1; *Solanum americanum* Mill. (Solanaceae), *Rider 133* (FLAS), 1999, 14, 1, 3, 1, 3; *Solanum capsicoides* All. (Solanaceae), *Rider 228* (FLAS), 2000, 13, 1, 3, 2, 1; *Solanum carolinense* L. (Solanaceae), *Rider 70* (FLAS), 1999, 14, 1, 3, 1, 1; *Solanum lycopersicum* L. (Solanaceae), *Rider 265* (FLAS), 2000, 13, 1, 3, 1, 3; *Polypremum procumbens* L. (Tetrachondraceae), *R.L. Wilbur 68532* (FLAS), 1997, 16, 1, 3, 1, 1; *Gordonia lasianthus* (L.) J. Ellis (Theaceae), *Mercurio & Wagamon 1* (FLAS), 1997, 16, 1, 2, 1, 3; *Piriqueta cistoides* subsp. *caroliniana* (Walter) Arbo (Turneraceae), *Rider 237* (FLAS), 2000, 13, 1, 3, 1, 1; *Typha latifolia* L. (Typhaceae), *Rider 110* (FLAS), 1999, 14, 1, 2, 1, 3; *Ulmus alata* Michx. (Ulmaceae), *Mercurio & Wagamon 153* (FLAS), 1997, 16, 1, 3, 1, 2; *Ulmus alata* Michx. (Ulmaceae), *Rider 283* (FLAS), 2000, 13, 1, 3, 2, 1; *Ulmus americana* L. (Ulmaceae), *Mercurio & Wagamon 134* (FLAS), 1997, 16, 1, 3, 2, 1; *Urtica urens* L. (Urticaceae), *Smith 01* (FLAS), 1999, 14, 1, 3, 2, 1; *Lantana depressa* Small (Verbenaceae), *Rider 271* (FLAS), 2000, 13, 1, 3, 1, 1; *Phyla nodiflora* (L.) Greene (Verbenaceae), *Rider 224* (FLAS), 2000, 13, 1, 3, 2, 1; *Viola lanceolata* L. (Violaceae), *Rider 17* (FLAS), 1999, 14, 1, 3, 1, 1; *Viola palmata* L. (Violaceae), *Rider 186* (FLAS), 2000, 13, 1, 3, 2, 1; *Viola palmata* L. (Violaceae), *Praenza 428* (FLAS), 2006, 7, 1, 3, 2, 1; *Viola palmata* L. (Violaceae), *Rider 39* (FLAS), 1999, 14, 1, 3, 2, 1; *Viola primulifolia* L. (Violaceae), *Rider 24* (FLAS), 1999, 14, 1, 3, 2, 1; *Viola sororia* Willd. (Violaceae), *Rider 14* (FLAS), 1999, 14, 1, 3, 1, 1; *Viola sororia* Willd. (Violaceae), *Rider 46* (FLAS), 1999, 14, 1, 3, 2, 1; *Ampelopsis arborea* (L.) Koehne (Vitaceae), *Rider 256* (FLAS), 2000, 13, 1, 3, 2, 1; *Parthenocissus quinquefolia* (L.) Planch. (Vitaceae), *Mercurio & Wagamon 65* (FLAS), 1997, 16, 0, 1, 2, 3; *Vitis aestivalis* Michx. (Vitaceae), *Rider 293* (FLAS), 2000, 13, 0, 0, 1, 2; *Vitis cinerea* (Engelm.) Engelm. ex Millardet (Vitaceae), *Rider 286* (FLAS), 2000, 13, 1, 1, 1, 2; *Vitis rotundifolia* Michx. (Vitaceae), *Rider 130* (FLAS), 1999, 14, 0, 0, 0, 1; *Vitis rotundifolia* Michx. (Vitaceae), *Rider 317* (FLAS), 2000, 13, 1, 1, 1, 1; *Vitis rotundifolia* Michx. (Vitaceae), *Mercurio & Wagamon 17* (FLAS), 1997, 16, 0, 0, 1, 2; *Xyris* L. (Xyridaceae), *Mercurio & Wagamon 12* (FLAS), 1997, 16, 0, 0, 1, 2; *Zamia pumila* L. (Zamiaceae), *Rider 184* (FLAS), 2000, 13, 1, 3, 1, 2. **Abbott Collection data set from herbarium specimens:** *Alternanthera philoxeroides* (Mart.) Griseb. (Amaranthaceae), *Abbott 3230* (FLAS), 1992, 21, 0, 0, 1, 2; *Toxicodendron pubescens* Mill. (Anacardiaceae), *Abbott 10812* (FLAS), 1997, 16, 0, 0, 0, 1; *Eryngium prostratum* Nutt. ex DC. (Apiaceae), *Abbott 3634* (FLAS), 1992, 21, 0, 0, 0, 1; *Ptilimnium capillaceum* (Michx.) Raf. (Apiaceae), *Abbott 1775* (FLAS), 1992, 21, 0, 0, 1, 2; *Ptilimnium capillaceum* (Michx.) Raf. (Apiaceae), *Abbott 1791* (FLAS), 1992, 21, 0, 0, 0, 1; *Trepocarpus aethusae* Nutt. ex DC. (Apiaceae), *Abbott 3213* (FLAS), 1992, 21, 1, 1, 2, 3; *Asclepias perennis* Walter (Apocynaceae), *Abbott 3630* (FLAS), 1992, 21, 0, 0, 0, 1; *Ilex coriacea* (Pursh) Chapm. (Aquifoliaceae), *Abbott 10792* (FLAS), 1997, 16, 0, 0, 0, 1; *Ilex coriacea* (Pursh) Chapm. (Aquifoliaceae), *Abbott 6683* (FLAS), 1994, 19, 0, 0, 0, 1; *Ilex* L. (Aquifoliaceae), *Abbott 14188* (FLAS), 2001, 12, 1, 1, 2, 3; *Ilex x meserveae* S.Y. Hu (Aquifoliaceae), *Abbott 14187* (FLAS), 2001, 12, 0, 0, 1, 2; *Wolffia columbiana* H. Karst. (Araceae), *Abbott 19630* (FLAS), 2004, 9, 1, 3, 1, 2; *Araucaria bidwillii* Hook. (Araucariaceae), *Abbott 12936a* (FLAS), 1999, 14, 0, 0, 1, 2; *Butia capitata* (Mart.) Becc. (Arecaceae), *Abbott 6702* (FLAS), 1994, 19, 1, 3, 1, 2; *Asparagus setaceus* (Kunth) Jessop (Asparagaceae), *Abbott 1828* (FLAS), 1992, 21, 0, 0, 0, 1; *Asplenium platyneuron* (L.) Britton, Sterns & Poggenb. (Aspleniaceae), *Abbott 7978* (FLAS), 1994, 19, 0, 0, 0, 1; *Spilanthes oppositifolia* (Lam.) D'Arcy (Asteraceae), *Abbott 3209* (FLAS), 1992, 21, 0, 0, 0, 1; *Ambrosia trifida* L. (Asteraceae), *Abbott 14352* (FLAS), 2001, 12, 1, 1, 1, 2; *Coreopsis tinctoria* Nutt. (Asteraceae), *Abbott 1774* (FLAS), 1992, 21, 0, 0, 1, 2; *Emilia fosbergii* Nicolson (Asteraceae), *Abbott 1802* (FLAS), 1992, 21, 0, 0, 0, 1; *Gamochaeta falcata* (Lam.) Cabrera (Asteraceae), *Abbott 1805* (FLAS), 1992, 21, 0, 0, 0, 1; *Soliva anthemifolia* (Juss.) Sweet (Asteraceae), *Abbott 6694* (FLAS), 1994, 19, 0, 0, 0, 1; *Mikania scandens* (L.) Willd. (Asteraceae), *Abbott 3207* (FLAS), 1992, 21, 0, 0, 0, 1; *Palafoxia feayi* A. Gray (Asteraceae), *Abbott 17794* (FLAS), 2003, 10, 1, 3, 1, 1; *Palafoxia feayi* A. Gray (Asteraceae), *Abbott 17793* (FLAS), 2003, 10, 0, 0, 1, 2; *Pluchea baccharis* (Mill.) Pruski (Asteraceae), *Abbott 3632* (FLAS), 1992, 21, 0, 0, 0, 1; *Nandina domestica* Thunb. (Berberidaceae), *Abbott 11368* (FLAS), 1998, 15, 0, 0, 0, 1; *Tecoma capensis* (Thunb.) Lindl. (Bignoniaceae), *Abbott 6704* (FLAS), 1994, 19, 0, 0, 1, 2; *Woodwardia areolata* (L.) T. Moore (Blechnaceae), *Abbott 7984* (FLAS), 1994, 19, 0, 0, 0, 1; *Lepidium virginicum* L. (Brassicaceae), *Abbott 1798* (FLAS), 1992, 21, 0, 0, 0, 1; *Raphanus raphanistrum* L. (Brassicaceae), *Abbott 6692* (FLAS), 1994, 19, 0, 0, 1, 1; *Tillandsia recurvata* (L.) L.

(Bromeliaceae), *Abbott 1837* (FLAS), 1992, 21, 0, 0, 0, 0; *Epiphyllum oxypetalum* (DC.) Haw. (Cactaceae), *Abbott 6703* (FLAS), 1994, 19, 0, 0, 0, 0; *Lobelia brevifolia* Nutt. ex A. DC. (Campanulaceae), *Abbott 10793* (FLAS), 1997, 16, 1, 1, 2, 3; *Triodanis perfoliata* (L.) Nieuwl. (Campanulaceae), *Abbott 6681* (FLAS), 1994, 19, 1, 1, 1, 2; *Triodanis perfoliata* (L.) Nieuwl. (Campanulaceae), *Abbott 6693* (FLAS), 1994, 19, 1, 1, 1, 1; *Wahlenbergia marginata* (Thunb.) A. DC. (Campanulaceae), *Abbott 6679* (FLAS), 1994, 19, 0, 0, 0, 1; *Wahlenbergia marginata* (Thunb.) A. DC. (Campanulaceae), *Abbott 10811* (FLAS), 1997, 16, 0, 0, 0, 1; *Humulus lupulus* L. (Cannabaceae), *Abbott 13191* (FLAS), 2000, 13, 1, 1, 1, 2; *Lonicera fragrantissima* Lindl. & Paxton (Caprifoliaceae), *Abbott 11364* (FLAS), 1998, 15, 0, 0, 1, 2; *Paronychia americana* (Nutt.) Fenzl ex Walp. (Caryophyllaceae), *Abbott 3655* (FLAS), 1992, 21, 1, 3, 1, 2; *Paronychia erecta* (Chapm.) Shinners (Caryophyllaceae), *Abbott 10806* (FLAS), 1997, 16, 0, 0, 1, 2; *Maytenus* Molina (Celastraceae), *Abbott 19618* (FLAS), 2004, 9, 1, 3, 2, 1; *Lechea* L. (Cistaceae), *Abbott 3637* (FLAS), 1992, 21, 0, 0, 0, 1; *Lechea* L. (Cistaceae), *Abbott 17804* (FLAS), 2003, 10, 0, 1, 1, 1; *Lechea* L. (Cistaceae), *Abbott 17799* (FLAS), 2003, 10, 0, 0, 0, 1; *Lechea tenuifolia* Michx. (Cistaceae), *Abbott 14380* (FLAS), 2001, 12, 0, 0, 1, 2; *Polanisia tenuifolia* Torr. & A. Gray (Cleomaceae), *Abbott 10807* (FLAS), 1997, 16, 0, 0, 1, 2; *Clethra alnifolia* L. (Clethraceae), *Abbott 10794* (FLAS), 1997, 16, 0, 0, 1, 2; *Laguncularia racemosa* (L.) C.F. Gaertn. (Combretaceae), *Abbott 17792* (FLAS), 2003, 10, 0, 0, 0, 1; *Merremia dissecta* (Jacq.) Hallier f. (Convolvulaceae), *Abbott 3793* (FLAS), 1992, 21, 0, 0, 1, 2; *Melothria pendula* L. (Cucurbitaceae), *Abbott 3794* (FLAS), 1992, 21, 0, 0, 1, 2; *Juniperus virginiana* L. (Cupressaceae), *Abbott 1823* (FLAS), 1992, 21, 0, 0, 1, 2; *Metasequoia glyptostroboides* Hu & W.C. Cheng (Cupressaceae), *Abbott 11367* (FLAS), 1998, 15, 0, 0, 0, 1; *Cycas circinalis* L. (Cycadaceae), *Abbott 10896* (FLAS), 1997, 16, 0, 0, 1, 2; *Bulbostylis* Kunth (Cyperaceae), *Abbott 17797* (FLAS), 2003, 10, 0, 0, 1, 2; *Carex cephalophora* Muhl. ex Willd. (Cyperaceae), *Abbott 6700* (FLAS), 1994, 19, 1, 1, 1, 1; *Carex festucacea* Schkuhr ex Willd. (Cyperaceae), *Abbott 6701* (FLAS), 1994, 19, 0, 1, 1, 1; *Carex lupuliformis* Sartwell ex Dewey (Cyperaceae), *Abbott 3211* (FLAS), 1992, 21, 0, 0, 0, 1; *Carex* L. (Cyperaceae), *Abbott 3647* (FLAS), 1992, 21, 0, 0, 1, 2; *Cyperus croceus* Vahl (Cyperaceae), *Abbott 14370* (FLAS), 2001, 12, 1, 1, 1, 2; *Cyperus distinctus* Steud. (Cyperaceae), *Abbott 3620* (FLAS), 1992, 21, 0, 0, 0, 1; *Cyperus filiculmis* Vahl (Cyperaceae), *Abbott 10810* (FLAS), 1997, 16, 0, 0, 0, 1; *Cyperus iria* L. (Cyperaceae), *Abbott 3212* (FLAS), 1992, 21, 0, 0, 0, 1; *Pycreus polystachyos* (Rottb.) P. Beauv. (Cyperaceae), *Abbott 3644* (FLAS), 1992, 21, 0, 0, 0, 1; *Cyperus surinamensis* Rottb. (Cyperaceae), *Abbott 3618* (FLAS), 1992, 21, 0, 0, 0, 1; *Eleocharis radicans* (Poir.) Kunth (Cyperaceae), *Abbott 14846* (FLAS), 2002, 11, 1, 1, 1, 2; *Fimbristylis* Vahl (Cyperaceae), *Abbott 3625* (FLAS), 1992, 21, 0, 0, 0, 1; *Fuirena squarrosa* Michx. (Cyperaceae), *Abbott 3658* (FLAS), 1992, 21, 0, 0, 1, 2; *Kyllinga brevifolia* Rottb. (Cyperaceae), *Abbott 3614* (FLAS), 1992, 21, 0, 0, 0, 1; *Rhynchospora colorata* (L.) H. Pfeiff. (Cyperaceae), *Abbott 3628* (FLAS), 1992, 21, 0, 0, 0, 1; *Rhynchospora colorata* (L.) H. Pfeiff. (Cyperaceae), *Abbott 1790* (FLAS), 1992, 21, 0, 0, 0, 1; *Rhynchospora inexpansa* (Michx.) Vahl (Cyperaceae), *Abbott 14374* (FLAS), 2001, 12, 0, 0, 1, 2; *Rhynchospora* Vahl (Cyperaceae), *Abbott 3717* (FLAS), 1992, 21, 0, 0, 0, 1; *Rhynchospora* Vahl (Cyperaceae), *Abbott 3623* (FLAS), 1992, 21, 0, 0, 0, 1; *Rhynchospora* Vahl (Cyperaceae), *Abbott 3648* (FLAS), 1992, 21, 0, 0, 0, 1; *Cliftonia monophylla* (Lam.) Britton ex Sarg. (Cyrillaceae), *Abbott 10797* (FLAS), 1997, 16, 0, 0, 0, 1; *Cliftonia monophylla* (Lam.) Britton ex Sarg. (Cyrillaceae), *Abbott 6686* (FLAS), 1994, 19, 0, 0, 1, 2; *Diospyros virginiana* L. (Ebenaceae), *Abbott 3217* (FLAS), 1992, 21, 0, 0, 0, 1; *Chimaphila maculata* (L.) Pursh (Ericaceae), *Abbott 11371* (FLAS), 1998, 15, 0, 0, 1, 2; *Gaylussacia dumosa* (Andrews) A. Gray (Ericaceae), *Abbott 6682* (FLAS), 1994, 19, 0, 0, 0, 1; *Gaylussacia dumosa* (Andrews) A. Gray (Ericaceae), *Abbott 6685* (FLAS), 1994, 19, 0, 0, 0, 1; *Gaylussacia frondosa* (L.) Torr. & A. Gray (Ericaceae), *Abbott 6684* (FLAS), 1994, 19, 0, 0, 0, 1; *Leucothoe racemosa* (L.) A. Gray (Ericaceae), *Abbott 6687* (FLAS), 1994, 19, 0, 1, 2, 3; *Rhododendron* L. (Ericaceae), *Abbott 6688* (FLAS), 1994, 19, 0, 1, 1, 2; *Vaccinium arboreum* Marshall (Ericaceae), *Abbott 6596* (FLAS), 1994, 19, 0, 0, 0, 1; *Vaccinium myrsinites* Lam. (Ericaceae), *Abbott 6691* (FLAS), 1994, 19, 0, 0, 0, 1; *Zenobia pulverulenta* (W. Bartram ex Willd.) Pollard (Ericaceae), *Abbott 14375* (FLAS), 2001, 12, 0, 0, 0, 1; *Eriocaulon compressum* Lam. (Eriocaulaceae), *Abbott 10787* (FLAS), 1997, 16, 0, 0, 0, 1; *Lachnocaulon anceps* (Walter) Morong (Eriocaulaceae), *Abbott 3612* (FLAS), 1992, 21, 0, 0, 0, 1; *Syngonanthus flavidulus* (Michx.) Ruhland (Eriocaulaceae), *Abbott 6677* (FLAS), 1994, 19, 0, 0, 0, 1; *Erythroxylum coca* Lam. (Erythroxylaceae), *Abbott 14376* (FLAS), 2001, 12, 0, 0, 1, 2; *Acalypha gracilens* A. Gray (Euphorbiaceae), *Abbott 3788* (FLAS), 1992, 21, 0, 0, 0, 1; *Euphorbia hypericifolia* L. (Euphorbiaceae), *Abbott 1768* (FLAS), 1992, 21, 0, 0, 0, 1; *Cnidoscolus urens* (L.) Arthur (Euphorbiaceae), *Abbott 3796* (FLAS), 1992, 21, 0, 0, 1, 2; *Croton michauxii* G.L. Webster (Euphorbiaceae), *Abbott 3639* (FLAS), 1992, 21, 0, 0, 0, 1; *Euphorbia cyathophora* Murray (Euphorbiaceae), *Abbott 6705* (FLAS), 1994, 19, 1, 1, 1, 2; *Euphorbia floridana* Chapm. (Euphorbiaceae), *Abbott 10808* (FLAS), 1997, 16, 0, 0, 0, 1; *Sapium sebiferum* (L.) Roxb. (Euphorbiaceae), *Abbott 3801* (FLAS), 1992, 21, 0, 0, 1, 2; *Amorpha fruticosa* L. (Fabaceae), *Abbott 3206* (FLAS), 1992, 21, 0, 0, 0, 1; *Dalbergia ecastaphyllum* (L.) Taub. (Fabaceae), *Abbott 17791* (FLAS), 2003, 10, 1, 1, 1, 2; *Desmanthus* Willd. (Fabaceae), *Abbott 3218* (FLAS), 1992, 21, 1, 1, 2, 3; *Lupinus perennis* L. (Fabaceae), *Abbott 10814* (FLAS), 1997, 16, 0, 1, 2, 3; *Pongamia pinnata* (L.) Pierre (Fabaceae), *Abbott 17902* (FLAS), 2003, 10, 0, 0, 1, 2; *Rhynchosia cytisoides* (Bertol.) Wilbur (Fabaceae), *Abbott 10815* (FLAS), 1997, 16, 0, 0, 0, 1; *Vicia acutifolia* Elliott (Fabaceae), *Abbott 6695* (FLAS), 1994, 19, 0, 0, 1, 2; *Quercus pumila* Walter (Fagaceae), *Abbott 10802* (FLAS), 1997, 16, 0, 0, 0, 1; *Quercus* L. (Fagaceae), *Abbott 17802* (FLAS), 2003, 10, 0, 0, 1, 2; *Sabatia campanulata* (L.) Torr. (Gentianaceae), *Abbott 3653* (FLAS), 1992, 21, 0, 0, 0, 0; *Sabatia grandiflora* (A. Gray) Small (Gentianaceae), *Abbott 3643* (FLAS), 1992, 21, 0, 0, 0, 1; *Sabatia grandiflora* (A. Gray) Small (Gentianaceae), *Abbott 3659* (FLAS), 1992, 21, 0, 0, 0, 0; *Lachnanthes caroliniana* (Lam.) Dandy (Haemodoraceae), *Abbott 10795* (FLAS), 1997, 16, 1, 1, 1, 1; *Lachnanthes caroliniana* (Lam.) Dandy (Haemodoraceae), *Abbott 3633* (FLAS), 1992, 21, 0, 0, 0, 1; *Proserpinaca palustris* L. (Haloragaceae), *Abbott 1767* (FLAS), 1992, 21, 0, 0, 0, 1; *Egeria densa* Planch. (Hydrocharitaceae), *Abbott 3789* (FLAS), 1992, 21, 0, 0, 1, 2; *Hypericum hypericoides* (L.) Crantz (Hypericaceae), *Abbott 6689* (FLAS), 1994, 19, 0, 1, 1, 2; *Hypericum suffruticosum* W.P. Adams & N. Robson (Hypericaceae), *Abbott 3622* (FLAS), 1992, 21, 0, 0, 0, 1; *Hypericum tetrapetalum* Lam. (Hypericaceae), *Abbott 3660* (FLAS), 1992, 21, 0, 0, 0, 1; *Crocus vernus* Hill (Iridaceae), *Abbott 11369* (FLAS), 1998, 15, 0, 0, 0, 1; *Isoetes flaccida* A. Braun (Isoetaceae), *Abbott 18460* (FLAS), 2003, 10, 0, 0, 0, 0; *Carya floridana* Sarg. (Juglandaceae), *Abbott 17801* (FLAS), 2003, 10, 0, 0, 2, 3; *Juncus megacephalus* M.A. Curtis (Juncaceae), *Abbott 1786* (FLAS), 1992, 21, 0, 0, 0, 1; *Calamintha ashei* (Weath.) Shinners (Lamiaceae), *Abbott 10805* (FLAS), 1997, 16, 1, 1, 2, 3; *Calamintha dentata* Chapm. (Lamiaceae), *Abbott 10804* (FLAS), 1997, 16, 0, 0, 1, 2; *Conradina* A. Gray (Lamiaceae), *Abbott 17796* (FLAS), 2003, 10, 1, 1, 1, 1; (Lauraceae), *Abbott 19143* (FLAS), 2004, 9, 1, 1, 1, 1; *Linum floridanum* (Planch.) Trel. (Linaceae), *Abbott 10796* (FLAS), 1997, 16, 0, 0, 1, 2; *Lindernia anagallidea* (Michx.) Pennell (Linderniaceae), *Abbott 3214* (FLAS), 1992, 21, 0, 0, 0, 1; *Lindernia grandiflora* Nutt. (Linderniaceae), *Abbott 3641* (FLAS), 1992, 21, 0, 0, 0, 1; *Micranthemum glomeratum* (Chapm.) Shinners (Linderniaceae), *Abbott 3611* (FLAS), 1992, 21, 0, 0, 0, 1; *Eucnide* Zucc. (Loasaceae), *Abbott 19852* (FLAS), 2005, 8, 1, 1, 1, 2; *Mitreola petiolata* (Walter ex J.F. Gmel.) Torr. & A. Gray (Loganiaceae), *Abbott 3616* (FLAS), 1992, 21, 0, 0, 0, 1; *Lythrum alatum* Pursh (Lythraceae), *Abbott 3631* (FLAS), 1992, 21, 0, 0, 0, 1; *Gossypium hirsutum* L. (Malvaceae), *Abbott 3216* (FLAS), 1992, 21, 0, 0, 0, 1; *Melia azedarach* L. (Meliaceae), *Abbott 3800* (FLAS), 1992, 21, 0, 0, 1, 2; *Cocculus carolinus* (L.) DC. (Menispermaceae), *Abbott 14382* (FLAS), 2001, 12, 0, 0, 1, 2; *Melaleuca quinquenervia* (Cav.) S.T. Blake (Myrtaceae), *Abbott 3787* (FLAS), 1992, 21, 0, 0, 0, 1; *Lophiola americana* (Pursh) A. Wood (Nartheciaceae), *Abbott 10798* (FLAS), 1997, 16, 0, 0, 0, 1; *Osmanthus americanus* (L.) Benth. & Hook. f. ex A. Gray (Oleaceae), *Abbott 17795* (FLAS), 2003, 10, 0, 1, 1, 1; *Ludwigia peploides* (Kunth) P.H. Raven (Onagraceae), *Abbott 3201* (FLAS), 1992, 21, 0, 1, 1, 1; *Oenothera humifusa* Nutt. (Onagraceae), *Abbott 17803* (FLAS), 2003, 10, 0, 0, 0, 1; *Ophioglossum nudicaule* L. f. (Ophioglossaceae), *Abbott 19180* (FLAS), 2004, 9, 0, 0, 1, 2; *Habenaria repens* Nutt. (Orchidaceae), *Abbott 3651* (FLAS), 1992, 21, 0, 0, 0, 1; *Buchnera americana* L. (Orobanchaceae), *Abbott 3624* (FLAS), 1992, 21, 0, 0, 0, 1; *Passiflora pallida* L. (Passifloraceae), *Abbott 18103* (FLAS), 2003, 10, 1, 1, 1, 1; *Petenaea cordata* Lundell (Petenaeaceae), *Abbott 19767* (FLAS), 2005, 8, 0, 0, 1, 2; *Astrocasia jacobinensis* (Müll. Arg.) G.L. Webster (Phyllanthaceae), *Abbott 16262* (FLAS), 1995, 18, 0, 0, 1, 2; *Bacopa caroliniana* (Walter) B.L. Rob. (Plantaginaceae), *Abbott 3652* (FLAS), 1992, 21, 1, 1, 2, 3; *Gratiola hispida* (Benth. ex Lindl.) Pollard (Plantaginaceae), *Abbott 3644* (FLAS), 1992, 21, 0, 0, 0, 1; *Linaria canadensis* (L.) Dum. Cours. (Plantaginaceae), *Abbott 1794* (FLAS), 1992, 21, 0, 0, 0, 1; *Plantago virginica* L. (Plantaginaceae), *Abbott 1806* (FLAS), 1992, 21, 0, 0, 0, 1; *Scoparia dulcis* L. (Plantaginaceae), *Abbott 3636* (FLAS), 1992, 21, 0, 0, 0, 1; *Scoparia dulcis* L. (Plantaginaceae), *Abbott 1771* (FLAS), 1992, 21, 0, 0, 0, 1; *Andropogon virginicus* L. (Poaceae), *Abbott 3613* (FLAS), 1992, 21, 0, 0, 0, 1; *Cenchrus incertus* M.A. Curtis (Poaceae), *Abbott 1818* (FLAS), 1992, 21, 0, 0, 0, 1; *Cynodon dactylon* (L.) Pers. (Poaceae), *Abbott 1819* (FLAS), 1992, 21, 0, 0, 1, 2; *Dichanthelium chamaelonche* (Trin.) Freckmann & Lelong (Poaceae), *Abbott 17805* (FLAS), 2003, 10, 1, 1, 2, 3; *Eragrostis* Wolf (Poaceae), *Abbott 3633* (FLAS), 1992, 21, 0, 0, 0, 1; *Eustachys* Desv. (Poaceae), *Abbott 1821* (FLAS), 1992, 21, 0, 0, 1, 2; *Eustachys* Desv. (Poaceae), *Abbott 3626* (FLAS), 1992, 21, 0, 0, 0, 1; *Coleataenia longifolia* subsp. *rigidula* (Bosc ex Nees) Soreng (Poaceae), *Abbott 3629* (FLAS), 1992, 21, 0, 0, 0, 1; *Paspalum setaceum* Michx. (Poaceae), *Abbott 3649* (FLAS), 1992, 21, 0, 0, 0, 1; *Paspalum* L. (Poaceae), *Abbott 3615* (FLAS), 1992, 21, 0, 0, 0, 1; *Paspalum* L. (Poaceae), *Abbott 3647* (FLAS), 1992, 21, 0, 0, 0, 1; *Paspalum urvillei* Steud. (Poaceae), *Abbott 3619* (FLAS), 1992, 21, 0, 0, 0, 1; *Paspalum vaginatum* Sw. (Poaceae), *Abbott 3627* (FLAS), 1992, 21, 0, 0, 0, 1; *Sacciolepis striata* (L.) Nash (Poaceae), *Abbott 3621* (FLAS), 1992, 21, 0, 0, 0, 1; *Setaria parviflora* (Poir.) Kerguélen (Poaceae), *Abbott 3215* (FLAS), 1992, 21, 0, 0, 0, 1; *Polygala boykinii* Nutt. (Polygalaceae), *Abbott 14371* (FLAS), 2001, 12, 0, 0, 0, 1; *Polygala incarnata* L. (Polygalaceae), *Abbott 14379* (FLAS), 2001, 12, 0, 0, 1, 2; *Polygala lutea* L. (Polygalaceae), *Abbott 6678* (FLAS), 1994, 19, 0, 0, 0, 1; *Polygala nuttallii* Torr. & A. Gray (Polygalaceae), *Abbott 14373* (FLAS), 2001, 12, 0, 0, 1, 2; *Polygala polygama* Walter (Polygalaceae), *Abbott 14372* (FLAS), 2001, 12, 0, 0, 0, 1; *Polygala verticillata* L. (Polygalaceae), *Abbott 14378* (FLAS), 2001, 12, 0, 0, 0, 1; *Antigonon leptopus* Hook. & Arn. (Polygonaceae), *Abbott 3786* (FLAS), 1992, 21, 0, 0, 0, 1; *Eriogonum tomentosum* Michx. (Polygonaceae), *Abbott 10803* (FLAS), 1997, 16, 0, 0, 0, 1; *Rumex hastatulus* Baldwin (Polygonaceae), *Abbott 6553* (FLAS), 1994, 19, 0, 0, 0, 1; *Oldenlandia uniflora* L. (Rubiaceae), *Abbott 3654* (FLAS), 1992, 21, 0, 0, 0, 1; *Richardia brasiliensis* Gomes (Rubiaceae), *Abbott 3802* (FLAS), 1992, 21, 1, 2, 1, 3; *Richardia brasiliensis* Gomes (Rubiaceae), *Abbott 1795* (FLAS), 1992, 21, 0, 0, 0, 1; *Richardia scabra* L. (Rubiaceae), *Abbott 3803* (FLAS), 1992, 21, 1, 1, 1, 2; *Spermacoce remota* Lam. (Rubiaceae), *Abbott 1769* (FLAS), 1992, 21, 0, 0, 1, 2; *Citrus aurantiifolia* (Christm.) Swingle (Rutaceae), *Abbott 6711* (FLAS), 1994, 19, 1, 3, 1, 2; *Acer saccharinum* L. (Sapindaceae), *Abbott 11366* (FLAS), 1998, 15, 0, 0, 1, 2; *Cardiospermum halicacabum* L. (Sapindaceae), *Abbott 3219* (FLAS), 1992, 21, 0, 1, 2, 3; *Euscaphis japonica* (Thunb. ex Roem. & Schult.) Dippel (Staphyleaceae), *Abbott 14377* (FLAS), 2001, 12, 0, 0, 1, 2; *Styrax americanus* Lam. (Styracaceae), *Abbott 6696* (FLAS), 1994, 19, 0, 0, 1, 2; *Polypremum procumbens* L. (Tetrachondraceae), *Abbott 3642* (FLAS), 1992, 21, 1, 2, 1, 3; *Phyla nodiflora* (L.) Greene (Verbenaceae), *Abbott 3635* (FLAS), 1992, 21, 0, 0, 0, 1; *Hybanthus* Jacq. (Violaceae), *Abbott 19766* (FLAS), 2005, 8, 1, 3, 2, 1; *Viola pedata* L. (Violaceae), *Abbott 14381* (FLAS), 2001, 12, 0, 0, 1, 2; *Ximenia americana* L. (Ximeniaceae), *Abbott 17806* (FLAS), 2003, 10, 0, 0, 1, 2.

B) Herbarium samples for age discrimination. ***Asimina*** **(Annonaceae) data set from herbarium specimens:** *Asimina incana* (W. Bartram) Exell, *Antoni-Dewald s.n.* (FLAS), 1984, 29, 1, 3, 1, 2; *A. incana*, *Arnold s.n.* (FLAS), 1941, 72, 0, 0, 1, 2; *A. incana*, *Bailey 35* (FLAS), 1991, 22, 0, 1, 1, 2; *A. incana*, *Buckner 340* (FLAS), 1991, 22, 0, 1, 2, 3; *A. incana*, *Carr 5352* (FLAS), 2001, 12, 0, 1, 1, 1; *A. incana*, *Casey E2* (FLAS), 1966, 47, 0, 1, 1, 2; *A. incana*, *Cooley & Eaton 6591* (FLAS), 1959, 54, 0, 0, 0, 1; *A. incana*, *D'Arcy 1503* (FLAS), 1967, 46, 0, 0, 1, 2; *A. incana*, *D'Arcy 1549* (FLAS), 1967, 46, 0, 0, 0, 1; *A. incana*, *DeLaney 3071c* (FLAS), 1998, 15, 0, 1, 1, 2; *A. incana*, *Easley 765* (FLAS), 1988, 25, 1, 3, 1, 2; *A. incana*, *Equihua 33* (FLAS), 1988, 25, 1, 3, 1, 2; *A. incana*, *Haring & Hoffmann 4* (FLAS), 2007, 6, 1, 3, 2, 1; *A. incana*, *Herring 1160* (FLAS), 1993, 20, 1, 3, 2, 1; *A. incana*, *Herring 648* (FLAS), 1992, 21, 1, 1, 1, 2; *A. incana*, *Hornby s.n.* (FLAS), 1989, 24, 0, 1, 1, 2;

A. incana, Hume s.n. (FLAS), 1937, 76, 0, 0, 0, 1; *A. incana, Kral 2277* (FLAS), 1956, 57, 0, 0, 0, 1; *A. incana, Kral 2711* (FLAS), 1956, 57, 0, 0, 1, 2; *A. incana, Layne s.n.* (FLAS), 1893, 120, 0, 0, 0, 1; *A. incana, Majure 3035* (FLAS), 2008, 5, 1, 3, 1, 1; *A. incana, Martin 1003* (FLAS), 1977, 36, 0, 0, 0, 1; *A. incana, Martin 1009* (FLAS), 1977, 36, 0, 1, 1, 2; *A. incana, Murrill s.n.* (FLAS), 1925, 88, 0, 0, 0, 1; *A. incana, Penneys 1479* (FLAS), 2002, 11, 0, 0, 1, 2; *A. incana, Skean 1602* (FLAS), 1985, 28, 0, 1, 1, 2; *A. incana, Skean 1603* (FLAS), 1985, 28, 1, 3, 1, 2; *A. incana, Tan 443* (FLAS), 1990, 23, 0, 0, 1, 2; *A. incana, Viers 1* (FLAS), 1993, 20, 1, 3, 1, 2; *A. incana, Ward 1232* (FLAS), 1959, 54, 0, 0, 0, 1; *A. incana, Ward 3442* (FLAS), 1963, 50, 0, 0, 0, 1; *A. incana, Ward 4502* (FLAS), 1965, 48, 0, 0, 0, 1; *A. incana, Ward 4557* (FLAS), 1965, 48, 1, 0, 0, 1; *A. incana, West & Arnold s.n.* (FLAS), 1941, 72, 0, 0, 0, 1; *A. incana, West & Arnold s.n.* (FLAS), 1946, 67, 0, 0, 0, 1; *A. incana, West & Arnold s.n.* (FLAS), 1940, 73, 0, 0, 0, 1; *A. incana, West s.n.* (FLAS), 1939, 74, 0, 0, 0, 1; *A. incana, Wiggins 19721* (FLAS), 1965, 48, 0, 1, 1, 2; *A. longifolia* Kral, *Arnold & West s.n.* (FLAS), 1946, 67, 0, 1, 1, 2; *A. longifolia, Arnold & West s.n.* (FLAS), 1937, 76, 0, 0, 0, 1; *A. longifolia, Arnold & West s.n.* (FLAS), 1935, 78, 0, 1, 2, 3; *A. longifolia, Arnold s.n.* (FLAS), 1931, 82, 0, 0, 1, 2; *A. longifolia, Beckner 1253* (FLAS), 1966, 47, 0, 1, 2, 3; *A. longifolia, Bryan s.n.* (FLAS), 1985, 28, 0, 1, 1, 2; *A. longifolia, Gulledge 313* (FLAS), 1997, 16, 1, 3, 1, 3; *A. longifolia, Herring 728* (FLAS), 1992, 21, 0, 1, 1, 2; *A. longifolia, Kabat 59* (FLAS), 2001, 12, 1, 3, 2, 1; *A. longifolia, Kea s.n.* (FLAS), 1933, 80, 0, 0, 0, 1; *A. longifolia, Martin 1042* (FLAS), 1977, 36, 0, 1, 1, 1; *A. longifolia, Martin 1128* (FLAS), 1977, 36, 0, 1, 1, 2; *A. longifolia, Orzell & Bridges 20040* (FLAS), 1992, 21, 1, 3, 2, 1; *A. longifolia, Penneys 1116* (FLAS), 1998, 15, 1, 3, 2, 1; *A. longifolia, Skean 974* (FLAS), 1982, 31, 0, 1, 1, 2; *A. longifolia, Smith 1505* (FLAS), 1967, 46, 0, 1, 2, 3; *A. longifolia, Smith 1720* (FLAS), 1976, 37, 0, 1, 1, 2; *A. longifolia, Tan 608* (FLAS), 1990, 23, 1, 2, 2, 1; *A. longifolia, Viers 50* (FLAS), 1993, 20, 1, 3, 2, 1; *A. longifolia, Weber s.n.* (FLAS), 1927, 86, 0, 1, 2, 3; *A. longifolia, West & Arnold s.n.* (FLAS), 1941, 72, 0, 1, 1, 1; *A. longifolia, Wiggins 19748* (FLAS), 1965, 48, 0, 1, 1, 2; *A. longifolia, Wilmot s.n.* (FLAS), 1945, 68, 0, 0, 0, 0; *A. obovata* (Willd.) Nash, *Baltzell 964* (FLAS), 1969, 44, 0, 1, 1, 2; *A. obovata, Baltzell 10688* (FLAS), 1979, 34, 0, 1, 1, 2; *A. obovata, Baltzell 8269* (FLAS), 1976, 37, 0, 1, 1, 1; *A. obovata, Beckner 2325* (FLAS), 1969, 44, 0, 1, 1, 1; *A. obovata, Bradley 1622* (FLAS), 1998, 15, 1, 3, 2, 1; *A. obovata, Braun 14757* (FLAS), 1945, 68, 0, 0, 1, 2; *A. obovata, Christman 1677* (FLAS), 1987, 26, 0, 1, 1, 1; *A. obovata, Christman 381* (FLAS), 1986, 27, 1, 3, 1, 1; *A. obovata, Christman 477* (FLAS), 1986, 27, 0, 1, 1, 1; *A. obovata, Christman 527* (FLAS), 1986, 27, 0, 1, 1, 1; *A. obovata, Christman 599* (FLAS), 1986, 27, 0, 1, 1, 3; *A. obovata, Christman 890* (FLAS), 1986, 27, 0, 1, 1, 1; *A. obovata, Connard s.n.* (FLAS), 1963, 50, 0, 1, 1, 2; *A. obovata, Judd 2776* (FLAS), 1980, 33, 1, 3, 1, 1; *A. obovata, Kral 2144* (FLAS), 1956, 57, 0, 1, 1, 2; *A. obovata, Martin & Cooper 430* (FLAS), 1975, 38, 0, 0, 1, 1; *A. obovata, Martin & Cooper 461* (FLAS), 1975, 38, 0, 1, 1, 1; *A. obovata, Orzell & Bridges 16657* (FLAS), 1991, 22, 1, 3, 2, 1; *A. obovata, Ward 29* (FLAS), 1960, 53, 0, 1, 1, 2; *A. obovata, Watson & Murrill s.n.* (FLAS), 1939, 74, 0, 1, 2, 3; *A. obovata, Weber s.n.* (FLAS), 1936, 77, 0, 0, 1, 2; *A. obovata, West & Arnold s.n.* (FLAS), 1946, 67, 0, 0, 1, 2; *A. obovata, Zerba s.n.* (FLAS), 1988, 25, 1, 3, 1, 1; *A. obovata, Zona 36* (FLAS), 1982, 31, 1, 3, 1, 1; *A. parviflora* (Michx.) Dunal, *Bickner s.n.* (FLAS), 1977, 36, 0, 1, 2, 2; *A. parviflora, Ford & West s.n.* (FLAS), 1959, 54, 0, 1, 2, 2; *A. parviflora, Herring 381* (FLAS), 1991, 22, 1, 3, 2, 1; *A. parviflora, Howard s.n.* (FLAS), 2005, 8, 1, 3, 2, 1; *A. parviflora, Judd 3296* (FLAS), 1983, 30, 0, 1, 1, 2; *A. parviflora, Malone 65* (FLAS), 1979, 34, 0, 1, 1, 1; *A. parviflora, Morris 50* (FLAS), 1991, 22, 0, 1, 1, 1; *A. parviflora, Tan 716* (FLAS), 1990, 23, 1, 3, 2, 1; *A. parviflora, Thomas 110781* (FLAS), 1989, 24, 0, 0, 0, 0; *A. pygmaea* (W. Bartram) Dunal, *Amoroso 638* (FLAS), 1991, 22, 1, 3, 1, 2; *A. pygmaea, Baltzell 8407* (FLAS), 1976, 37, 0, 0, 0, 1; *A. pygmaea, Beckner 1196* (FLAS), 1966, 47, 0, 1, 2, 3; *A. pygmaea, Curtiss 6129* (FLAS), 1898, 115, 0, 0, 0, 1; *A. pygmaea, Easley 763* (FLAS), 1988, 25, 1, 3, 2, 1; *A. pygmaea, Hornby s.n.* (FLAS), 1989, 24, 1, 1, 2, 3; *A. pygmaea, Matthews & Scanlon 117* (FLAS), 2000, 13, 1, 3, 1, 1; *A. pygmaea, Orzell & Bridges 13876* (FLAS), 1990, 23, 1, 1, 1, 1; *A. pygmaea, Orzell & Bridges 199909* (FLAS), 1992, 21, 1, 3, 2, 1; *A. pygmaea, West s.n.* (FLAS), 1928, 85, 0, 0, 1, 2; *A. reticulata* Shuttlew. ex Chapm., *Arnold & West s.n.* (FLAS), 1935, 78, 0, 0, 0, 1; *A. reticulata, Baltzell 3935* (FLAS), 1972, 41, 0, 1, 2, 3; *A. reticulata, Baltzell 5803* (FLAS), 1974, 39, 0, 1, 2, 3; *A. reticulata, Beckner 1739* (FLAS), 1967, 46, 0, 1, 2, 3; *A. reticulata, Christman 1678* (FLAS), 1987, 26, 0, 1, 2, 3; *A. reticulata, Christman 1722* (FLAS), 1987, 26, 0, 1, 2, 3; *A. reticulata, Christman 351* (FLAS), 1986, 27, 0, 1, 2, 3; *A. reticulata, Cox EWR36* (FLAS), 2002, 11, 1, 3, 2, 1; *A. reticulata, Easley 764* (FLAS), 1988, 25, 0, 1, 1, 2; *A. reticulata, Goldman 2768* (FLAS), 2004, 9, 1, 3, 1, 2; *A. reticulata, Hume & West s.n.* (FLAS), 1936, 77, 0, 0, 0, 2; *A. reticulata, Kabat 285* (FLAS), 2001, 12, 1, 3, 2, 1; *A. reticulata, Kral 2068* (FLAS), 1956, 57, 0, 0, 1, 2; *A. reticulata, Kral 2124* (FLAS), 1956, 57, 0, 1, 2, 3; *A. reticulata, Lotspeich 377* (FLAS), 1978, 35, 0, 0, 1, 2; *A. reticulata, Scanlon 182* (FLAS), 2001, 12, 1, 3, 2, 1; *A. reticulata, Scanlon 322* (FLAS), 2002, 11, 0, 1, 2, 3; *A. reticulata, vanHoek & Wargo 872* (FLAS), 1997, 16, 0, 1, 2, 3; *A. reticulata, Ward B-70* (FLAS), 1961, 52, 0, 1, 1, 1; *A. reticulata, Zomlefer 712* (FLAS), 1999, 14, 1, 3, 2, 1; *A. tetramera* Small, *Kral 2517* (FLAS), 1956, 57, 0, 1, 1, 1; *A. tetramera, Orzell & Bridges 16912* (FLAS), 1991, 22, 1, 3, 2, 1; *A. triloba* (L.) Dunal, *Abbott 1935* (FLAS), 1992, 21, 1, 2, 1, 3; *A. × nashii* Kral, *Ward 1844* (FLAS), 1960, 53, 0, 1, 1, 2. ***Mikania* (Asteraceae) data set from herbarium specimens:** *Mikania* Willd., *Aymard 6231* (FLAS), 1987, 24, 0, 0, 0, 1; *Mikania* Willd., *Croat 79897* (MO), 1997, 14, 1, 3, 1, 1; *Mikania* Willd., *Hatschbach 71975* (MO), 2001, 10, 1, 1, 1, 1; *Mikania* Willd., *Huaylla 1811* (MO), 2005, 6, 1, 3, 1, 1; *Mikania* Willd., *Lewis 578* (MO), 1993, 18, 1, 3, 1, 0; *Mikania* Willd., *Morrone 1841* (MO), 1996, 15, 1, 3, 2, 1; *Mikania* Willd., *Pruski 4043* (MO), 2006, 5, 1, 1, 1, 1; *Mikania* Willd., *Ratter R3099* (MO), 1976, 35, 0, 0, 0, 1; *Mikania* Willd., *Ratter R3137* (MO), 1976, 35, 1, 1, 2, 2; *Mikania alvimii* R.M. King & H. Rob., *Harley H50729* (MO), 1992, 19, 1, 1, 1, 1; *M. anethifolia* (DC.) Matzenbacher, *Pedersen 13884* (MO), 1984, 27, 1, 3, 1, 1; *M. argyreiae* DC., *Wasum 8627* (MO), 1992, 19, 1, 1, 1, 1; *M. argyreiae, Zardini 7341* (MO), 1988, 23, 1, 1, 1, 1; *M. banisteriae* DC., *Acevedo-Rdgz. 7596* (MO), 1995, 16, 0, 0, 1, 1; *M. banisteriae, Bonaldo 1121* (MO), 1987, 24, 0, 1, 1, 2; *M. banisteriae, Dryer 1736* (MO), 1978, 33, 0, 0, 0, 1; *M. banisteriae, Goldman 2418* (MO), 1996, 15, 0, 0, 0, 1; *M. banisteriae, Kummrow*

3065 (MO), 1988, 23, 1, 1, 1, 1; *M. banisteriae*, *Rojas 2326* (MO), 2004, 7, 1, 1, 1, 1; *M. banisteriae*, *Silva 489* (MO), 1988, 23, 1, 1, 1, 1; *M. batatifolia* DC., *Lewis 7167* (MO), 1968, 43, 0, 1, 2, 3; *M. burchellii* Baker, *Hatschbach 46842* (MO), 1983, 28, 0, 0, 0, 1; *M. campanulata* Gardner, *Laner 10233* (MO), 1994, 17, 1, 1, 1, 1; *M. capensis* DC., *Banda 3457* (MO), 1989, 22, 0, 0, 0, 1; *M. capensis*, *Chapman 9249* (MO), 1988, 23, 0, 0, 1, 1; *M. capensis*, *Chikuni 168* (MO), 1989, 22, 0, 1, 2, 3; *M. capensis*, *Gentry 11396* (MO), 1974, 37, 0, 0, 1, 1; *M. capensis*, *Goldblatt 12526* (MO), 2004, 7, 1, 3, 1, 1; *M. capensis*, *Lowry 4305* (MO), 1987, 24, 0, 1, 1, 2; *M. chenopodifolia* Willd., *Croat 53482* (MO), 1981, 30, 0, 0, 0, 1; *M. chenopodifolia*, *Festo 2139* (MO), 2005, 6, 1, 3, 1, 1; *M. chenopodifolia*, *Festo 958* (MO), 2001, 10, 1, 1, 1, 1; *M. chenopodifolia*, *Jacques-Georges 16463* (MO), 1958, 53, 0, 0, 0, 1; *M. chenopodifolia*, *Kuchar 22388* (MO), 1999, 12, 1, 3, 1, 1; *M. chenopodifolia*, *Merello 1356* (MO), 1996, 15, 1, 3, 1, 1; *M. chevalieri* (C.D. Adams) W.C. Holmes & McDaniel, *Adam 30009* (MO), 1975, 36, 0, 0, 0, 1; *M. chevalieri*, *Jacques-Georges 25130* (MO), 1969, 42, 0, 1, 1, 2; *M. chlorolepis* Baker, *Hassler 9332* (MO), 1905, 106, 0, 0, 0, 1; *M. chlorolepis*, *Zuloaga 5531* (MO), 1996, 15, 0, 1, 1, 1; *M. congesta* DC., *King 10285* (MO), 1992, 19, 1, 1, 2, 3; *M. congesta*, *Liogier 32923* (MO), 1982, 29, 0, 0, 1, 2; *M. congesta*, *Nee 44166* (MO), 1993, 18, 1, 1, 1, 1; *M. congesta*, *Ruiz SAN1[illegible]8* (MO), 1992, 19, 1, 1, 1, 2; *M. congesta*, *Soria 4586* (MO), 1991, 20, 1, 1, 1, 1; *M. cordata* (Burm. f.) B.L. Rob., *Adam 30066* (MO), 1975, 36, 1, 1, 2, 3; *M. cordata*, *Baylis 10174* (MO), 1985, 26, 0, 1, 1, 1; *M. cordata*, *Cedrman 10* (MO), 1983, 28, 0, 0, 1, 2; *M. cordata*, *Carvalho 3686* (MO), 1988, 23, 1, 3, 1, 1; *M. cordata*, *Carvalho 4167* (MO), 1989, 22, 1, 1, 1, 1; *M. cordata*, *Chikuni 183* (MO), 1989, 22, 0, 0, 1, 2; *M. cordata*, *Kennedy 38* (MO), 1984, 27, 0, 0, 0, 0; *M. cordata*, *Kornas 14* (MO), 1971, 40, 0, 1, 1, 1; *M. cordata*, *Phillips 1529* (MO), 1976, 35, 0, 1, 2, 3; *M. cordata*, *Pilz 2656* (MO), 1981, 30, 0, 0, 0, 1; *M. cordata*, *Rwaburindore 1129* (MO), 1985, 26, 0, 0, 1, 2; *M. cordata*, *Tawakali 1555* (MO), 1989, 22, 1, 1, 2, 3; *M. cordifolia* (L. f.) Willd., *Alipi 1139* (MO), 1998, 13, 1, 3, 1, 1; *M. cordifolia*, *Araujo-M. 2838* (MO), 2006, 5, 1, 3, 1, 2; *M. cordifolia*, *Aymard 5246* (FLAS), 1987, 24, 0, 0, 0, 1; *M. cordifolia*, *Cristóbal 2248* (MO), 1992, 19, 1, 1, 1, 1; *M. cordifolia*, *Croat 50966* (MO), 1980, 31, 1, 3, 1, 1; *M. cordifolia*, *Fisher-Meerow 805* (FLAS), 1981, 30, 0, 0, 1, 2; *M. cordifolia*, *Jimenez 64* (FLAS), 2000, 11, 0, 1, 2, 3; *M. cordifolia*, *King 10463* (MO), 1993, 18, 1, 1, 1, 1; *M. cordifolia*, *Liesner 1534* (MO), 1974, 37, 0, 0, 0, 1; *M. cordifolia*, *Linneo 598* (MO), 2006, 5, 1, 3, 2, 1; *M. cordifolia*, *Lott 3571* (FLAS), 1991, 20, 1, 1, 1, 2; *M. cordifolia*, *Miller 5930* (MO), 1991, 20, 0, 1, 1, 1; *M. cordifolia*, *Nee 48888* (MO), 1998, 13, 1, 3, 1, 1; *M. cordifolia*, *Schinini 6875* (MO), 1973, 38, 0, 1, 2, 3; *M. cordifolia*, *Toledo 13201* (MO), 1995, 16, 1, 3, 1, 1; *M. cordifolia*, *Velazquez 27623* (MO), 1991, 20, 1, 1, 1, 2; *M. cordifolia*, *Wasum 11565* (MO), 1996, 15, 1, 3, 1, 1; *M. cordifolia*, *Wasum 5597* (MO), 1989, 22, 0, 0, 0, 1; *M. cordifolia*, *Zanoni 28005* (MO), 1983, 28, 0, 0, 0, 1; *M. cordifolia*, *Zardini 2722* (MO), 1987, 24, 1, 3, 1, 2; *M. decumbens* Malme, *Davidse 11101A* (MO), 1976, 35, 0, 0, 0, 1; *M. decumbens*, *Wasum 1396* (MO), 2002, 9, 1, 3, 1, 1; *M. dusenii* B.L. Rob., *Pedersen 15003* (MO), 1988, 23, 0, 1, 1, 1; *M. dusenii*, *Pedersen 5053* (MO), 1959, 52, 0, 0, 1, 2; *M. elliptica* DC., *Thomas 9716* (MO), 1993, 18, 0, 0, 0, 0; *M. corymbosa* W.C. Holmes, *Wright 46* (MO), 1982, 29, 0, 1, 1, 2; *M. fragilis* Urb., *King 10625* (MO), 1995, 16, 0, 0, 0, 1; *M. fulva* (Hook. & Arn.) Baker, *Pedersen 13731* (MO), 1984, 27, 0, 1, 2, 3; *M. glomerata* Spreng., *Zardini 6769* (MO), 1988, 23, 0, 0, 0, 1; *M. goyazensis* (B.L. Rob.) R.M. King & H. Rob., *King 8280* (MO), 1980, 31, 0, 0, 0, 1; *M. guaco* Bonpl., *Acosta 92* (MO), 1999, 12, 1, 3, 1, 1; *M. guaco*, *Jaramillo 200* (MO), 1994, 17, 1, 1, 1, 1; *M. guaco*, *McDaniel 23735* (MO), 1980, 31, 0, 0, 0, 1; *M. guaco*, *McDowell 692* (MO), 1982, 29, 1, 2, 1, 3; *M. guaco*, *McPherson 20723* (MO), 2008, 3, 1, 3, 1, 2; *M. guaco*, *Rimachi Y. 5619* (MO), 1981, 30, 0, 0, 1, 2; *M. hirsutissima* DC., *Krapovickas 44153* (MO), 1992, 19, 1, 1, 1, 1; *M. hirsutissima*, *Pedersen 15025* (MO), 1988, 23, 1, 1, 1, 2; *M. hirsutissima*, *Pedersen 6553* (MO), 1962, 49, 1, 1, 1, 1; *M. hirsutissima*, *Vinuzi 865* (MO), 1987, 24, 1, 1, 1, 2; *M. hoffmanniana* Dusén, *Hatschbach 54800* (MO), 1990, 21, 1, 1, 1, 1; *M. hookeriana* DC., *Mori 2102* (MO), 1974, 37, 0, 1, 1, 1; *M. hookeriana*, *Nee 7019* (MO), 1973, 38, 0, 0, 0, 1; *M. hookeriana*, *Rimachi Y. 5597* (MO), 1981, 30, 1, 1, 1, 1; *M. hookeriana*, *Rosa 12639* (MO), 1995, 16, 1, 3, 1, 1; *M. hookeriana*, *Villa 417* (MO), 2000, 11, 0, 0, 1, 1; *M. hookeriana*, *Webster 23197* (MO), 1978, 33, 0, 1, 1, 1; *M. houstoniana* (L.) B.L. Rob., *Martinez S. 8647* (MO), 1984, 27, 1, 3, 1, 1; *M. involucrata* Hook. & Arn., *Rosato 4540* (MO), 1988, 23, 0, 1, 2, 3; *M. involucrata*, *Wasum 10309* (MO), 1994, 17, 1, 3, 1, 1; *M. involucrata*, *Wasum 1559* (MO), 2002, 9, 1, 3, 1, 1; *M. laevigata* Sch. Bip. ex Baker, *Romero 4311* (MO), 1997, 14, 1, 3, 1, 1; *M. leiostachya* Benth., *Croat 13493* (MO), 1971, 40, 0, 0, 0, 1; *M. lepidophora* Urb., *Zanoni 42928* (MO), 1989, 22, 0, 0, 0, 1; *M. ligustrifolia* DC., *Hatschbach 24054* (MO), 1970, 41, 1, 3, 1, 1; *M. lindleyana*, *Vásquez 23947* (MO), 1997, 14, 1, 3, 1, 1; *M. lindleyana*, *Zardini 5697* (MO), 1988, 23, 1, 3, 1, 2; *M. lindleyana*, *Zardini 6485* (MO), 1988, 23, 1, 3, 1, 2; *M. lundiana* DC., *Hatschbach 34322* (MO), 1974, 37, 0, 0, 1, 1; *M. micrantha* Kunth, *Anderson SN* (NA), 2011, 0, 1, 3, 0, 0; *M. micrantha*, *Aymard 4491* (FLAS), 1986, 25, 0, 0, 0, 0; *M. micrantha*, *Aymard 5351* (FLAS), 1987, 24, 0, 0, 0, 0; *M. micrantha*, *Bennet 7539* (FLAS), 2004, 7, 0, 0, 0, 0; *M. micrantha*, *Berthelat 1687* (MO), 2006, 5, 1, 1, 1, 2; *M. micrantha*, *Cabrera 26148* (MO), 1974, 37, 0, 1, 1, 1; *M. micrantha*, *Carter 5184* (MO), 1986, 25, 0, 0, 0, 1; *M. micrantha*, *Castillo M. 1604* (MO), 1992, 19, 0, 0, 0, 0; *M. micrantha*, *Correa 414* (MO), 1967, 44, 0, 0, 0, 1; *M. micrantha*, *Degener 15084* (MO), 1941, 70, 0, 0, 0, 1; *M. micrantha*, *Fortunato 6838* (MO), 2000, 11, 1, 1, 1, 1; *M. micrantha*, *Garcia 5352* (MO), 1993, 18, 0, 0, 0, 1; *M. micrantha*, *Gentry 15160* (MO), 1975, 36, 0, 0, 0, 1; *M. micrantha*, *Haber 10362* (MO), 1990, 21, 1, 1, 1, 1; *M. micrantha*, *Haber 3720* (MO), 1985, 26, 0, 0, 0, 1; *M. micrantha*, *Hahn 2327* (MO), 1984, 27, 0, 0, 0, 1; *M. micrantha*, *Hammel 8162* (MO), 1980, 31, 1, 1, 1, 2; *M. micrantha*, *Harling 26818* (MO), 1993, 18, 0, 0, 1, 1; *M. micrantha*, *Higgins 94* (MO), 1994, 17, 0, 0, 0, 1; *M. micrantha*, *House 1810* (MO), 1994, 17, 1, 1, 1, 1; *M. micrantha*, *Jaramillo 266* (MO), 1994, 17, 0, 0, 0, 1; *M. micrantha*, *King 10646* (MO), 1996, 15, 0, 0, 0, 1; *M. micrantha*, *King 12106* (MO), 2002, 9, 1, 3, 1, 2; *M. micrantha*, *Korning 47019* (MO), 1983, 28, 0, 0, 0, 1; *M. micrantha*, *Liesner 487* (MO), 1973, 38, 0, 0, 0, 1; *M. micrantha*, *Luna 19901* (MO), 1988, 23, 0, 3, 1, 2; *M. micrantha*, *Madriñan 106* (MO), 1989, 22, 0, 0, 0, 1; *M. micrantha*, *Martinez S. 31777* (MO), 1999, 12, 1, 3, 1, 1; *M. micrantha*, *Mason 3412* (MO), 1980, 31, 0, 0, 0, 1; *M. micrantha*, *McDan-*

sel 17321 (MO), 1973, 38, 0, 1, 2, 3; *M. micrantha*, *McPherson 6618* (MO), 1984, 27, 0, 0, 0, 1; *M. micrantha*, *Melon 12122* (MO), 1997, 14, 1, 3, 1, 2; *M. micrantha*, *Moreno 5209* (MO), 1980, 31, 0, 0, 0, 1; *M. micrantha*, *Morrone 219* (MO), 1992, 19, 1, 1, 1, 1; *M. micrantha*, *NA* (MO), 2007, 4, 1, 3, 1, 1; *M. micrantha*, *Nee 29308* (MO), 1984, 27, 0, 0, 0, 1; *M. micrantha*, *Neill 844* (MO), 1976, 35, 0, 0, 0, 1; *M. micrantha*, *Novelo R. 2249* (MO), 1998, 13, 1, 3, 1, 2; *M. micrantha*, *Overholt MS304* (NA), 2011, 0, 1, 3, 2, 1; *M. micrantha*, *Rios 90* (MO), 1984, 27, 0, 0, 1, 1; *M. micrantha*, *Rondeau 187* (MO), 1982, 29, 0, 0, 0, 1; *M. micrantha*, *Ros SAN297* (MO), 1992, 19, 1, 3, 1, 2; *M. micrantha*, *Sandoval 1485* (MO), 1993, 18, 0, 0, 0, 0; *M. micrantha*, *Schinini 24080* (MO), 1984, 27, 0, 0, 1, 2; *M. micrantha*, *Schmalzel 221* (MO), 1981, 30, 0, 0, 0, 1; *M. micrantha*, *Stuessy 6046* (MO), 1981, 30, 0, 0, 0, 1; *M. micrantha*, *Vásquez 24739* (MO), 1997, 14, 0, 0, 0, 1; *M. micrantha*, *Villacorta 899* (MO), 1991, 20, 0, 0, 1, 1; *M. micrantha*, *Wasum 8397* (MO), 1992, 19, 1, 1, 2, 2; *M. micrantha*, *Williams 1131* (MO), 1990, 21, 1, 1, 1, 1; *M. micrantha*, *Zak 3236* (MO), 1987, 24, 1, 1, 1, 1; *M. microcephala* DC., *Heringer 18210* (MO), 1981, 30, 0, 0, 1, 2; *M. micropteris* DC., *Bidgood 4456* (MO), 2000, 11, 1, 3, 1, 1; *M. micropteris*, *Gobbo 362* (MO), 1999, 12, 1, 3, 1, 1; *M. micropteris*, *McDaniel 23283* (FLAS), 1980, 31, 0, 0, 0, 1; *M. natalensis* DC., *Balkwill 10587* (MO), 1998, 13, 1, 3, 1, 1; *M. natalensis*, *Reid 1112* (MO), 1986, 25, 0, 0, 1, 2; *M. nitida* (DC.) R.M. King & H. Rob., *Hind 60* (MO), 1992, 19, 0, 0, 1, 2; *M. nummularia* DC., *Nakajima 1885* (MO), 1996, 15, 1, 1, 1, 1; *M. oblongifolia* DC., *Cordeiro 1984* (MO), 2002, 9, 1, 3, 1, 1; *M. oblongifolia*, *Kummrow 1784* (MO), 1982, 29, 1, 1, 1, 2; *M. oblongifolia*, *Kummrow 3228* (MO), 1990, 21, 1, 3, 1, 1; *M. oblongifolia*, *Nakajima 1320* (MO), 1995, 16, 1, 1, 1, 1; *M. oblongifolia*, *Pacheco 439* (MO), 2002, 9, 1, 3, 2, 1; *M. obsoleta* (Vell.) G.M. Barroso, *Thomas 10453* (MO), 1994, 17, 1, 1, 1, 1; *M. obtusata* DC., *Hatschbach 51216* (MO), 1987, 24, 0, 0, 1, 1; *M. odoratissima* Urb., *Acevedo-Rdgz. 7056* (MO), 1994, 17, 0, 0, 0, 0; *M. odoratissima*, *Axelrod 9489* (MO), 1995, 16, 1, 3, 1, 1; *M. odoratissima*, *Hansen 9486* (MO), 1981, 30, 0, 0, 1, 1; *M. officinalis* Mart., *Duarte s.n.* (MO), 1914, 97, 0, 0, 1, 2; *M. officinalis*, *Harley 27208* (MO), 1988, 23, 1, 3, 1, 1; *M. officinalis*, *Harley H50721* (MO), 1992, 19, 1, 3, 1, 1; *M. officinalis*, *Heringer 3429* (MO), 1980, 31, 0, 1, 1, 1; *M. officinalis*, *Miranda 408* (MO), 2002, 9, 0, 0, 0, 1; *M. officinalis*, *Philcox 3041* (MO), 1967, 44, 0, 0, 1, 2; *M. officinalis*, *Romero 4590* (MO), 1997, 14, 1, 3, 2, 1; *M. officinalis*, *Stannard H51776* (MO), 1992, 19, 1, 3, 1, 2; *M. pachyphylla* Urb., *Axelrod 6221* (MO), 1993, 18, 1, 1, 1, 1; *M. pachyphylla*, *Taylor 10889* (MO), 1992, 19, 1, 3, 1, 1; *M. palustris* (Gardner) R.M. King & H. Rob., *Irwin 32022* (MO), 1971, 40, 1, 1, 1, 1; *M. paniculata* DC., *Hatschbach 51214* (MO), 1987, 24, 0, 0, 1, 2; *M. paniculata*, *Hatschbach s.n.* (MO), 1984, 27, 0, 1, 1, 1; *M. papillosa* Klatt, *Valeur 280* (MO), 1929, 82, 0, 0, 0, 1; *M. papillosa*, *Zanoni 32452* (MO), 1984, 27, 0, 0, 0, 0; *M. paranensis* Dusén, *Wasum 1420* (MO), 2002, 9, 1, 3, 1, 1; *M. parodii* Cabrera, *Pedersen 6940* (MO), 1964, 47, 0, 0, 1, 2; *M. parviflora* (Aubl.) H. Karst., *Burnham 1770* (MO), 1998, 13, 1, 1, 1, 1; *M. parviflora*, *Duarte 2687* (MO), 1950, 61, 0, 0, 1, 2; *M. parviflora*, *McDaniel 24775* (MO), 1981, 30, 0, 0, 1, 2; *M. periplocifolia* Hook. & Arn., *Cowan 4076* (MO), 1983, 28, 1, 3, 1, 1; *M. periplocifolia*, *Fortunato 5957* (MO), 1998, 13, 1, 1, 1, 2; *M. periplocifolia*, *Mendez 5193* (MO), 1993, 18, 1, 1, 2, 3; *M. periplocifolia*, *Zardini 36712* (MO), 1993, 18, 1, 3, 1, 1; *M. phaeoclados* Mart., *Irwin 29085* (MO), 1971, 40, 0, 0, 0, 1; *M. phaeoclados*, *Pirani H51326* (MO), 1992, 19, 1, 1, 1, 2; *M. pohlii* (Baker) R.M. King & H. Rob., *King 8320* (MO), 1980, 31, 0, 0, 0, 1; *M. porosa* Urb., *Grimes 3234* (MO), 1992, 19, 1, 3, 2, 1; *M. producta* Urb. & Ekman, *Zanoni 19202* (MO), 1982, 29, 0, 3, 1, 1; *M. pseudorimachii* W.C. Holmes & McDaniel, *Zardini 13276* (MO), 1989, 22, 1, 1, 2, 3; *M. psilostachya* DC., *Croat 73274* (MO), 1992, 19, 1, 3, 1, 1; *M. psilostachya*, *Dwyer 7799* (MO), 1967, 44, 0, 0, 0, 1; *M. psilostachya*, *Heringer 7013* (MO), 1981, 30, 0, 0, 1, 2; *M. psilostachya*, *Nee 6679* (MO), 1973, 38, 0, 0, 0, 1; *M. psilostachya*, *Pereira 301* (MO), 1982, 29, 0, 1, 2, 3; *M. psilostachya*, *Ritter 1641* (MO), 1995, 16, 1, 3, 2, 1; *M. psilostachya*, *Smith 6935* (MO), 1984, 27, 0, 1, 1, 2; *M. psilostachya*, *Solomon 11719* (MO), 1984, 27, 0, 0, 1, 2; *M. psilostachya*, *Solomon 11993* (MO), 1984, 27, 0, 0, 1, 2; *M. purpurascens* (Baker) R.M. King & H. Rob., *Romero 1632* (MO), 1995, 16, 0, 1, 1, 2; *M. pyramidata* Donn. Sm., *Luna 407* (MO), 1988, 23, 1, 1, 1, 1; *M. ramosissima* Gardner, *Pereira 327* (MO), 1982, 29, 0, 1, 1, 2; *M. ramosissima*, *Romero 3555* (MO), 1996, 15, 1, 3, 1, 1; *M. sagittifera* B.L. Rob., *Long 706* (MO), 1987, 24, 1, 3, 1, 1; *M. sagittifera*, *Rowmier 5533* (MO), 1996, 15, 1, 3, 2, 1; *M. sagittifera*, *Sitoni 1322* (MO), 2000, 11, 1, 1, 2, 3; *M. scandens* (L.) Willd., *Abbott 9468* (FLAS), 1996, 15, 1, 1, 1, 2; *M. scandens*, *Ahles 19323* (FLAS), 1956, 57, 0, 0, 0, 1; *M. scandens*, *Amoroso 463* (FLAS), 1993, 18, 1, 3, 1, 1; *M. scandens*, *Anderson 12360* (FLAS), 1989, 22, 1, 3, 1, 2; *M. scandens*, *Arnold s.n.* (FLAS), 1940, 73, 0, 0, 0, 1; *M. scandens*, *Baltzell 7267* (FLAS), 1975, 38, 0, 0, 0, 1; *M. scandens*, *Beatre s.n.* (FLAS), 2004, 7, 1, 3, 1, 2; *M. scandens*, *Blomquist 5283* (FLAS), 1932, 81, 0, 0, 0, 1; *M. scandens*, *Brass 15026* (FLAS), 1945, 68, 0, 0, 0, 1; *M. scandens*, *Breedlove 20637* (MO), 1971, 40, 0, 0, 0, 1; *M. scandens*, *Breedlove 23834* (MO), 1972, 39, 0, 0, 1, 2; *M. scandens*, *Bridges 24190* (FLAS), 1995, 16, 1, 1, 1, 1; *M. scandens*, *Brumbach 628-32* (FLAS), 1932, 81, 0, 0, 0, 0; *M. scandens*, *Bryson 4919* (FLAS), 1986, 25, 0, 1, 2, 3; *M. scandens*, *Christman 16* (FLAS), 1964, 49, 0, 0, 0, 1; *M. scandens*, *Craighead s.n.* (FLAS), 1955, 58, 0, 0, 0, 1; *M. scandens*, *Craighead s.n.* (FLAS), 1956, 57, 0, 0, 0, 1; *M. scandens*, *Creager 264* (FLAS), 1963, 50, 0, 0, 0, 1; *M. scandens*, *Croat 28936* (MO), 1973, 38, 0, 1, 1, 1; *M. scandens*, *Cuthbert s.n.* (FLAS), 1998, 15, 0, 0, 0, 1; *M. scandens*, *D'Arcy 2165* (FLAS), 1967, 46, 0, 0, 0, 1; *M. scandens*, *D'Arcy 8230* (MO), 1975, 36, 0, 0, 0, 1; *M. scandens*, *Davis s.n.* (FLAS), 1941, 72, 0, 0, 0, 1; *M. scandens*, *Dunn 157* (FLAS), 1978, 35, 0, 0, 0, 1; *M. scandens*, *Easley 564* (FLAS), 1986, 27, 0, 0, 0, 1; *M. scandens*, *Edwards 81* (FLAS), 2001, 10, 1, 3, 1, 1; *M. scandens*, *Fleming 417* (FLAS), 1978, 35, 0, 0, 0, 1; *M. scandens*, *Fletner 2* (FLAS), 1985, 26, 1, 1, 1, 2; *M. scandens*, *Ford 162* (FLAS), 1934, 79, 0, 0, 0, 1; *M. scandens*, *Ford 3127* (FLAS), 1954, 59, 0, 0, 0, 1; *M. scandens*, *Fried 00-046* (FLAS), 2000, 11, 1, 3, 1, 1; *M. scandens*, *Garland 204* (FLAS), 1983, 28, 1, 3, 1, 1; *M. scandens*, *Godfrey 50059* (FLAS), 1949, 64, 0, 0, 0, 1; *M. scandens*, *Gulledge 112* (FLAS), 1996, 15, 1, 3, 1, 2; *M. scandens*, *Hernandez M. 6828* (MO), 1981, 30, 0, 1, 1, 1; *M. scandens*, *Herring 1621* (FLAS), 2002, 9, 1, 1, 1, 1; *M. scandens*, *Herring 460* (FLAS), 1991, 20, 1, 1, 1, 2; *M. scandens*, *Herring 70* (FLAS), 1990, 21, 0, 0, 0, 1; *M. scandens*, *Hood 2386* (FLAS), 1949, 64, 0, 0, 0, 1; *M. scandens*, *Hood 421* (FLAS), 1947, 66, 0, 0, 0, 1; *M. scandens, Ionta 106* (FLAS), 2001, 10, 1, 3, 1, 1; *M. scandens, Jacono 793* (FLAS), 2011, 0, 1, 3, 0, 0; *M. scandens, King 10593* (MO), 1993, 18, 1, 3, 1, 2; *M. scandens, Kirkman 413* (FLAS), 1975, 36, 0, 0, 1, 2; *M. scandens, Kron 1202* (FLAS), 1982, 29, 0, 0, 1, 2; *M. scandens, Ledin s.n.* (FLAS), 1946, 67, 0, 0, 0, 1; *M. scandens, Longbottom 7992* (FLAS), 2006, 5, 1, 3, 2, 1; *M. scandens, Nee 52873* (MO), 2004, 7, 1, 3, 1, 1; *M. scandens, Nelson 24215* (FLAS), 2003, 8, 1, 1, 1, 1; *M. scandens, Neubig 14-2003* (FLAS), 2003, 8, 1, 3, 1, 1; *M. scandens, Novelo 193* (MO), 1975, 36, 0, 0, 0, 1; *M. scandens, Orzell & Bridges 12556* (FLAS), 1989, 22, 1, 3, 1, 2; *M. scandens, Rakotomalala 419* (MO), 1995, 16, 0, 0, 0, 0; *M. scandens, Rogers 682* (FLAS), 1986, 25, 0, 0, 1, 2; *M. scandens, Savoie 12* (FLAS), 2001, 10, 1, 3, 1, 2; *M. scandens, Scanlan 35* (FLAS), 2000, 11, 1, 1, 1, 1; *M. scandens, Schatz 1457* (MO), 1987, 24, 1, 1, 1, 1; *M. scandens, Scull s.n.* (FLAS), 1937, 76, 0, 0, 0, 1; *M. scandens, Sherman 266* (MO), 1991, 20, 1, 3, 2, 1; *M. scandens, Small 6993* (FLAS), 1915, 98, 0, 0, 0, 1; *M. scandens, Small 8240* (FLAS), 1917, 96, 0, 0, 0, 1; *M. scandens, Smith 1731* (FLAS), 1967, 46, 0, 0, 0, 1; *M. scandens, Smith 3831* (MO), 2003, 8, 1, 3, 1, 1; *M. scandens, Smith 731* (FLAS), 1961, 52, 0, 0, 0, 1; *M. scandens, Smurl s.n.* (FLAS), 2006, 5, 1, 3, 1, 1; *M. scandens, Thomas 145589* (MO), 1995, 16, 1, 3, 2, 1; *M. scandens, Tilley 2382* (FLAS), 2001, 10, 1, 3, 1, 2; *M. scandens, Tilley 2607* (FLAS), 2001, 10, 1, 3, 1, 2; *M. scandens, van Hoek 712* (FLAS), 1996, 15, 0, 0, 1, 1; *M. scandens, van Montfrans 95* (FLAS), 1978, 33, 0, 0, 1, 2; *M. scandens, Vincent 573* (FLAS), 1976, 37, 0, 0, 1, 1; *M. scandens, Weber s.n.* (FLAS), 1935, 78, 0, 0, 0, 1; *M. scandens, West & Arnold s.n.* (FLAS), 1940, 73, 0, 0, 0, 1; *M. scandens, Wichterman 41* (FLAS), 1971, 42, 0, 0, 0, 1; *M. scandens, Windler et al. 4133* (FLAS), 1972, 41, 0, 0, 0, 1; *M. scandens, Wunderlin 8547* (MO), 1979, 32, 0, 0, 0, 1; *M. schenckii* Hieron., *Irwin 28933* (MO), 1971, 40, 0, 0, 0, 1; *M. sessilifolia* DC., *Romero 4057* (MO), 1997, 14, 1, 3, 1, 1; *M. sessilifolia, Silva 1074* (MO), 1992, 19, 0, 1, 1, 1; *M. sessilifolia, Silva 579* (MO), 1989, 22, 1, 3, 1, 1; *M. setigera* Sch. Bip. ex Baker, *Cordeiro 1439* (MO), 1997, 14, 0, 1, 1, 1; *M. smilacina* DC., *Heringer 1915* (MO), 1979, 32, 0, 0, 1, 2; *M. stevensiana* Britton, *Liogier 32692* (MO), 1982, 29, 0, 0, 1, 2; *M. stuebelii* Hieron., *Jørgensen 1563* (MO), 1995, 16, 1, 3, 2, 1; *M. stuebelii, Jørgensen 92370* (MO), 1990, 21, 1, 3, 1, 1; *M. sylvatica* Klatt, *Croat 79917* (MO), 1997, 14, 1, 3, 2, 1; *M. sylvatica, Gentry 5782* (MO), 1972, 39, 0, 0, 0, 1; *M. sylvatica, Haber 10068* (MO), 1990, 21, 0, 0, 0, 1; *M. sylvatica, Tipaz 1687* (MO), 1992, 19, 0, 1, 1, 1; *M. sylvatica, van der Werff 12184* (MO), 1991, 20, 1, 1, 1, 1; *M. thapsoides* DC., *Romero 4873* (MO), 1998, 13, 0, 0, 1, 1; *M. thapsoides, Zardini 17159* (MO), 1989, 22, 0, 0, 0, 0; *M. tonduzii* B.L. Rob., *Harmon 299* (MO), 1992, 19, 1, 1, 1, 1; *M. tonduzii, Manriquez 3330* (MO), 1989, 22, 0, 1, 2, 3; *M. trachypleura* B.L. Rob., *Pedersen 5975* (MO), 1961, 50, 0, 1, 1, 2; *M. trachypleura, Robinson 1984* (MO), 1981, 30, 0, 1, 1, 1; *M. trachypleura, Robinson 1989* (MO), 1989, 22, 1, 0, 0, 0; *M. urticifolia* Hook. & Arn., *Cabrera 26189* (MO), 1975, 36, 1, 3, 1, 1; *M. variifolia* Hieron., *Pedersen 13921* (MO), 1984, 27, 1, 3, 1, 2; *M. variifolia, Soria 4209* (MO), 1990, 21, 1, 1, 1, 1; *M. virgata* B.L. Rob., *Hatschbach 26593* (MO), 1971, 40, 0, 1, 2, 3; *M. vitifolia* DC., *Poveda A. 3949* (MO), 1985, 26, 0, 0, 1, 2; *M. vitifolia, Rodríguez 4273* (MO), 1999, 12, 1, 3, 1, 1; *M. warmingii* Sch. Bip. ex Baker, *Nakajima 1914* (MO), 1996, 15, 1, 1, 1, 1. **Polygalaceae data set from herbarium specimens:** *Acanthocladus guayaquilensis* B. Eriksen & B. Ståhl, *Valverde 1703* (MO), 1982, 30, 0, 0, 0, 1; *Asemeia acuminata* (Willd.) J.F.B. Pastore & J.R. Abbott, *Araujo 1198* (MO), 2004, 8, 1, 3, 1, 0; *A. acuminata, Araujo 1370* (MO), 2004, 8, 0, 0, 0, 0; *A. acuminata, Freitas 17* (MO), 2006, 7, 1, 1, 1, 1; *Asemeia* Raf., *Portal 355* (MO), 2008, 5, 1, 3, 1, 2; *Asemeia* Raf., *Stevens 33039* (MO), 2012, 1, 1, 3, 1, 1; *Asemeia* Raf., *Villarroel 746* (MO), 2006, 7, 0, 0, 0, 0; *Asemeia violacea* (Aubl.) J.F.B. Pastore & J.R. Abbott, *Abbott25297* (FLAS), 2010, 2, 1, 3, 1, 1; *Asemeia violacea, Morales 9582* (MO), 2003, 10, 0, 0, 0, 0; *Asemeia violacea, Roubik 191* (MO), 1977, 35, 0, 0, 0, 1; *Atroxima afzeliana* (Oliv.) Stapf, *Jongkind 8275* (MO), 2008, 4, 1, 3, 1, 1; *Bredemeyera* Willd., *Parada 818* (MO), 2008, 4, 0, 1, 1, 1; *Bredemeyera colletioides* (Phil.) Chodat, *Fortunato 5561* (MO), 1997, 16, 0, 0, 0, 1; *B. densiflora* A.W. Benn., *Choque 215* (MO), 2005, 7, 1, 3, 1, 1; *B. floribunda* Willd., *Choque 94* (MO), 2005, 7, 1, 3, 1, 1; *B. lucida* (Benth.) Klotzsch ex Hassk., *Stevens 32594* (MO), 2012, 1, 1, 3, 1, 2; *Caamembeca* J.F.B. Pastore, *Teran 3131* (MO), 2008, 5, 1, 1, 2, 3; *Caamembeca* J.F.B. Pastore, *Teran 3607* (MO), 2009, 4, 1, 1, 2, 3; *Caamembeca spectabilis* (DC.) J.F.B. Pastore, *Brummitt 19367* (MO), 1996, 16, 0, 1, 1, 1; *Carpolobia* G. Don, *Abeid 689* (MO), 1999, 13, 1, 3, 1, 1; *Carpolobia* G. Don, *Festo 465* (MO), 1999, 13, 1, 1, 1, 1; *Carpolobia* G. Don, *Hizza 175* (MO), 1998, 14, 0, 1, 1, 2; *Carpolobia* G. Don, *Kayombo 5143* (MO), 2005, 7, 1, 3, 1, 1; *Carpolobia* G. Don, *Kindeketa 2599* (MO), 2005, 7, 1, 3, 1, 1; *Carpolobia* G. Don, *Sallu 326* (MO), 1999, 13, 0, 1, 1, 1; *Carpolobia* G. Don, *Sitoni 798* (MO), 1999, 13, 0, 1, 1, 1; *Carpolobia alba* G. Don, *White 1057* (MO), 1993, 20, 0, 0, 1, 0; *Comesperma ericinum* DC., *Hadobas 79* (MO), 1989, 23, 1, 3, 1, 1; *C. ericinum* DC., *Jobson 5280* (MO), 1997, 15, 1, 1, 1, 1; *C. pallidum* Pedley, *Latz 11705* (MO), 1990, 22, 0, 1, 1, 1; *C. secundum* Banks ex DC., *Harwood 942* (MO), 2000, 12, 1, 3, 1, 1; *C. secundum, Ritler 686* (MO), 2001, 11, 0, 1, 2, 3; *Epirixanthes elongata* Blume, *Hsu 17814* (TAIE), 2012, 1, 1, 3, 2, 1; *Epirixanthes elongata, Shih-Wen Chung s.n.* (NA), 2012, 1, 1, 3, 2, 1; *Epirixanthes elongata, Tam HK43266* (HK), 2012, 1, 1, 3, 2, 1; *Gymnosperia* (Wight & Arn.) Benth. & Hook. f., *Hatschbach 46915* (MO), 1983, 29, 0, 0, 1, 2; *Hebecarpa* (Chodat) J.R. Abbott, *Morales 9519* (MO), 2003, 10, 0, 0, 0, 0; *Hebecarpa* (Chodat) J.R. Abbott, *Blandón 107* (MO), 2007, 5, 0, 0, 0, 1; *Hebecarpa* (Chodat) J.R. Abbott, *Davidse 35213* (MO), 1994, 19, 0, 0, 0, 1; *Hebecarpa* (Chodat) J.R. Abbott, *Garcia 1973* (MO), 2000, 13, 1, 3, 1, 2; *Hebecarpa* (Chodat) J.R. Abbott, *Holt E8074* (MO), 2010, 3, 1, 3, 1, 2; *Hebecarpa* (Chodat) J.R. Abbott, *Martinez 23914* (MO), 1988, 25, 1, 1, 2, 3; *Hebecarpa* (Chodat) J.R. Abbott, *Morales 9744* (MO), 2003, 10, 0, 0, 0, 1; *Hebecarpa* (Chodat) J.R. Abbott, *Stevens 27975* (MO), 2009, 4, 1, 3, 1, 2; *Hebecarpa* (Chodat) J.R. Abbott, *Stevens 30253* (MO), 2010, 3, 1, 3, 1, 2; *Hebecarpa* (Chodat) J.R. Abbott, *Stevens 30843* (MO), 2010, 3, 1, 3, 1, 2; *Hebecarpa* (Chodat) J.R. Abbott, *Stevens 33071* (MO), 2012, 1, 1, 3, 1, 2; *Hebecarpa* (Chodat) J.R. Abbott, *Stevens 33209* (MO), 2012, 1, 1, 3, 1, 2; *Hebecarpa* (Chodat) J.R. Abbott, *Zamora 1517* (MO), 1988, 24, 1, 3, 1, 2; *Hebecarpa barbeyana* (Chodat) J.R. Abbott, *Lott 5701* (MO), 2006, 7, 1, 3, 1, 2; *Heterosamara cabrae* (Chodat) Paiva, *Carvalho 2772* (MO), 1986, 27, 0, 0, 0, 0; *Monnina* Ruiz & Pav., *Araujo 3834* (MO), 2007, 5, 1, 3, 1, 3; *Monnina* Ruiz & Pav., *Araujo 3870* (MO), 2007, 5, 1, 3, 2, 1; *Monnina* Ruiz & Pav., *Arroyo P. 4802* (MO), 2010, 3, 1, 3, 1, 2; *Monnina* Ruiz & Pav., *Feist 4001* (MO), 2007, 6, 1, 1, 1, 2; *Monnina* Ruiz & Pav., *Feist 4044* (MO), 2007, 6, 1, 3, 1, 2; *Monnina* Ruiz & Pav., *Fuentes 11540* (MO), 2007, 5, 1, 1, 1, 1; *Monnina* Ruiz & Pav., *Fuentes 9689* (MO), 2005, 7, 1, 3, 1, 1; *Monnina* Ruiz & Pav., *Lliully 1691* (MO), 2009, 4, 1, 3, 1, 2; *Monnina* Ruiz & Pav., *Maldonado 2031* (MO), 2002, 10, 1, 3, 1, 1; *Monnina* Ruiz & Pav., *Penaranda 624* (MO), 2008, 5, 1, 3, 1, 2; *Monnina* Ruiz & Pav., *Teran 2312* (MO), 2008, 5, 1, 1, 1, 2; *Monnina* Ruiz & Pav., *Teran 3542* (MO), 2009, 4, 1, 1, 1, 1; *Monnina* Ruiz & Pav., *Teran 3578* (MO), 2009, 4, 1, 1, 1, 1; *Monnina* Ruiz & Pav., *Ulloa 1312* (MO), 2003, 10, 1, 1, 1, 2; *Monnina* Ruiz & Pav., *Ulloa 1377* (MO), 2003, 10, 1, 3, 1, 2; *Monnina arbutus* Chodat, *Linneo 1467* (MO), 2008, 5, 0, 0, 0, 1; *M. bridgesii* Chodat, *Arroyo 3096* (MO), 2005, 7, 1, 3, 1, 1; *M. ciliolata* Sessé & Moc. ex DC., *Garcia 114* (MO), 2007, 5, 1, 3, 1, 1; *M. ciliolata*, *Tolentino 84* (MO), 2010, 3, 1, 3, 1, 2; *M. crepinii* Chodat, *Aguilar 4516* (MO), 1996, 16, 0, 0, 0, 0; *M. herzogii* Chodat, *Carrasco 278* (MO), 2004, 8, 1, 3, 1, 1; *M. herzogii*, *Luteyn 13600* (MO), 1990, 22, 1, 3, 1, 2; *M. lechleriana* Chodat, *Fernández 1950* (MO), 2003, 9, 1, 3, 2, 1; *M. lechleriana* Chodat, *NA* (MO), 2002, 10, 1, 1, 3, 2; *M. longifolia* DC., *Mayfield s.n.* (MO), 2003, 9, 1, 2, 1, 3; *M. longifolia* DC., *Rodriguez 5517* (MO), 1999, 13, 0, 0, 1, 2; *M. marroclada* Chodat, *Solomon 5999* (MO), 1981, 31, 1, 3, 1, 2; *M. pseudopilosa* Ferreyra, *Cerón 32010* (MO), 1998, 14, 1, 3, 1, 2; *M. pseudopilosa*, *Cerón 57510* (MO), 2006, 6, 0, 1, 1, 1; *M. rusbyi* Chodat, *Ritter 1801* (MO), 1995, 17, 1, 3, 1, 1; *M. salicifolia* Ruiz & Pav., *Fuentes 6708* (MO), 2004, 8, 1, 3, 2, 1; *M. salicifolia*, *Liberman 1280* (MO), 1986, 26, 1, 3, 2, 1; *M. sapragena* Donn. Sm., *Martinez 383* (MO), 1995, 17, 0, 0, 0, 1; *M. weddelliana* Chodat, *Schimt 117* (MO), 1991, 21, 1, 3, 1, 1; *Moutabea* Aubl., *Monteagudo 11223* (MO), 2005, 8, 0, 0, 0, 1; *Moutabea aculeata* (Ruiz & Pav.) Poepp. & Endl., *Chiquimaco 12021* (MO), 2008, 5, 0, 0, 0, 1; *M. aculeata*, *Huamantupa 7867* (MO), 2006, 6, 1, 1, 1, 1; *Muraltia* DC., *Lavranos 22969* (MO), 1985, 27, 0, 1, 2, 3; *Muraltia harveyana* Levyns, *Goldblatt 11666* (MO), 2001, 12, 1, 1, 1, 2; *Muraltia heisteria* (L.) DC., *Madden s.n.* (MO), 2006, 6, 1, 3, 1, 2; *M. heisteria*, *Syman 15213* (MO), 1994, 18, 0, 1, 2, 3; *M. spinosa* (L.) F.Forest & J.C.Manning, *Goldblatt 11669* (MO), 2001, 12, 0, 0, 1, 2; *Polygala* L., *An Mingtai 3617* (MO), 2003, 10, 1, 3, 1, 2; *Polygala* L., *Araujo 4095* (MO), 2008, 4, 1, 3, 1, 2; *Polygala* L., *Araujo-Murakami 3951* (MO), 2007, 6, 1, 3, 1, 2; *Polygala* L., *Arroyo P. 5050* (MO), 2010, 3, 1, 3, 1, 2; *Polygala* L., *Burley 2810* (MO), 1989, 23, 0, 1, 1, 1; *Polygala* L., *Carretero 876* (MO), 2003, 10, 1, 1, 1, 1; *Polygala* L., *Carretero 876* (MO), 2003, 9, 1, 3, 2, 1; *Polygala* L., *Cayola 2972* (MO), 2009, 4, 1, 3, 1, 2; *Polygala* L., *Clarke 70-03* (MO), 1991, 21, 1, 1, 2, 3; *Polygala* L., *Croat 53261* (MO), 1981, 31, 0, 0, 0, 1; *Polygala* L., *Croat 96287* (MO), 2006, 7, 1, 3, 2, 1; *Polygala* L., *Dold 3516* (MO), 1999, 13, 0, 0, 1, 2; *Polygala* L., *Elia 108* (MO), 1999, 13, 1, 3, 2, 1; *Polygala* L., *Festo 1960* (MO), 2005, 7, 1, 3, 2, 1; *Polygala* L., *Festo 492* (MO), 2000, 12, 1, 3, 1, 2; *Polygala* L., *Festo 79* (MO), 1998, 14, 0, 1, 1, 1; *Polygala* L., *Gereau 3118* (MO), 1989, 23, 0, 0, 0, 1; *Polygala* L., *Gereau 3527* (MO), 1991, 21, 0, 0, 1, 1; *Polygala* L., *Gereau 4281* (MO), 1991, 21, 0, 0, 0, 1; *Polygala* L., *Gereau 4354* (MO), 1991, 21, 0, 0, 1, 1; *Polygala* L., *Gereau 4441* (MO), 1991, 21, 0, 0, 1, 1; *Polygala* L., *Gereau 5075* (MO), 1992, 20, 0, 1, 2, 3; *Polygala* L., *Gobbo 263* (MO), 1999, 13, 0, 1, 2, 3; *Polygala* L., *Gobbo 301* (MO), 1999, 13, 0, 0, 1, 2; *Polygala* L., *GSBS 26781* (MO), 2005, 8, 1, 1, 1, 1; *Polygala* L., *GSBS 26884* (MO), 2005, 8, 0, 1, 1, 1; *Polygala* L., *GSBS 28364* (MO), 2005, 8, 1, 1, 1, 2; *Polygala* L., *GSBS 28386* (MO), 2005, 8, 0, 1, 1, 1; *Polygala* L., *GSBS 28820* (MO), 2005, 8, 0, 1, 1, 2; *Polygala* L., *Gutierrez 1258* (MO), 2005, 8, 1, 1, 1, 1; *Polygala* L., *Gutiérrez 1258* (MO), 2005, 7, 1, 3, 2, 1; *Polygala* L., *Harder 2511* (MO), 1995, 17, 1, 1, 1, 1; *Polygala* L., *Harder 2758* (MO), 1995, 17, 1, 1, 1, 1; *Polygala* L., *Harder 3094* (MO), 1994, 18, 0, 0, 0, 1; *Polygala* L., *Harder 3262* (MO), 1994, 18, 1, 1, 1, 1; *Polygala* L., *Harder 3269* (MO), 1994, 18, 1, 3, 1, 1; *Polygala* L., *Harder 3491* (MO), 1996, 16, 0, 1, 1, 1; *Polygala* L., *Harder 3623* (MO), 1996, 16, 1, 1, 1, 3; *Polygala* L., *Harder 3629* (MO), 1996, 16, 0, 0, 0, 0; *Polygala* L., *Harder 3630* (MO), 1996, 16, 1, 2, 1, 3; *Polygala* L., *Harder 3826* (MO), 1997, 15, 0, 0, 0, 0; *Polygala* L., *Harder 3833* (MO), 1997, 15, 1, 2, 1, 1; *Polygala* L., *Harder 3878* (MO), 1997, 15, 0, 1, 1, 1; *Polygala* L., *Jiménez 771* (MO), 2007, 5, 1, 3, 1, 2; *Polygala* L., *Kayombo 2158* (MO), 1999, 13, 0, 0, 0, 0; *Polygala* L., *Kayombo 2541* (MO), 1999, 13, 1, 3, 1, 2; *Polygala* L., *Kayombo 2743* (MO), 1999, 13, 1, 1, 1, 1; *Polygala* L., *Kayombo 443* (MO), 1989, 23, 0, 0, 0, 0; *Polygala* L., *Kayombo 456* (MO), 1989, 23, 0, 1, 2, 3; *Polygala* L., *Kayombo 4814* (MO), 2004, 8, 0, 0, 0, 1; *Polygala* L., *Kuchar 24310* (MO), 2001, 11, 1, 3, 1, 2; *Polygala* L., *Kuchar 24335* (MO), 2001, 11, 0, 0, 0, 1; *Polygala* L., *Kuchar 24495* (MO), 2001, 11, 1, 3, 1, 2; *Polygala* L., *Kuchar 25045* (MO), 2002, 10, 1, 1, 1, 2; *Polygala* L., *Kuchar 25136* (MO), 2002, 10, 1, 3, 1, 2; *Polygala* L., *Li Heng 8909* (MO), 1997, 16, 1, 2, 1, 3; *Polygala* L., *Lovett 151* (MO), 1991, 21, 1, 1, 2, 3; *Polygala* L., *Lovett 1691* (MO), 1987, 25, 0, 0, 0, 1; *Polygala* L., *Lovett 1748* (MO), 1987, 25, 0, 0, 1, 2; *Polygala* L., *Lovett 237* (MO), 1991, 21, 1, 1, 1, 1; *Polygala* L., *Lovett 2397* (MO), 1987, 25, 1, 1, 2, 3; *Polygala* L., *Lovett 29* (MO), 1991, 21, 1, 3, 1, 2; *Polygala* L., *Lovett 3428* (MO), 1989, 23, 0, 0, 1, 2; *Polygala* L., *Lovett 3465* (MO), 1989, 23, 0, 0, 1, 2; *Polygala* L., *Lovett 3884* (MO), 1990, 22, 0, 0, 1, 2; *Polygala* L., *Lovett 402* (MO), 1991, 21, 0, 1, 2, 3; *Polygala* L., *Lovett 4149* (MO), 1990, 22, 0, 1, 2, 3; *Polygala* L., *Lovett 4177* (MO), 1990, 22, 0, 1, 2, 3; *Polygala* L., *Lovett 4211* (MO), 1990, 22, 0, 1, 2, 3; *Polygala* L., *Lovett 4417* (MO), 1990, 22, 0, 1, 2, 3; *Polygala* L., *Lowry 4855* (MO), 1997, 15, 0, 0, 0, 1; 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(MO), 2007, 5, 0, 0, 0, 0; *Polygala* L., *Sallu 203* (MO), 1999, 13, 1, 3, 2, 1; *Polygala* L., *Sallu 76* (MO), 1998, 14, 0, 0, 1, 2; *Polygala* L., *Sant'Ana 942* (MO), 2000, 13, 1, 1, 2, 3; *Polygala* L., *Schatz 3569* (MO), 1993, 19, 1, 1, 1, 1; *Polygala* L., *Schatz 4059* (MO), 2003, 9, 1, 3, 2, 1; *Polygala* L., *Schmidt 1316* (MO), 1994, 18, 1, 2, 1, 3; *Polygala* L., *Schmidt 2348* (MO), 1997, 15, 0, 0, 0, 1; *Polygala* L., *Schmidt 2446* (MO), 1997, 15, 1, 3, 2, 1; *Polygala* L., *Schmidt 2448* (MO), 1997, 15, 1, 1, 2, 2; *Polygala* L., *Schmidt 2514* (MO), 1997, 15, 1, 3, 1, 2; *Polygala* L., *Schmidt 2543* (MO), 1997, 15, 1, 3, 1, 2; *Polygala* L., *Shunda 12* (MO), 1998, 14, 0, 0, 1, 2; *Polygala* L., *Simon 441* (MO), 2000, 12, 0, 1, 1, 2; *Polygala* L., *Simon 503* (MO), 2000, 12, 0, 0, 1, 2; *Polygala* L., *Simon 885* (MO), 2001, 11, 0, 1, 1, 2; *Polygala* L., *Sitoni 1023* (MO), 1999, 13, 1, 2, 1, 3; *Polygala* L., *Sitoni 1209* (MO), 2000, 12, 1, 1, 1, 1; *Polygala* L., *Stuckey 600* (MO), 2010, 3, 1, 3, 1, 2; *Polygala* L., *Sugong WS-1916* (MO), 2008, 4, 0, 0, 0, 0; *Polygala* L., *Sugong WS-2192* (MO), 2008, 4, 1, 3, 1, 1; *Polygala* L., *Teran 2984* (MO), 2008, 4, 1, 3, 1, 2; *Polygala* L., *Teran 995* (MO), 2007, 5, 1, 3, 2, 1; *Polygala* L., *Teran 996* (MO), 2007, 5, 1, 2, 1, 1; *Polygala* L., *Tep-Jorgensen DA161* (MO), 1999, 13, 1, 3, 1, 2; *Polygala* L., *Torres 410* (MO), 2009, 4, 1, 3, 2, 1; *Polygala* L., *van der Werff 14411* (MO), 1997, 16, 0, 0, 0, 0; *Polygala* L., *van der Werff 20124* (MO), 2005, 8, 0, 0, 1, 2; *Polygala* L., *van Valkenberg 2922* (MO), 2004, 9, 1, 3, 1, 2; *Polygala* L., *Villalobos 308* (MO), 2005, 7, 1, 3, 2, 1; *Polygala* L., *Xian Gongshan 14629* (MO), 2002, 11, 1, 1, 1, 1; *Polygala* L., *Zhu 2317* (MO), 1999, 14, 0, 0, 0, 1; *Polygala* L., *Zimba 1068* (MO), 1997, 15, 1, 3, 1, 2; *Polygala* L., *Zimba 661* (MO), 1995, 17, 0, 0, 0, 0; *Polygala* L., *Zimba 795* (MO), 1996, 16, 0, 0, 0, 0; *Polygala englerii* Chodat, *Auquier 2765* (MO), 1972, 41, 0, 0, 0, 1; *P. englerii*, *Auquier 3397* (MO), 1974, 39, 0, 0, 0, 1; *P. englerii*, *Ewango 2153* (MO), 1999, 14, 0, 0, 0, 1; *P. major* Jacq., *Barta 2001-58* (MO), 2001, 12, 0, 0, 0, 1; *P. rupestris* Pourr., *Delannay 1351* (MO), 1974, 39, 0, 0, 0, 1; *P. umbonata* Craib, *Maxwell 01-558* (MO), 2001, 11, 0, 0, 0, 1; *P. umbonata*, *Sankamethawee 260* (MO), 2001, 11, 0, 0, 0, 1; *P. abyssinica* R. Br. ex Fresen., *de Wilde 227* (MO), 1969, 44, 0, 0, 0, 1; *P. acicularis* Oliv., *Walters 1213* (MO), 2003, 10, 0, 1, 1, 1; *P. acicularis*, *Walters 1898* (MO), 2007, 5, 1, 1, 1, 2; *P. acicularis*, *White 1368* (MO), 1995, 18, 0, 1, 1, 1; *P. adamsonii* Exell, *Patel 7107* (MO), 2005, 7, 1, 1, 1, 1; *P. africana* Chodat, *Bidgood 6950* (MO), 2008, 5, 1, 3, 1, 2; *P. albicans* (A.W. Benn.) Grondona, *Zardini 7390* (MO), 1988, 24, 0, 0, 1, 2; *P. albida* Schinz, *Harder 3937* (MO), 1997, 15, 0, 0, 0, 1; *P. albida*, *Leeuwenberg 10206* (MO), 1972, 41, 0, 0, 0, 1; *P. albida*, *Leeuwenberg 8455* (MO), 1971, 42, 0, 0, 0, 1; *P. albida*, *Zimba 1066* (MO), 1997, 15, 0, 0, 1, 2; *P. amarella* Crantz, *Polatschek s.n.* (MO), 1989, 24, 0, 0, 0, 1; *P. arenaria* Oliv., *McPherson 16912* (MO), 1997, 16, 0, 0, 0, 1; *P. arenaria*, *White 1432* (MO), 1995, 18, 0, 0, 0, 1; *P. arillata* Buch.-Ham. ex D. Don, *KEKE 945* (MO), 1989, 23, 1, 2, 1, 3; *P. asperuloides* Kunth, *Antoja 1493* (MO), 2004, 8, 1, 3, 2, 1; *P. chinensis* L., *Greijmans 182* (MO), 2001, 11, 0, 0, 0, 0; *P. compressa* H. Perrier, *Gautier 5216* (MO), 2007, 6, 1, 3, 2, 1; *P. compressa*, *Leandri 4578* (MO), 1960, 53, 0, 0, 0, 0; *P. compressa*, *Razanajatovo 32* (MO), 2008, 5, 1, 1, 1, 1; *P. cristata* P. Taylor, *Jongkind 7420* (MO), 2006, 6, 1, 3, 2, 1; *P. darwiniana* A.W. Benn., *Clarke 79-11* (MO), 1991, 21, 0, 1, 1, 1; *P. didyma* C.Y. Wu, *Gaoligong Shan Biodiversity Survey 23811* (MO), 2005, 7, 1, 3, 2, 1; *P. didyma*, *GSBS 19513* (MO), 2004, 9, 1, 1, 2, 2; *P. eriopteza* DC., *Bidgood 6123* (MO), 2006, 6, 1, 3, 1, 2; *P. fallax* Hemsl., *Deng Yunfei s.n.* (MO), 1993, 20, 0, 0, 0, 0; *P. fallax*, *Long Chuan 4270* (MO), 2004, 9, 0, 0, 1, 1; *P. fernandesiana* Paiva, *Leeuwenberg 10187* (MO), 1972, 41, 0, 0, 0, 1; *P. gilletiana* E.M.A. Petit, *White 1299* (MO), 1995, 18, 1, 1, 1, 2; *P. grandidieri* Baill., *Basser 18875* (MO), 1964, 49, 0, 0, 0, 1; *P. grandidieri*, *Humbert 28188* (MO), 1955, 58, 0, 0, 0, 0; *P. hilgreveana* Baill., *Thulin 11818* (MO), 2010, 3, 1, 3, 1, 2; *P. hildebrandtii* Baill., *Gautier 2522* (MO), 1994, 18, 0, 0, 1, 2; *P. hildebrandtii*, *Gautier 5370* (MO), 2009, 4, 1, 1, 1, 1; *P. humbertii* H. Perrier, *Randriambololona 80* (MO), 1994, 18, 0, 0, 0, 0; *P. irwinii* Wurdack, *Maas 8714* (MO), 1999, 13, 0, 1, 1, 1; *P. japonica* Houtt., *Li Ji-Dong 512* (MO), 2004, 9, 0, 0, 0, 1; *P. japonica*, *Long Chuan 4243* (MO), 2004, 9, 0, 0, 0, 1; *P. kalaxariensis* Schinz, *Bester 9254* (MO), 2009, 4, 1, 3, 1, 1; *P. longicaulis* Kunth, *Croat 101604* (MO), 2011, 2, 1, 3, 1, 2; *P. longifolia* Poir., *Sankamethawee 252* (MO), 2001, 11, 0, 1, 1, 2; *P. lutea* L., *Arnold s.n.* (FLAS), 1937, 76, 0, 0, 0, 0; *P. lutea*, *Arnold s.n.* (FLAS), 1932, 81, 0, 0, 0, 0; *P. lutea*, *Brinkley 12* (FLAS), 1931, 82, 0, 0, 0, 1; *P. lutea*, *Cruz 188* (FLAS), 1961, 52, 0, 0, 0, 1; *P. lutea*, *D'Arcy 1538* (FLAS), 1967, 46, 0, 0, 0, 1; *P. lutea*, *Duncan 20230* (FLAS), 1956, 57, 0, 0, 0, 0; *P. lutea*, *Earle s.n.* (FLAS), 1889, 124, 0, 0, 0, 0; *P. lutea*, *Evers s.n.* (FLAS), 1936, 77, 0, 0, 0, 1; *P. lutea*, *Hood 1677* (FLAS), 1949, 64, 0, 0, 0, 1; *P. lutea*, *Hood 366* (FLAS), 1947, 66, 0, 0, 0, 1; *P. lutea*, *Jaspersey s.n.* (FLAS), 1893, 120, 0, 0, 0, 0; *P. lutea*, *Jones 15952* (FLAS), 1969, 44, 0, 0, 0, 1; *P. lutea*, *Kea s.n.* (FLAS), 1933, 80, 0, 0, 0, 0; *P. lutea*, *Kral 7767* (FLAS), 1958, 55, 0, 0, 0, 1; *P. lutea*, *Loucks & West s.n.* (FLAS), 1927, 86, 0, 0, 0, 0; *P. lutea*, *Melvin 3589* (FLAS), 1956, 57, 0, 0, 0, 1; *P. lutea*, *Moore & Lawrence 748* (FLAS), 1949, 64, 0, 0, 0, 1; *P. lutea*, *Murrill s.n.* (FLAS), 1941, 72, 0, 0, 0, 1; *P. lutea*, *Radford 44855* (FLAS), 1966, 47, 0, 0, 0, 1; *P. lutea*, *Rau s.n.* (FLAS), 1885, 128, 0, 0, 0, 1; *P. lutea*, *Rau s.n.* (FLAS), 1884, 129, 0, 0, 0, 1; *P. lutea*, *Rolfs 291* (FLAS), 1893, 120, 0, 0, 0, 0; *P. lutea*, *Scull s.n.* (FLAS), 1937, 76, 0, 0, 0, 1; *P. lutea*, *Shippy s.n.* (FLAS), 1937, 76, 0, 0, 0, 1; *P. lutea*, *Smith & Hodgdon 964* (FLAS), 1939, 74, 0, 0, 0, 1; *P. lutea*, *Smith & Myint 287* (FLAS), 1961, 52, 0, 0, 0, 1; *P. lutea*, *Smith & Myint 494* (FLAS), 1961, 52, 0, 0, 0, 1; *P. lutea*, *Smith s.n.* (FLAS), 1961, 52, 0, 0, 0, 0; *P. lutea*, *Ward & Smith 2545* (FLAS), 1961, 52, 0, 0, 0, 1; *P. lutea*, *Ward 1276* (FLAS), 1959, 54, 0, 0, 0, 1; *P. lutea*, *Ward 6229* (FLAS), 1967, 46, 0, 0, 0, 1; *P. lutea*, *West & Arnold s.n.* (FLAS), 1940, 73, 0, 0, 0, 1; *P. lutea*, *West & Arnold s.n.* (FLAS), 1940, 73, 0, 0, 0, 1; *P. lutea*, *West s.n.* (FLAS), 1942, 71, 0, 0, 0, 1; *P. lutea*, *West s.n.* (FLAS), 1926, 87, 0, 0, 0, 0; *P. lutea*, *Wiggins 19514* (FLAS), 1965, 48, 0, 0, 0, 1; *P. mandonii* Chodat, *Vargas 247* (MO), 2005, 7, 1, 3, 1, 2; *P. melilotoides* Chodat, *Bidgood 6894* (MO), 2008, 5, 1, 1, 1, 2; *P. nambalensis* Gürke, *Bidgood 5349* (MO), 2006, 6, 1, 3, 1, 1; *P. oblongata* (Britton) S.F. Blake, *Michelangeli 1454* (NA), 2009, 3, 1, 3, 1, 2; *P. paniculata* L., *Goodwin 1467* (MO), 2010, 3, 1, 3, 1, 2; *P. paniculata*, *Labat 3901* (MO), 2006, 6, 1, 3, 1, 2; *P. peplis* Baill., *Cremers 3707* (MO), 1975, 38, 0, 0, 0, 1; *P. persicariifolia* DC., *Maxwell 98-1083* (MO), 1998, 14, 0, 0, 0, 0; *P. petitiana* A. Rich., *Chapman 9013* (MO), 1988, 24, 0, 1, 2, 3; *P. producta* N.E. Br., *Sanguer 684* (MO), 1983, 30, 0, 0, 0, 1; *P. rupicola* Hochst. & Steud., *de Wilde 4930* (MO), 1969, 44, 0, 0, 0, 1; *P. rupicola*, *de Wilde 4990* (MO), 1969, 44, 0, 0, 0, 1; *P. senega* var. *latifolia* Torr. & A. Gray, *Ester 9369* (MO), 2006, 6, 1, 3, 1, 1; *P. serpyllifolia* Hose, *Delaunay 1074* (MO), 1975, 40, 0, 0, 0, 1; *P. sibirica* L., *Boufford 38265* (MO), 2007, 5, 1, 3, 1, 2; *P. sibirica*, *Duan Lin-Dong 679* (MO), 2004, 9, 0, 0, 0, 1; *P. sibirica*, *Li Ji-Dong 631* (MO), 2004, 9, 0, 0, 1, 1; *P. sibirica*, *Song Jie 113c-02* (MO), 2008, 5, 1, 3, 1, 2; *P. subopposita* S.K. Chen, *Xiao Jian-xi 5594* (MO), 2003, 10, 0, 0, 0, 1; *P. subopposita* S.K. Chen, *Zhu 2144* (MO), 1999, 14, 0, 0, 0, 1; *P. tricholopha* Chodat, *Maxwell 99-300* (MO), 1999, 13, 1, 3, 1, 2; *P. usafuensis* Gürke, *Bidgood 5336* (MO), 2006, 6, 1, 3, 1, 1; *P. variabilis* Kunth, *Croat 101601* (MO), 2011, 2, 1, 3, 2, 1; *P. verticillata* L., *Abbott25336* (FLAS), 2010, 2, 1, 3, 1, 2; *P. virgata* var. *decora* (Sond.) Harv., *Iversen 1114* (MO), 1984, 29, 0, 0, 0, 1; *P. virgata* var. *decora*, *Muangoka 5485* (MO), 2007, 5, 1, 3, 1, 1; *P. vulgaris* L., *Lewis 15901* (MO), 2004, 9, 0, 0, 0, 1; *P. vulgaris*, *Pignal 1763* (MO), 2001, 12, 0, 0, 0, 1; *P. welwitschii* Chodat, *Bidgood 8112* (MO), 2009, 4, 0, 0, 0, 1; *P. welwitschii*, *Kemi 1312* (MO), 2011, 2, 1, 1, 1, 1; *Polygaloides chamaebuxus* (L.) O.Schwarz, *Andrews s.n.* (MO), 2007, 6, 1, 1, 1, 2; *Pteromonnina herbacea* (DC.) B. Eriksen, *Lægaard 19731B* (MO), 1999, 13, 1, 3, 1, 1; *Rhinotropis* (S.F. Blake) J.R. Abbott, *Wilder 10-148* (MO), 2010, 3, 1, 3, 1, 2; *Rhinotropis cornuta* (Kellogg) J.R. Abbott, *Ahart 13921* (MO), 2007, 6, 0, 0, 0, 1; *R. subspinosa* (S. Watson) J.R. Abbott, *Tiehm 16221* (MO), 2010, 3, 1, 3, 1, 2; *Salomonia* Lour., *Greijmans 157* (MO), 2001, 11, 0, 1, 1, 1; *S. cantoniensis*, *Nishiro 9760524* (MO), 1997, 15, 1, 3, 1, 1; *S. cantoniensis*, *Nishiro 9830009* (MO), 1998, 14, 1, 3, 1, 2; *Securidaca* L., *Eerom 156* (MO), 2005, 7, 1, 1, 1, 1; *Securidaca* L., *Fuentes 7916* (MO), 2005, 7, 1, 3, 1, 1; *Securidaca* L., *Gereau 3854* (MO), 1991, 21, 0, 0, 1, 1; *Securidaca* L., *Gereau 4347* (MO), 1991, 21, 0, 0, 1, 2; *Securidaca* L., *Jardim 1717* (MO), 1998, 15, 0, 0, 0, 1; *Securidaca* L., *Wu Su-Gong 2615* (MO), 2011, 2, 1, 3, 1, 1; *Securidaca inappendiculata* Hassk., *Fan 11382* (NA), 2012, 1, 1, 3, 1, 2; *S. inappendiculata*, *Fan 11383* (NA), 2012, 1, 1, 3, 1, 2; *S. sylvestris* Schltdl., *Pena-Chocarro 2883* (MO), 2007, 6, 1, 1, 1, 1; *S. welwitschii* Oliv., *de Koning 7064* (MO), 1976, 37, 0, 0, 0, 0; *S. yaoshanensis* K.S. Hao, *Fan 11400* (NA), 2012, 1, 1, 3, 1, 2; *S. yaoshanensis*, *Fan 11401* (NA), 2012, 1, 1, 3, 1, 2; *S. yaoshanensis*, *Fan 11402* (NA), 2012, 1, 1, 3, 1, 2. **Portulaca (Portulacaceae) data set from herbarium specimens:** *Portulaca amilis* Sprg., *Abbott 22102* (FLAS), 2006, 7, 1, 1, 1, 1; *P. amilis*, *Andrews s.n.* (FLAS), 2003, 10, 1, 3, 2, 1; *P. amilis*, *Bhan s.n.* (FLAS), 2006, 7, 1, 3, 1, 1; *P. amilis*, *Burkhalter 10684* (FLAS), 1987, 26, 0, 0, 0, 0; *P. amilis*, *Cronger 505* (FLAS), 1965, 48, 0, 0, 0, 0; *P. amilis*, *Easley 1024* (FLAS), 1990, 23, 0, 0, 0, 0; *P. amilis*, *Easterday 631* (FLAS), 1981, 32, 0, 0, 1, 1; *P. amilis*, *Gholson 4385* (FLAS), 1976, 37, 0, 0, 0, 0; *P. amilis*, *Godfrey 79803* (FLAS), 1982, 31, 0, 0, 0, 0; *P. amilis*, *Godfrey 82428* (FLAS), 1987, 26, 0, 0, 0, 1; *P. amilis*, *Guala 903* (FLAS), 1988, 25, 1, 1, 1, 1; *P. amilis*, *Judd s.n.* (FLAS), 1979, 34, 0, 0, 1, 1; *P. amilis*, *Martin 186* (FLAS), 2002, 11, 0, 0, 1, 1; *P. amilis*, *Notis 179* (FLAS), 2001, 12, 0, 0, 1, 1; *P. amilis*, *Penneys 1229* (FLAS), 1998, 15, 0, 0, 1, 1; *P. amilis*, *Riley 198* (FLAS), 2001, 12, 1, 3, 1, 1; *P. amilis*, *Scudder 1086* (FLAS), 1975, 38, 0, 0, 0, 1; *P. amilis*, *Scudder 952* (FLAS), 1973, 40, 0, 0, 0, 1; *P. amilis*, *Shuey 2129* (FLAS), 1978, 35, 1, 1, 1, 1; *P. amilis*, *Wilson 2* (FLAS), 1976, 37, 0, 0, 0, 0; *P. oleracea* L., *Baltzell 11235* (FLAS), 1980, 33, 0, 0, 0, 0; *P. oleracea*, *Baltzell 5619* (FLAS), 1973, 40, 0, 0, 0, 0; *P. oleracea*, *Burgis s.n.* (FLAS), 1947, 66, 0, 0, 0, 0; *P. oleracea*, *Cooley 2568* (FLAS), 1954, 59, 0, 0, 0, 0; *P. oleracea*, *Craighead s.n.* (FLAS), 1956, 57, 0, 0, 0, 0; *P. oleracea*, *Cronger 424* (FLAS), 1965, 48, 0, 0, 0, 1; *P. oleracea*, *D'Arcy 2942* (FLAS), 1968, 45, 0, 0, 0, 0; *P. oleracea*, *Greenberg 19* (FLAS), 1991, 22, 1, 3, 2, 1; *P. oleracea*, *Gunter 148* (FLAS), 1988, 25, 0, 0, 0, 1; *P. oleracea*, *Hoffman 11* (FLAS), 1963, 50, 0, 0, 0, 0; *P. oleracea*, *Howard 20851* (FLAS), 1992, 21, 0, 0, 1; *P. oleracea*, *Lange 1514* (FLAS), 2012, 1, 1, 3, 1, 1; *P. olerace* *Martin 76* (FLAS), 2000, 13, 0, 0, 0, 1; *P. oleracea*, *McCa 10866* (FLAS), 1969, 44, 0, 0, 0, 1; *P. oleracea*, *oulbach 28* (FLAS), 1961, 52, 0, 0, 0, 0; *P. oleracea*, *Porter-Utley 95-2* (FLAS), 1995, 18, 0, 0, 0, 1; *P. oleracea*, *Small 5471* (FLAS) 1915, 98, 0, 0, 0, 1; *P. oleracea*, *Smith 1648* (FLAS), 1967, 4 0, 0, 0, 0; *P. oleracea*, *Smith 1872* (FLAS), 1967, 46, 0, 0, 0, *P. oleracea*, *West s.n.* (FLAS), 1932, 81, 0, 0, 0, 1. **Hibiscu (Malvaceae) data set from herbarium specimens:** *Abelmosch sagittifolius* (Kurz) Merr., *Hiep HLF7330* (MO), 2008, 3, 0, 1, 1; *Cienfuegosia humbertiana* (Hochr.) Fryxell, *Phillipson 395* (MO), 1992, 19, 1, 3, 2, 1; *Bombycidendron vidalianum* (Náve Merr. & Rolfe, *Margraff 106605* (FLAS), 1949, 64, 0, 0, 0, *Hibiscus* L., *Arlenfoer 248* (MO), 1972, 39, 0, 0, 1, 1; *Hibis* L., *Craven 6650* (MO), 1981, 30, 1, 3, 1, 2; *Hibiscus* L., *La 7044* (MO), 1977, 34, 1, 2, 1, 3; *Hibiscus* L., *Lorence 29* (MO), 1979, 32, 1, 1, 1, 1; *Hibiscus* L., *Wilson 96-1* (MO 1996, 15, 1, 2, 1, 3; *Hibiscus asper* Hook. f., *Gillis 6928* (FLA 1968, 45, 0, 0, 0, 1; *H. asper*, *Weber s.n.* (FLAS), 1966, 47, 0, 0, 1; *H. asper*, *Wilmot s.n.* (FLAS), 1943, 70, 0, 0, 0, 1; *H. ca sius* Garcke, *Eichler 22299* (MO), 1977, 34, 1, 3, 1, 2; *H. ca sius*, *Stewart 15084* (MO), 1935, 76, 1, 1, 2, 3; *H. dimidia* Schrank, *Strudwick 3478* (FLAS), 1981, 32, 0, 0, 1, 1; *H. ew bariae* Fryxell, *Holm-Nielsen 2218* (MO), 1973, 38, 0, 0, 0, *H. fallax* Craven, F.D.Wilson & Fryxell, *Leach 4662* (MO 2001, 10, 0, 0, 0, 0; *H. faulknerae* Vollesen, *Mhoro 69* (MC 2000, 11, 0, 0, 0, 0; *H. ferrugineus* Cav., *Geyder 3143* (MC 1989, 22, 1, 3, 1, 2; *H. ferrugineus*, *Lovett 3357* (MO), 19 22, 1, 1, 1, 1; *H. ferrugineus*, *Phillipson 3942* (MO), 1992, 1, 3, 1, 2; *H. flavifolius* Ulbr., *Elia 6* (MO), 1999, 12, 1, 3, 1, *H. flavifolius*, *Friis 3354* (MO), 1982, 29, 1, 3, 1, 2; *H. flavi lius*, *Gereau 6414* (MO), 2000, 11, 1, 3, 1, 2; *H. fleckii* Gürk *Seydel 2588* (MO), 1961, 50, 0, 2, 1, 3; *H. fragrans* Roxbu *Cuong 973* (MO), 2000, 11, 0, 0, 0, 0; *H. furcellatus* De *Baltzell 8351* (FLAS), 1976, 37, 0, 0, 0, 1; *H. furcellatus*, *Ca 225* (FLAS), 1967, 46, 0, 0, 0, 0; *H. furcellatus*, *Curtis 5* (FLAS), 1896, 117, 0, 0, 0, 1; *H. furcellatus*, *D'Arcy 2* (FLAS), 1968, 45, 0, 0, 0, 1; *H. furcellatus*, *Delaney 1* (FLAS), 1984, 29, 0, 0, 0, 1; *H. furcellatus*, *Gernany s.n.* (FLA 2003, 10, 0, 0, 0, 1; *H. furcellatus*, *Godfrey 65652* (FLA 1964, 49, 0, 0, 0, 1; *H. furcellatus*, *Hood 4310* (FLAS), 19 62, 0, 0, 0, 1; *H. furcellatus*, *McCart 11062* (FLAS), 1969, 0, 0, 0, 1; *H. furcellatus*, *Perkins s.n.* (FLAS), 1937, 76, 0, 0, 1; *H. furcellatus*, *Small 9494* (FLAS), 1920, 93, 0, 0, 0, 0 *furcellatus*, *Wunderlin 10188* (FLAS), 1985, 28, 0, 0, 0, 1 *gilletii* De Wild., *Lowiika 235* (MO), 1996, 15, 0, 0, 1, 2; *grandidieri* Baill., *Randriatafika 399* (MO), 2004, 7, 1, 3, 1, *H. hamabo* Siebold & Zucc., *McFadden s.n.* (FLAS), 1959, 0, 0, 0, 1; *H. heterophyllus* Vent., *Henderson H2995* (M 1983, 28, 0, 0, 1, 2; *H. hildebrandtii* Sprague & Hutch., *Mu goha 3954* (MO), 2005, 6, 1, 3, 1, 2; *H. hirtus* L., *Meijer 10* (MO), 1975, 36, 0, 0, 0, 0; *H. huegelii* Endl., *Cranfield* (MO), 1978, 33, 0, 0, 1, 2; *H. isalensis* Hochr. & Humb *Cours 5026* (MO), 1955, 56, 0, 0, 0, 1; *H. kirkii* Mast., *L 642* (MO), 1987, 24, 1, 1, 1, 2; *H. kirkii*, *Maui 1403* (M

1972, 39, 0, 1, 1, 1; *H. kokio* Hillebr. Ex Wawra, *Wood 3389* (MO), 1994, 17, 0, 0, 1, 1; *H. krichauffianus* F. Muell., *Cornwall 295* (MO), 1977, 34, 0, 0, 1, 1; *H. lavateroides* Moric. ex Ser., *Breedlove 47595* (MO), 1980, 31, 1, 1, 1, 2; *H. lavateroides, Jones 178* (MO), 1986, 25, 1, 1, 1, 2; *H. laxiflorus* A. St.-Hil., *Heringer 2617* (MO), 1979, 32, 0, 0, 0, 1; *H. lobatus* (Murray) Kuntze, *Bardot-Vaucoulon 1628* (MO), 2007, 4, 1, 3, 0, 0; *H. lobatus, Dorr 2728* (MO), 1984, 27, 0, 0, 1, 1; *H. lobatus, Harder 3650* (MO), 1996, 15, 1, 3, 1, 2; *H. lobatus, Mwasue 383* (MO), 1999, 12, 1, 3, 2, 0; *H. lobatus, Smith 4108* (MO), 1983, 28, 1, 1, 1, 1; *H. longifilus* Fryxell, *Tenorio L. 20138* (MO), 2001, 10, 1, 3, 1, 1; *H. longifilus, Tenorio L. 21310* (MO), 2001, 10, 1, 3, 2, 1; *H. ludwigii* Eckl. & Zeyh., *Ellemann 1083* (MO), 1994, 17, 1, 1, 1, 1; *H. ludwigii, Kucher 24706* (MO), 2001, 10, 1, 3, 1, 0; *H. lunarifolius* Willd., *Kayombo 2595* (MO), 1999, 12, 1, 1, 1, 1; *H. lunarifolius, Mollel 161* (MO), 2000, 11, 1, 3, 2, 1; *H. macrogonus* Baill., *Ralimanana 332* (MO), 2003, 8, 0, 0, 0, 0; *H. mandrarensis* Humbert ex Hochr., *Phillipson 3978* (MO), 1992, 19, 1, 3, 2, 1; *H. martianus* Zucc., *Ward 5712* (FLAS), 1966, 47, 0, 0, 0, 1; *H. martianus, Watson s.n.* (FLAS), 1938, 75, 0, 0, 0, 1; *H. mastersianus* Hiern, *Harder 2851* (MO), 1995, 16, 0, 0, 0, 1; *H. mastersianus, Schmidt 2475* (MO), 1997, 14, 0, 0, 0, 0; *H. mechowii* Garcke, *Metele 146* (MO), 1998, 13, 0, 0, 0, 1; *H. mechowii, Mwangulango 725* (MO), 2002, 9, 0, 0, 0, 0; *H. meyeri* Harv., *Hardy 7156* (MO), 1990, 21, 0, 1, 2, 3; *H. meyeri, Herman 1236* (MO), 1990, 21, 1, 3, 1, 2; *H. meyeri, Kucher 22642* (MO), 1999, 12, 1, 3, 1, 2; *H. micranthus* L. f., *Davidse 8430* (MO), 1974, 37, 0, 0, 1, 2; *H. micranthus, Gobbo 339* (MO), 1999, 12, 1, 3, 1, 0; *H. micranthus, Kindeketa 1094* (MO), 2001, 10, 1, 3, 1, 1; *H. micranthus, Kucher 23098* (MO), 2000, 11, 1, 1, 1, 1; *H. micranthus, McPherson 14939* (MO), 1990, 21, 1, 1, 1, 1; *H. micranthus, Smith 5700* (MO), 1994, 17, 1, 3, 1, 1; *H. micranthus, Wehing 56* (MO), 1996, 15, 1, 2, 1, 3; *H. microcarpus* Garcke, *Makwarela 30* (MO), 1997, 14, 1, 3, 2, 1; *H. migeodii* Exell, *Harder 4034* (MO), 1997, 14, 1, 3, 1, 1; *H. migeodii, Luwiika 669* (MO), 1997, 14, 1, 3, 2, 1; *H. mutabilis* L., *Beatley s.n.* (FLAS), 1948, 65, 0, 0, 0, 1; *H. mutabilis, West s.n.* (FLAS), 1937, 76, 0, 0, 0, 1; *H. mutabilis, Williams s.n.* (FLAS), 1929, 84, 0, 0, 0, 1; *H. mutatus* N.E. Br., *Leach 11328* (MO), 1961, 50, 0, 0, 0, 0; *H. nigricaulis* Baker f., *Luwiika 2354* (MO), 1996, 15, 0, 0, 0, 0; *H. noldeae, Lovett 3287* (MO), 1989, 22, 0, 0, 0, 1; *H. nyikensis* (Forssk.) Vahl, *La Croix 4731* (MO), 1987, 24, 1, 2, 1, 3; *H. ovalifolius* Bojer ex Baker, *Harder 1547* (MO), 1993, 18, 1, 1, 1, 2; *H. palmatus* Forssk., *Bidgood 6187* (MO), 2006, 5, 1, 3, 0, 1; *H. palmatus, Germishuizen 9495* (MO), 1997, 14, 1, 1, 1, 2; *H. panduriformis* Burm. f., *Ash 1348* (MO), 1971, 40, 1, 3, 0, 1; *H. panduriformis, Must 1267* (MO), 1974, 37, 0, 0, 1, 2; *H. panduriformis, Nattrass 870* (MO), 1952, 59, 0, 0, 0, 2; *H. paramutabilis* L.H. Bailey, *Bin 8533* (MO), 1999, 12, 1, 3, 0, 0; *H. paramutabilis, Min-Xiang 92346* (MO), 1992, 19, 1, 2, 1, 3; *H. paramutabilis, Zhanghui 474* (MO), 2002, 9, 1, 3, 1, 2; *H. pedunculatus* L. f., *Kemp 797* (MO), 1977, 34, 0, 0, 1, 1; *H. pedunculatus, Marques 2875* (MO), 1976, 35, 0, 0, 1, 1; *H. phoeniceus* Jacq., *Campos 6107* (MO), 1999, 12, 1, 3, 1, 2; *H. phoeniceus, Harmon 3488* (MO), 1970, 41, 0, 0, 1, 2; *H. phoeniceus, Stevens 26928* (MO), 2008, 3, 1, 3, 1, 1; *H. phoeniceus, Vasquez 27247* (MO), 2001, 10, 0, 0, 0, 0; *H. physaloides* Guill. & Perr., *Barthelat 743* (MO), 2002, 9, 1, 1, 1, 1; *H. physaloides, Barthelat 935* (MO), 2002, 9, 1, 3, 1, 1; *H. physaloides, de Nevers 3321* (MO), 1984, 27, 0, 0, 1, 1; *H. physaloides, Mwangulango 318* (MO), 1999, 12, 1, 1, 0, 0; *H. physaloides, Phillipson 3829* (MO), 1992, 19, 1, 3, 1, 0; *H. physaloides, White 1421* (MO), 1995, 16, 1, 3, 1, 1; *H. platanifolius* (Willd.) Sweet, *Brumbach 9411* (FLAS), 1978, 35, 0, 0, 0, 1; *H. platycalyx* Mast., *Schmidt 2365* (MO), 1997, 14, 1, 3, 0, 0; *H. platycalyx, Smith 2945* (MO), 1980, 31, 0, 0, 1, 2; *H. poeppigii* (Spreng.) Garcke, *Carnevali 5939* (MO), 2000, 11, 1, 3, 1, 2; *H. poeppigii, Garcia 1210* (MO), 1988, 23, 1, 1, 1, 1; *H. poeppigii, Tapia 1250* (MO), 2001, 10, 1, 3, 2, 1; *H. praeteritus* R.A. Dyer, *Fynn 49* (MO), 1991, 20, 1, 3, 1, 2; *H. praeteritus, Raymond 117* (MO), 1973, 38, 0, 0, 1, 2; *H. pusillus* Thunb., *Baylis 8490* (MO), 1978, 33, 0, 0, 1, 2; *H. pusillus, Bester 6469* (MO), 2006, 5, 1, 3, 1, 1; *H. pusillus, Fynn 31* (MO), 1991, 20, 1, 1, 1, 1; *H. pusillus, Glen 2537* (MO), 1991, 20, 1, 1, 2, 1; *H. pusillus, Kemp 1170* (MO), 1977, 34, 0, 0, 1, 1; *H. pycnostemon* Hochr., *Kayombo 3522* (MO), 2000, 11, 1, 2, 1, 3; *H. pycnostemon, Sitoni 1144* (MO), 2000, 11, 1, 3, 1, 2; *H. radiatus* Cav., *Grijalva 1500* (MO), 1982, 29, 0, 0, 0, 0; *H. radiatus, Guzman 1122* (MO), 1980, 31, 0, 0, 0, 0; *H. rhodanthus* Gürke ex Schinz, *Baylis 10159* (MO), 1984, 27, 0, 1, 2, 3; *H. rhodanthus, Brooks 186* (MO), 1990, 21, 1, 1, 1, 1; *H. rhodanthus, Gereau 5207* (MO), 1993, 18, 1, 3, 1, 1; *H. rhodanthus, Harder 1204* (MO), 1992, 19, 1, 3, 2, 1; *H. ribifolius* A. Gray, *Harbison s.n.* (FLAS), 1959, 54, 0, 0, 0, 1; *H. rosa-sinensis* L., *Avery 1669* (FLAS), 1976, 37, 0, 0, 0, 1; *H. rosa-sinensis, Dickey s.n.* (FLAS), 1939, 74, 0, 0, 0, 1; *H. rosa-sinensis, Hume s.n.* (FLAS), 1949, 64, 0, 0, 0, 1; *H. rosa-sinensis, McFarlin 10420* (FLAS), 1935, 78, 0, 0, 0, 1; *H. rosa-sinensis, McFarlin 8892* (FLAS), 1934, 79, 0, 0, 0, 0; *H. rosa-sinensis, Meyer & Mazzeo 14305* (FLAS), 1973, 40, 0, 0, 0, 1; *H. rosa-sinensis, Meyer & Mazzeo 14306* (FLAS), 1973, 40, 0, 0, 0, 0; *H. rosa-sinensis, Shearn 963* (FLAS), 1982, 31, 0, 1, 2, 3; *H. rosa-sinensis, Smith s.n.* (FLAS), 1979, 34, 1, 1, 2, 3; *H. rostellatus* Guill. & Perr., *Fay 6323* (MO), 1984, 27, 0, 0, 0, 1; *H. rostellatus, Festo 253* (MO), 1999, 12, 0, 0, 0, 1; *H. sabdariffa* L., *West s.n.* (FLAS), 1943, 70, 0, 0, 0, 1; *H. schinzii* Gürke, *Marques s.n.* (MO), 1974, 37, 0, 0, 1, 1; *H. schinzii, Smith 3285* (MO), 1980, 31, 0, 1, 1, 1; *H. schizopetalus* (Dyer) Hook. f., *McCart 9367* (FLAS), 1967, 46, 0, 0, 1, 1; *H. schizopetalus, Watson s.n.* (FLAS), 1939, 74, 0, 0, 0, 1; *H. scotellii* Baker f., *Gautier 28802* (MO), 1992, 19, 0, 0, 0, 1; *H. selloi* Gürke, *Krapovickas 46128* (MO), 1994, 17, 1, 1, 1, 2; *H. sidiformis* Baill., *Harder 3835* (MO), 1997, 14, 1, 3, 1, 2; *H. sidiformis, Ratovonsoa 753* (MO), 2004, 7, 0, 0, 1, 1; *H. sidiformis, Schmidt 2409* (MO), 1997, 14, 1, 1, 1, 1; *H. sinosyriacus* L.H. Bailey, *Lai 12* (MO), 1996, 15, 1, 3, 1, 1; *H. solandra* L'Hér., *Adams 15001* (MO), 1983, 28, 0, 0, 1, 2; *H. somalensis* Franch., *Gobbo 714* (MO), 2000, 11, 1, 3, 1, 2; *H. somalensis, Kayombo 2258* (MO), 1999, 12, 1, 3, 1, 1; *H. squamosus* Hochr., *Fay 5866* (MO), 1983, 28, 0, 0, 0, 1; *H. squamosus, Madsen 6201* (MO), 1996, 15, 0, 0, 0, 1; *H. stenophyllus* Baker, *Labat 3658* (MO), 2006, 5, 1, 3, 1, 2; *H. sterculiifolius* (Guill. & Perr.) Steud., *Duvall 374* (MO), 1999, 12, 1, 3, 2, 1; *H. striatus* Cav., *Zardini 57076* (MO), 2001, 10, 1, 1, 1, 1; *H. sturtii* Hook., *Bernardi 10* (MO), 1982, 29, 1, 1, 1, 1; *H. sturtii, Latz 13519* (MO), 1993, 18, 1, 3, 1, 2; *H. sturtii, Maconochie 1675* (MO), 1973, 38, 0, 0, 0, 1; *H. sturtii, Maconochie 1692* (MO), 1973, 38, 0, 0, 0, 1; *H. subreniformis* Burtt Davy, *Grosvenor 799* (MO), 1973, 38, 0, 0, 0, 1; *H. surattensis* L.,

Ching-I Peng 17869 (MO), 1999, 12, 0, 0, 0, 1; *H. surattensis*, *Mbora 365* (MO), 2000, 11, 0, 0, 0, 0; *H. surattensis*, *Mlangwa 1820* (MO), 2001, 10, 0, 0, 0, 0; *H. syriacus* L., *Arnold s.n.* (FLAS), 1936, 77, 0, 0, 0, 1; *H. syriacus*, *Harrison & R. Garren 34* (FLAS), 1975, 38, 0, 0, 0, 1; *H. syriacus*, *Weber s.n.* (FLAS), 1932, 81, 0, 0, 0, 1; *H. thespesianus* Baill., *Noyes 1026* (MO), 1992, 19, 1, 3, 2, 1; *H. trionum* L., *Guocheng-yong 20065-277-4* (MO), 2006, 5, 1, 3, 1, 1; *H. trionum*, *Henderson 95-760* (MO), 1995, 16, 1, 2, 1, 3; *H. trionum*, *Tadesse 12038* (MO), 2005, 6, 1, 3, 2, 1; *H. uncinellus* DC., *Gillis 9511* (FLAS), 1970, 43, 0, 0, 0, 0; *H. urticifolius* A. St.-Hil. & Naudin, *Fernandez Casas 6181* (MO), 1982, 29, 0, 0, 0, 1; *H. vitifolius* L., *Pierce 56* (FLAS), 1952, 61, 0, 0, 0, 1; *H. welbyi* Sprague, *de Wilde 5047* (MO), 1969, 42, 1, 1, 1, 1; *Howittia trilocularis* F. Muell., *Nordenstam 1263* (MO), 1989, 22, 0, 0, 0, 0; *Humbertiella* Hochr., *Manjakahery 110* (MO), 2006, 5, 1, 1, 1, 2; *Humbertiella decaryi* (Hochr.) Dorr, *Baum 385* (MO), 2003, 8, 0, 0, 0, 0; *H. decaryi*, *Capuron s.n.* (MO), 1968, 45, 0, 1, 2, 3; *H. decaryi*, *McPherson 14942* (MO), 1990, 21, 1, 3, 1, 1; *H. decaryi*, *Phillipson 2649* (MO), 1987, 24, 0, 1, 2, 3; *H. decaryi*, *Phillipson 3473* (MO), 1990, 21, 0, 1, 1, 1; *H. quararibeoides* Hochr., *Baum 389* (MO), 2003, 8, 1, 3, 2, 0; *H. quararibeoides*, *Luckow 4314* (MO), 1998, 13, 1, 3, 2, 1; *H. quararibeoides*, *McPherson 17457* (MO), 1998, 13, 0, 0, 1, 1; *Kosteletzkya reflexiflora* Hochr., *Phillipson 2898* (MO), 1988, 23, 1, 1, 1, 2; *K. retrobracteata* Hochr., *Bardot-Vaucoulon 1555* (MO), 2007, 4, 1, 3, 2, 0; *Malvaviscus concinnus* Kunth, *Araujo-M. 874* (MO), 2004, 7, 1, 1, 1, 1; *M. concinnus*, *Callejas 10454* (MO), 1992, 19, 1, 1, 1, 3; *M. concinnus*, *Hammel 4096* (MO), 1978, 33, 0, 0, 0, 1; *M. williamsii* Ulbr., *Harling 16693* (MO), 1980, 31, 0, 0, 0, 1; *M. williamsii*, *McDaniel 15218* (MO), 1971, 40, 0, 0, 0, 1; *Megistostegium microphyllum* Hochr., *Dorr 4110* (MO), 1985, 26, 0, 0, 1, 2; *M. microphyllum*, *Dumetz 1245* (MO), 1990, 21, 1, 1, 2, 1; *M. microphyllum*, *McPherson 14961* (MO), 1990, 21, 1, 1, 1, 1; *M. microphyllum*, *Schatz 2967* (MO), 1990, 21, 1, 1, 1, 1; *M. microphyllum*, *Willing 71* (MO), 1988, 23, 0, 1, 2, 3; *M. nodulosum* (Drake) Hochr., *Keating 2242* (MO), 1989, 22, 1, 1, 1, 2; *M. perrieri* Hochr., *Schatz 2971* (MO), 1990, 21, 0, 0, 0, 1; *Pavonia* Cav., *Ash 2430* (MO), 1974, 37, 0, 0, 1, 2; *Pavonia* Cav., *Friis 3351* (MO), 1982, 29, 1, 1, 2, 3; *Pavonia almasana* Ulbr., *Harley 55518* (MO), 2006, 5, 1, 3, 1, 1; *P. angustifolia* Benth., *Phillippe 21398* (MO), 1993, 18, 1, 1, 1, 1; *P. anisaster* (Standl.) Fryxell, *Flores-Franco 3791* (MO), 1994, 17, 1, 1, 1, 1; *P. arabica* Hochst. ex Steud., *Ash 2557* (MO), 1974, 37, 0, 0, 0, 1; *P. argentina* Gürke, *Krapovickas 30817* (MO), 1977, 34, 1, 1, 1, 2; *P. aurigloba* Krapov. & Cristóbal, *Krapovickas 47544* (MO), 1998, 13, 1, 1, 1, 2; *P. aurigloba*, *Quarin 2908* (MO), 1975, 36, 0, 0, 1, 2; *P. betonicifolia* C. Presl, *Pedersen 13407* (MO), 1982, 29, 0, 0, 1, 2; *P. burchellii* (DC.) R.A. Dyer, *Boulos 11406* (MO), 1977, 34, 0, 0, 1, 2; *P. burchellii*, *Rasabarindore 5849* (MO), 2004, 7, 1, 1, 1, 1; *P. burchellii*, *Simon 59* (MO), 1999, 12, 1, 3, 1, 1; *P. burchellii*, *Venter 10222* (MO), 2003, 8, 1, 3, 1, 0; *P. calycina* Ulbr., *Zimba 1000* (MO), 1997, 14, 1, 3, 1, 2; *P. cancellata* (L.) Cav., *Haber 8903* (MO), 1988, 23, 0, 1, 1, 1; *P. cancellata*, *Krapovickas 42905* (MO), 1989, 22, 1, 1, 1, 1; *P. cancellata*, *Short 152* (MO), 1996, 15, 1, 3, 1, 2; *P. castaneifolia* A. St.-Hil. & Naudin, *Harling 24230* (MO), 1985, 26, 1, 2, 1, 3; *P. castaneifolia*, *Mayfield s.n.* (MO), 2001, 10, 1, 1, 1, 1; *P. clathrata* Mast., *Balkwill 4332* (MO), 1989, 22, 1, 3, 1, 2; *P. coccinea* Cav., *Gentry 50560* (MO), 1985, 26, 1, 1, 1, 2; *P. columella* Cav., *Chap-*
man 8720 (MO), 1987, 24, 1, 2, 1, 3; *P. columella*, *Leveridge*
(MO), 1961, 50, 0, 0, 0, 1; *P. columella*, *Stalmans 1594* (MO
1987, 24, 1, 3, 1, 2; *P. columella*, *Stalmans 316* (MO), 1984, 2
0, 1, 2, 3; *P. communis* A. St.-Hil., *Zardini 8578* (MO), 19
23, 1, 1, 2, 3; *P. commutata* Gürke, *Krapovickas 43957* (MO
1992, 19, 1, 1, 1, 1; *P. cryptica* Krapov. & Cristóbal, *Jimen*
845 (MO), 2008, 3, 1, 3, 0, 0; *P. cymbalaria* A. St.-Hil.
Naudin, *Proyecto Ventania 659* (MO), 1979, 32, 0, 0, 1, 2;
dasypetala Turcz., *Foster 1455* (MO), 1969, 42, 0, 0, 0, 1;
dentata Burtt Davy, *Straub 152* (MO), 1983, 28, 1, 1, 2, 3;
dusenii Krapov., *Krapovickas 41956* (MO), 1988, 23, 0, 0, 1,
P. eurychlamys Ulbr., *Gutierrez 1046* (MO), 2004, 7, 1, 3, 2,
P. flavispina Miq., *Krapovickas 35498* (MO), 1980, 31, 0, 0,
1; *P. flavoferruginea* (Forssk.) Hepper & J.R.I. Wood, *Liebenb*
8828 (MO), 1977, 34, 0, 0, 0, 1; *P. flavoferruginea*, *Simon 6*
(MO), 2001, 10, 1, 3, 1, 1; *P. formosa* Fryxell, *Apasa 82* (MO
2007, 4, 1, 3, 1, 1; *P. friesii* Krapov., *Gutierrez 1116* (MO
2004, 7, 1, 3, 1, 1; *P. fruticosa* (Mill.) Fawc. & Rendle, *Mayfi*
s.n. (Sp. ID 585-585-1205) (MO), 2001, 10, 0, 0, 0, 1; *P. fru*
cosa, *McDaniel 23669* (MO), 1980, 31, 1, 3, 1, 1; *P. frutico*
Taylor 11637 (MO), 1994, 17, 1, 3, 1, 2; *P. fruticosa*, *Te*
1009 (MO), 2007, 4, 1, 1, 1, 1; *P. fryxellii* Krapov., *Term*
12561 (MO), 1988, 23, 1, 3, 1, 2; *P. garckeana* Gürke, *Hats*
bach 43833 (MO), 1981, 30, 0, 0, 0, 1; *P. garckeana*, *Villarr*
2047 (MO), 2008, 3, 1, 1, 1, 1; *P. geminiflora* Moric., *Janss*
cobs 2753 (MO), 1992, 19, 1, 3, 0, 0; *P. glaziouiana* Gürk
Harley 18936 (MO), 1977, 34, 0, 0, 0, 1; *P. glechomifolia* (
Rich.) Garcke, *O'Brien 194* (MO), 1985, 26, 0, 0, 1, 1;
glechomoides A. St.-Hil., *Cervantes E. 25* (MO), 2006, 5, 1, 3,
2; *P. gracilis* R.E. Fr., *Nee 38930* (MO), 1990, 21, 1, 1, 1, 1;
grandiflora A. St.-Hil., *Irwin 26532* (MO), 1970, 41, 0, 1, 2,
P. guerkeana R.E. Fr., *Krapovickas 22998* (MO), 1973, 38, 0,
1, 2; *P. guerkeana*, *Oliviera 238* (MO), 1980, 31, 0, 0, 1, 2;
harleyi Krapov., *Marim 1686* (MO), 1994, 17, 1, 1, 3, 1;
hassleriana Chodat, *Krapovickas 44588* (MO), 1993, 18, 1,
1, 2; *P. hastata* Cav., *Lepschi 534* (MO), 1991, 20, 1, 1, 2, 3;
hastata, *Villarroel 1414* (MO), 2007, 4, 1, 3, 1, 1; *P. hast*
Zardini 56658 (MO), 2001, 10, 0, 0, 0, 0; *P. heterotricha* Fry
ell, *Nee 48381* (MO), 1998, 13, 1, 1, 1, 2; *P. hieronymi* Gürk
Gutierrez 755 (MO), 2004, 7, 1, 1, 1, 1; *P. hieronymi* Gürk
Lozano 1363-A (MO), 2005, 6, 1, 3, 1, 1; *P. hieronymi* Gürk
Zardini 29464 (MO), 1991, 20, 1, 2, 1, 3; *P. humifusa* A. S
Hil., *Krapovickas 31548* (MO), 1977, 34, 0, 0, 1, 2; *P. immu*
lata R.E. Fr., *Flores 62* (MO), 2008, 3, 1, 3, 2, 1; *P. ianthocy*
Krapov., *Fuentes 3326* (MO), 2001, 10, 1, 1, 1, 1; *P. kiliman*
scharica Gürke, *Muasumbi 16187* (MO), 1992, 19, 1, 1, 2,
P. kilimandscharica, *Simon 601* (MO), 2000, 11, 1, 3, 2, 1;
kotschyi Hochst. ex Webb, *Wieland 4495* (MO), 1987, 24, 1,
2, 1; *P. laxifolia* A. St.-Hil., *Soloman 13715* (MO), 1985, 26,
1, 2, 3; *P. leiocarpa* Urb., *Burch 2530* (MO), 1970, 41, 1, 1,
3; *P. leucantha* Poepp. ex Garcke, *Korning 47064* (MO), 19
28, 0, 0, 1, 2; *P. macdougallii* Fryxell, *Hernandez 2318* (MO
1998, 13, 1, 1, 1, 1; *P. malacophylla* (Link & Otto) Garc
Nelson 4685 (MO), 1971, 40, 1, 1, 1, 1; *P. malacophylla*, *Wil*
3328 (MO), 1996, 15, 1, 1, 1, 1; *P. martii* Colla, *Irwin 23*
(MO), 1969, 42, 0, 1, 2, 3; *P. mattogrossensis* R.E. Fr., *Krap*
vickas 44410 (MO), 1993, 18, 1, 1, 1, 1; *P. missionum* Ekm
Krapovickas 14835 (MO), 1969, 42, 0, 0, 1, 2; *P. monta*
Fryxell, *Alvarado C. 728* (MO), 2002, 9, 1, 3, 1, 0; *P. multiflo*

A. St.-Hil., *Kallunki 588* (MO), 1994, 17, 1, 3, 1, 1; *P. mutisii* Kunth, *Nee 47856* (MO), 1998, 13, 1, 1, 1, 1; *P. narcissi* Krapov., *Zardini 9203* (MO), 1989, 22, 1, 1, 1, 2; *P. nayarensis* Fryxell, *Flores F. 1302* (MO), 1989, 22, 1, 3, 2, 1; *P. opulifolia* S. Moore, *Zardini 27616* (MO), 1991, 20, 1, 1, 2, 3; *P. oxyphyllaria* Donn. Sm., *Beaty 651* (MO), 1973, 38, 0, 0, 0, 1; *P. oxyphyllaria*, *Liesner 5062* (MO), 1978, 33, 0, 0, 0, 1; *P. oxyphyllaria*, *Villarroel 4* (MO), 2004, 7, 1, 3, 1, 1; *P. paludicola* Nicolson ex Fryxell, *Prevost 4104* (MO), 2001, 10, 0, 0, 1, 1; *P. paludicola*, *Worthington 21260* (MO), 1992, 19, 1, 3, 2, 1; *P. paniculata* Cav., *Haenicke 49* (MO), 1988, 23, 1, 3, 1, 2; *P. paniculata*, *Milanowski 5 Jan 9* (MO), 1972, 39, 1, 1, 2, 3; *P. paniculata*, *Whitefoord 10126* (MO), 1993, 18, 1, 3, 1, 2; *P. pauciloba* Hochr., *Belgrano 329* (MO), 1998, 13, 1, 3, 1, 1; *P. penduliflora* (Standl.) Standl., *Fernandez 333* (MO), 2005, 6, 1, 1, 1, 1; *P. peruviana* Gürke, *Dodson 8795* (MO), 1992, 19, 0, 0, 0, 1; *P. peruviana*, *Haber 680* (MO), 1979, 32, 0, 0, 0, 1; *P. peruviana*, *Morales 2759* (MO), 1984, 27, 0, 0, 1, 1; *P. peruviana*, *Nee 9761* (MO), 1994, 17, 1, 1, 1, 1; *P. pleuranthera* (DC.) Fryxell, *Tellez V.* 1974, 37, 0, 0, 0, 1; *P. praemorsa* Cav., *Youtbed 11842* (MO), 1989, 22, 1, 1, 1, 2; *P. procumbens* Walp., *Sedtan 737* (MO), 1998, 13, 1, 2, 1, 3; *P. pseudotyphalaea* Planch. & Linden ex Triana & Planch., *Delgado 71* (MO), 1969, 42, 0, 1, 2, 3; *P. rambai* Krapov. & Cristóbal, *Seur 282* (MO), 1999, 12, 0, 1, 1, 1; *P. ramosissimum* (Arechav.) Fryxell & Krapov., *Krapovickas 41933* (MO), 1999, 12, 1, 3, 2, 1; *P. rehmannii* Szyszyl., *Seydel 4484* (MO), 1988, 23, 0, 0, 1, 2; *P. rosea* Wall. ex Moris, *Castillo M. 2103* (MO), 1967, 44, 1, 1, 1, 1; *P. rosea*, *Melendez 929* (MO), 1993, 18, 0, 0, 1, 2; *P. rupestris* (Hassl.) Krapov. & Cristóbal, *Perez 504* (MO), 2005, 6, 1, 2, 1, 0; *P. sagittata* A. St.-Hil., *Krapovickas 35349* (MO), 1991, 20, 1, 2, 1, 3; *P. schiedeana* Steud., *Dwyer 7937* (MO), 1980, 31, 0, 0, 1, 2; *P. schiedeana*, *Oliverio 287* (MO), 1967, 44, 0, 0, 0, 1; *P. schiedeana*, *Reyes-Garcia 7436* (MO), 1981, 30, 0, 0, 1, 2; *P. schimperiana* Hutch. & Dalziel, *Friis 8856* (MO), 2004, 7, 0, 0, 0, 1; *P. schrankii* Spreng., *Krapovickas 40761* (MO), 1998, 13, 1, 1, 1, 2; *P. senegalensis* Leistner, *Davidse 6379* (MO), 1987, 24, 0, 1, 2, 3; *P. senegalensis* Leistner, *Long 429* (MO), 1974, 37, 0, 0, 1, 2; *P. senegalensis* Leistner, *Stevens 30* (MO), 1987, 24, 1, 1, 2, 3; *P. sepioides* Fryxell & Krapov., *Harling 22308* (MO), 2002, 9, 1, 3, 2, 1; *P. sepioides*, *Nee 45332* (MO), 1985, 26, 1, 1, 2, 3; *P. tiliifolia* Kunth, *Guareco 248* (MO), 1994, 17, 1, 3, 1, 0; *Talipariti hastatum* (L. f.) Fryxell, *Gaskins s.n.* (FLAS), 1995, 16, 1, 3, 1, 2; *T. tiliaceum* (L.) Fryxell, *West s.n.* (FLAS), 1959, 54, 1, 1, 1, 2; 1949, 64, 0, 0, 1, 1.

C) Frozen at -20C and -80C: *Chrysanthemum* L. (Asteraceae), *Urbatsch 7055* (LSU), 1995, 18, 1, 3, 1, 2; *Chrysothamnus depressus* Nutt. (Asteraceae), *NA* (NA), 2001, 12, 1, 3, 1, 1; *Chrysothamnus* Nutt. (Asteraceae), *NA* (NA), 2000, 13, 1, 3, 1, 2; *Lorandersonia spathulata* (L.C. Anderson) Urbatsch, R.P. Roberts & Neubig (Asteraceae), *NA* (NA), 2001, 12, 1, 3, 1, 1; *Columbiadoria* G.L. Nesom (Asteraceae), *NA* (NA), 2000, 13, 1, 3, 1, 1; *Rudbeckia amplexicaulis* Vahl (Asteraceae), *Urbatsch 6440* (LSU), 1990, 23, 1, 3, 1, 2; *Echinacea angustifolia* DC. (Asteraceae), *Bollick s.n.* (LSU), 1995, 18, 1, 3, 1, 1; *Echinacea purpurea* (L.) Moench (Asteraceae), *Urbatsch 7050* (LSU), 1995, 18, 1, 3, 1, 1; *Echinacea purpurea* (L.) Moench (Asteraceae), *Urbatsch 5879* (LSU), 1989, 24, 1, 3, 1, 1; *Echinacea sanguinea* Nutt. (Asteraceae), *Urbatsch 6001* (LSU), 1989, 24, 1, 3, 1, 1; *Ericameria bloomeri* (A. Gray) J.F. Macbr. (Asteraceae), *NA* (NA), 2000, 13, 1, 3, 1, 1; *Ericameria gilmanii* (S.F. Blake) G.L. Nesom (Asteraceae), *NA* (NA), 2001, 12, 1, 3, 1, 1; *Ericameria laricifolia* (A. Gray) Shinners (Asteraceae), *NA* (NA), 1992, 21, 1, 3, 1, 1; *Ericameria linearifolia* (DC.) Urbatsch & Wussow (Asteraceae), *NA* (NA), 2001, 12, 1, 3, 1, 1; *Ericameria nana* Nutt. (Asteraceae), *NA* (NA), 2001, 12, 1, 3, 1, 1; *Ericameria paniculata* (A. Gray) Rydb. (Asteraceae), *NA* (NA), 2001, 12, 1, 3, 1, 1; *Ericameria parishii* (Greene) H.M. Hall (Asteraceae), *NA* (NA), 1995, 18, 0, 0, 1, 2; *Ericameria teretifolia* (Durand & Hilg.) Jeps. (Asteraceae), *NA* (NA), 2001, 12, 1, 3, 1, 1; *Ericameria zionis* (L.C. Anderson) G.L. Nesom (Asteraceae), *NA* (NA), 2000, 13, 1, 3, 1, 2; *Eurybia* (Cass.) Cass. (Asteraceae), *NA* (NA), 2001, 12, 1, 3, 1, 1; *Gaillardia aestivalis* (Walter) H. Rock (Asteraceae), *Urbatsch 7057* (LSU), 1995, 18, 1, 3, 1, 1; *Helenium bigelovii* A. Gray (Asteraceae), *Urbatsch 6798* (LSU), 1990, 23, 1, 3, 1, 1; *Ratibida pinnata* (Vent.) Barnhart (Asteraceae), *Urbatsch 6518* (LSU), 1990, 23, 1, 3, 1, 1; *Rudbeckia alpicola* Piper (Asteraceae), *Urbatsch 6810* (LSU), 1990, 23, 1, 3, 1, 1; *Rudbeckia fulgida* Aiton (Asteraceae), *Urbatsch 7117* (LSU), 1996, 17, 1, 3, 1, 2; *Rudbeckia fulgida* Aiton (Asteraceae), *Urbatsch 7118* (LSU), 1996, 17, 1, 3, 1, 2; *Rudbeckia fulgida* Aiton (Asteraceae), *Urbatsch 7106* (LSU), 1996, 17, 1, 3, 1, 2; *Rudbeckia grandiflora* (Sweet) J.F. Gmel. ex DC. (Asteraceae), *Urbatsch 5866* (LSU), 1989, 24, 1, 3, 1, 1; *Rudbeckia hirta* L. (Asteraceae), *Urbatsch 6607* (LSU), 1990, 23, 1, 3, 1, 2; *Rudbeckia hirta* L. (Asteraceae), *Urbatsch 7115* (LSU), 1992, 21, 1, 3, 1, 2; *Rudbeckia klamathensis* P.B. Cox & Urbatsch (Asteraceae), *Urbatsch 6801* (LSU), 1990, 23, 1, 3, 1, 1; *Rudbeckia laciniata* L. (Asteraceae), *NA* (NA), 1992, 21, 1, 3, 1, 1; *Rudbeckia missouriensis* Engelm. ex C.L. Boynton & Beadle (Asteraceae), *NA* (NA), 1996, 17, 1, 3, 1, 1; *Rudbeckia missouriensis* Engelm. ex C.L. Boynton & Beadle (Asteraceae), *Urbatsch 7115* (LSU), 1992, 21, 1, 3, 1, 2; *Rudbeckia mohrii* A. Gray (Asteraceae), *Urbatsch 6701* (LSU), 1990, 23, 1, 3, 1, 1; *Rudbeckia mohrii* A. Gray (Asteraceae), *Urbatsch 6703* (LSU), 1990, 23, 1, 3, 1, 1; *Rudbeckia nitida* Nutt. (Asteraceae), *Urbatsch 6659* (LSU), 1990, 23, 1, 3, 1, 1; *Rudbeckia triloba* L. (Asteraceae), *Urbatsch 6262* (LSU), 1989, 24, 1, 3, 2, 1; *Silphium compositum* Michx. (Asteraceae), *Urbatsch 6626* (LSU), 1990, 23, 1, 3, 1, 1; *Silphium compositum* Michx. (Asteraceae), *Urbatsch 6678* (LSU), 1990, 23, 1, 3, 1, 1; *Smallanthus uvedalia* (L.) Mack. (Asteraceae), *Urbatsch 7020* (LSU), 1994, 19, 1, 3, 1, 1; *Tonestus* A. Nelson (Asteraceae), *NA* (NA), 2001, 12, 1, 3, 1, 1; *Chrysothamnus* Nutt. (Asteraceae), *NA* (NA), 2000, 13, 1, 3, 1, 1; *Wyethia amplexicaulis* (Nutt.) Nutt. (Asteraceae), *Urbatsch 6809* (LSU), 1990, 23, 1, 3, 1, 1; *Wyethia* Nutt. (Asteraceae), *Urbatsch 6800* (LSU), 1990, 23, 1, 3, 1, 1; *Gleditsia triacanthos* L. (Fabaceae), *Urbatsch 7041* (LSU), 1995, 18, 1, 3, 1, 2; *Sassafras albidum* (Nutt.) Nees (Lauraceae), *Urbatsch 6507* (LSU), 1990, 23, 1, 3, 1, 1; *Amianthium muscitoxicum* (Walter) A. Gray (Melanthiaceae), *NA* (NA), 1995, 18, 1, 3, 1, 1; *Chamaelirium* Willd. (Melanthiaceae), *NA* (NA), 1999, 14, 0, 0, 0, 1; *Veratrum californicum* Durand (Melanthiaceae), *NA* (NA), 1995, 18, 1, 3, 1, 2; *Zigadenus densus* (Desr.) Fernald (Melanthiaceae), *NA* (NA), 1995, 18, 0, 0, 0, 0; *Zigadenus densus* (Desr.) Fernald (Melanthiaceae), *NA* (NA), 1995, 18, 1, 3, 1, 1; *Zigadenus nuttallii* (A. Gray) S. Watson (Melanthiaceae), *NA* (NA), 1995, 18, 1, 3, 1, 1; *Tridens flavus* (L.) Hitchc. (Poaceae), *NA* (NA), 1998, 15, 1, 3, 1, 2; *Tridens flavus* (L.) Hitchc. (Poaceae), *NA* (NA), 1998, 15, 1, 3, 1, 2; *Tridens flavus* (L.) Hitchc. (Poaceae), *NA* (NA), 1998, 15, 1, 3, 1, 1; *Tridens strictus* (Nutt.) Nash (Poaceae), *NA* (NA), 1998, 15, 1, 3, 1, 1; *Zanthoxylum clava-herculis* subsp. *fruticosum* (A. Gray) Reynel (Rutaceae), *NA* (NA), 1998, 15, 1, 3, 1, 2. **Silica-dried and in falcon tubes:** *Alstroemeria* L. (Alstroemeriaceae), *Zomlefer 722* (FLAS), 1999, 14, 0, 1, 1, 1; *Zephyranthes* Herb. (Amaryllidaceae), *Pittillo s.n.* (FLAS), 1999, 14, 1, 1, 1, 1; *Zephyranthes* Herb. (Amaryllidaceae), *Pittillo s.n.* (FLAS), 1999, 14, 1, 1, 1, 1; *Zephyranthes* Herb. (Amaryllidaceae), *Pittillo s.n.* (FLAS), 1999, 14, 0, 1, 1, 1; *Ilex opaca* Aiton (Aquifoliaceae), *Soltis s.n.* (NA), 1995, 18, 0, 2, 1, 3; *Podophyllum peltatum* L. (Berberidaceae), *Soltis 2522* (NA), 1995, 18, 1, 3, 1, 1; *Brexia madagascariensis* (Lam.) Ker Gawl. (Celastraceae), *Herbst s.n.* (NA), 1995, 18, 1, 3, 1, 1; *Gloriosa superba* L. (Colchicaceae), *Zomlefer 659* (FLAS), 1997, 16, 0, 1, 1, 1; *Juglans nigra* L. (Juglandaceae), *Soltis 2520* (NA), 1995, 18, 0, 1, 2, 3; *Lilium catesbaei* Walter (Liliaceae), *Zomlefer 767* (FLAS), 1999, 14, 1, 3, 1, 1; *Amianthium muscitoxicum* (Walter) A. Gray (Melanthiaceae), *NA* (FLAS), 1999, 14, 0, 1, 1, 1; *Amianthium muscitoxicum* (Walter) A. Gray (Melanthiaceae), *NA* (FLAS), 1998, 15, 0, 1, 1, 1; *Amianthium muscitoxicum* (Walter) A. Gray (Melanthiaceae), *Pittillo s.n.* (FLAS), 1999, 14, 0, 1, 1, 1; *Amianthium muscitoxicum* (Walter) A. Gray (Melanthiaceae), *Pittillo s.n.* (FLAS), 1999, 14, 0, 1, 1, 1; *Amianthium muscitoxicum* (Walter) A. Gray (Melanthiaceae), *Pittillo s.n.* (FLAS), 1999, 14, 0, 1, 1, 1; *Amianthium muscitoxicum* (Walter) A. Gray (Melanthiaceae), *Zomlefer 716* (FLAS), 1999, 14, 1, 3, 1, 1; *Amianthium muscitoxicum* (Walter) A. Gray (Melanthiaceae), *Wyble 305* (FLAS), 1999, 14, 0, 1, 1, 1; *Chamaelirium luteum* (L.) A. Gray (Melanthiaceae), *Wieboldt 10170* (FLAS), 1999, 14, 1, 3, 1, 1; *Melanthium latifolium* Desr. (Melanthiaceae), *NA* (FLAS), 1999, 14, 1, 3, 1, 1; *Melanthium latifolium* Desr. (Melanthiaceae), *Wieboldt s.n.* (FLAS), 1999, 14, 1, 3, 1, 1; *Melanthium latifolium* Desr. (Melanthiaceae), *Pittillo s.n.* (FLAS), 1999, 14, 1, 3, 1, 1; *Melanthium latifolium* Desr. (Melanthiaceae), *Pittillo s.n.* (FLAS), 1999, 14, 1, 3, 1, 1; *Melanthium parviflorum* (Michx.) S. Watson (Melanthiaceae), *Pittillo s.n.* (FLAS), 1999, 14, 0, 1, 1, 1; *Melanthium parviflorum* (Michx.) S. Watson (Melanthiaceae), *Pittillo s.n.* (FLAS), 1999, 14, 0, 1, 1, 1; *Melanthium parviflorum* (Michx.) S. Watson (Melanthiaceae), *Pittillo s.n.* (FLAS), 1999, 14, 0, 1, 1, 1; *Melanthium parviflorum* (Michx.) S. Watson (Melanthiaceae), *Pittillo s.n.* (FLAS), 1999, 14, 0, 1, 1, 1; *Melanthium virginicum* L. (Melanthiaceae), *NA* (FLAS), 1999, 14, 1, 3, 1, 1; *Melanthium virginicum* L. (Melanthiaceae), *Zomlefer 697* (FLAS), 1998, 15, 0, 1, 1, 1; *Schoenocaulon dubium* (Michx.) Small (Melanthiaceae), *F-673* (FLAS), 1998, 15, 0, 1, 1, 1; *Schoenocaulon texanum* Scheele (Melanthiaceae), *Sivinski 4712* (FLAS), 1999, 14, 0, 1, 1, 1; *Schoenocaulon texanum* Scheele (Melanthiaceae), *Sivinski 4836* (FLAS), 1999, 14, 1, 3, 1, 1; *Schoenocaulon texanum* Scheele (Melanthiaceae), *Worthington 28255* (FLAS), 1998, 15, 1, 1, 1, 1; *Schoenocaulon texanum* Scheele (Melanthiaceae), *Wendt 7016* (FLAS), 1999, 14, 1, 3, 1, 2; *Stenanthium gramineum* (Ker Gawl.) Morong (Melanthiaceae), *Gholson 12683* (FLAS), 1999, 14, 1, 3, 2, 1; *Stenanthium gramineum* (Ker Gawl.) Morong (Melanthiaceae), *Wyble 308* (FLAS), 1999, 14, 0, 1, 1, 2; *Stenanthium gramineum* (Ker Gawl.) Morong (Melanthiaceae), *Pittillo s.n.* (FLAS), 1999, 14, 1, 3, 2, 1; *Trillium maculatum* Raf. (Melanthiaceae), *Whitten s.n.* (FLAS),

1998, 15, 1, 3, 2, 1; *Veratrum album* L. (Melanthiaceae), *F*
selbach s.n. (FLAS), 1999, 14, 1, 3, 1, 1; *Veratrum californic*
Durand (Melanthiaceae), *Roth 1012a* (FLAS), 1999, 14, 1,
1, 1; *Veratrum californicum* Durand (Melanthiaceae), *R*
1012b (FLAS), 1999, 14, 1, 3, 1, 1; *Veratrum californicum* (
rand (Melanthiaceae), *Sivinski 4985* (FLAS), 1999, 14, 1, 3
2; *Melanthium parviflorum* (Michx.) S. Watson (Melanthia
ae), *Wyble 307* (FLAS), 1999, 14, 1, 1, 1, 1; *Veratrum*
(Melanthiaceae), *Gerald Smith s.n.* (FLAS), 1999, 14, 1, 3, 1
Veratrum viride Aiton (Melanthiaceae), *Wyble 306* (FLA
1999, 14, 1, 3, 2, 1; *Veratrum viride* Aiton (Melanthiace
Wieboldt 10172 (FLAS), 1999, 14, 1, 3, 1, 1; *Melanthium w*
dii (J.W. Robbins ex Alph. Wood) Bodkin (Melanthiaceae),
(FLAS), 1998, 15, 1, 3, 2, 1; *Melanthium woodii* (J.W. Robb
ex Alph. Wood) Bodkin (Melanthiaceae), *Gholson s.n.* (FLA
1999, 14, 1, 3, 1, 1; *Zigadenus densus* (Desr.) Fernald (Mel
thiaceae), *NA* (FLAS), 1998, 15, 1, 3, 2, 1; *Zigadenus de*
(Desr.) Fernald (Melanthiaceae), *NA* (FLAS), 1998, 15, 0, 1
1; *Zigadenus elegans* Pursh (Melanthiaceae), *Sivinski 4*
(FLAS), 1999, 14, 1, 1, 1, 1; *Zigadenus exaltatus* Eastw. (Me
thiaceae), *NA* (FLAS), 1999, 14, 1, 1, 1, 1; *Zigadenus glabe*
mus Michx. (Melanthiaceae), *Zomlefer 696a* (FLAS), 1999,
1, 1, 1, 1; *Zigadenus elegans* Pursh (Melanthiaceae), *NA* (FLA
1999, 14, 1, 3, 1, 1; *Zigadenus venenosus* var. *gramineus* (Ry
O.S. Walsh ex C.L. Hitchc. (Melanthiaceae), *Sivinski 4*
(FLAS), 1999, 14, 1, 2, 1, 3; *Zigadenus micranthus* Ea
(Melanthiaceae), *NA* (FLAS), 1999, 14, 0, 1, 1, 1; *Zigade*
mogollonensis W.J. Hess & Sivinski (Melanthiaceae), *Sivinsk*
Tonne 5106 (FLAS), 1999, 14, 1, 3, 1, 0; *Zigadenus nuttallii*
Gray) S. Watson (Melanthiaceae), *Wendt 7013* (FLAS), 19
14, 1, 3, 1, 1; *Zigadenus virescens* (Kunth) J.F. Macbr. (Me
thiaceae), *Sivinski 4973* (FLAS), 1999, 14, 1, 3, 2, 1; *M*
alba L. (Moraceae), *Soltis 2518* (NA), 1995, 18, 1, 2, 1, 3; *P*
tolacca americana L. (Phytolaccaceae), *Soltis 2523* (NA), 19
18, 1, 3, 1, 1; *Populus grandidentata* Michx. (Salicaceae), *Pit*
s.n. (FLAS), 1999, 14, 0, 1, 1, 1; *Populus grandidentata* Mi
(Salicaceae), *Pittillo s.n.* (FLAS), 1999, 14, 0, 1, 1, 1; *Viti*
(Vitaceae), *Soltis 2519* (NA), 1995, 18, 0, 1, 2, 3. **Silica-d**
in glass jars: *Acineta chrysantha* (C. Morren) Lindl. & Pax
(Orchidaceae), *Whitten 95031* (FLAS), 1995, 18, 1, 3, 1
Benzingia reichenbachiana (Schltr.) Dressler (Orchidaceae),
(FLAS), 1995, 18, 0, 1, 1, 1; *Cirrhaea dependens* Loudon (
chidaceae), *Whitten 93152* (FLAS), 1995, 18, 0, 1, 1, 1;
rhaea pallida Lindl. (Orchidaceae), *NA* (FLAS), 1995, 18, 0
1, 1; *Coeliopsis hyacinthosma* Rchb. f. (Orchidaceae), *Wh*
93153 (FLAS), 1995, 18, 0, 1, 1, 1; *Gongora cassidea* Rchb
(Orchidaceae), *Whitten 90532* (FLAS), 1995, 18, 0, 1, 1
Gongora chocoensis Jenny (Orchidaceae), *Whitten 9*
(FLAS), 1995, 18, 0, 1, 1, 1; *Gongora erecta* Whitten
D.E.Benn. (Orchidaceae), *Bennett 4700-1* (FLAS), 1995, 1
1, 1, 1; *Gongora hirtzii* Dodson & N.H. Williams (Orchid
ae), *Whitten 93109* (FLAS), 1995, 18, 0, 1, 1, 1; *Gongora le*
chila Lem. (Orchidaceae), *Whitten 3241* (FLAS), 1995, 1
1, 1, 1; *Gongora scaphephorus* Rchb. f. & Warsz. (Orchidace
Whitten 87145 (FLAS), 1995, 18, 0, 1, 1, 1; *Kegeliella atro*
sa L.O. Williams & A.H. Heller (Orchidaceae), *Hills 87*
(FLAS), 1995, 18, 0, 0, 0, 0; *Kegeliella kupperi* Mansf. (Or
daceae), *NA* (FLAS), 1995, 18, 0, 0, 0, 0; *Lueddemannia R*
f. (Orchidaceae), *NA* (FLAS), 1995, 18, 0, 1, 1, 1; *Peris*
Hook. (Orchidaceae), *Whitten 90121* (FLAS), 1995, 18, 0

1, 1; *Pescatorea* Rchb. f. (Orchidaceae), *Whitten 93041* (FLAS), 1995, 18, 0, 1, 1, 1; *Stanhopea grandiflora* (Lodd.) Lindl. (Orchidaceae), *Chase 90174* (FLAS), 1995, 18, 0, 1, 1, 1; *Stanhopea xytriophora* Rchb. f. (Orchidaceae), *NA* (FLAS), 1995, 18, 0, 1, 1, 1; *Xylobium colleyi* (Bateman ex Lindl.) Rolfe (Orchidaceae), *Whitten 2825* (FLAS), 1995, 18, 0, 1, 1, 1; *Xylobium leontoglossum* (Rchb. f.) Rolfe (Orchidaceae), *Whitten 91384* (FLAS), 1995, 18, 0, 1, 1, 1. **Silica-dried in Ziploc® bags:** *Agathis lanceolata* Warb. (Araucariaceae), *Plunkett 4676* (NA), 1997, 16, 0, 0, 0, 0; *Balanophora* J.R. Forst. & G. Forst. (Balanophoraceae), *Plunkett 4702* (NA), 1997, 16, 0, 0, 0, 0; *Berberis lehmannii* Hieron. (Berberidaceae), *Whitten 2314* (FLAS), 2003, 10, 1, 3, 1, 1; *Apteria aphylla* (Nutt.) Barnhart ex Small (Burmanniaceae), *Whitten 2321* (FLAS), 2003, 10, 1, 3, 1, 1; *Epigaea asiatica* Maxim. (Ericaceae), *Tategama s.n.* (NA), 1994, 19, 0, 0, 0, 1; *Cladrastis lutea* (Michx.) K. Koch (Fabaceae), *Gastony s.n.* (NA), 1993, 20, 1, 3, 1, 1; *Bonamia* Thouars (Gesneriaceae), *Whitten 2320* (FLAS), 2003, 10, 0, 0, 0, 0; *Ribes aureum* Pursh (Grossulariaceae), *Brunsfeld s.n.* (NA), 2005, 8, 1, 3, 1, 1; *Aglaia meridionalis* Pannell (Meliaceae), *NA* (NA), 1997, 16, 0, 1, 1, 1; *Myrteola* O. Berg (Myrtaceae), *Whitten 2311* (FLAS), 2003, 10, 1, 3, 1, 1; *Cryptocentrum latifolium* Schltr. (Orchidaceae), *Whitten 2349* (FLAS), 2003, 10, 1, 3, 1, 1; *Cryptocentrum lehmannii* (Rchb. f.) Garay (Orchidaceae), *Whitten 2325* (FLAS), 2003, 10, 1, 3, 1, 1; *Cryptocentrum* Benth. (Orchidaceae), *Whitten 2322* (FLAS), 2003, 10, 1, 3, 1, 1; *Cryptocentrum* Benth. (Orchidaceae), *Whitten 2324* (FLAS), 2003, 10, 1, 3, 1, 1; *Cryptocentrum standleyi* Ames (Orchidaceae), *Whitten 2323* (FLAS), 2003, 10, 0, 0, 0, 0; *Cyrtochilum aureum* (Lindl.) Senghas (Orchidaceae), *Whitten 2354* (FLAS), 2003, 10, 1, 3, 1, 1; *Cyrtochilum* Kunth (Orchidaceae), *Whitten 2352* (FLAS), 2003, 10, 1, 3, 2, 1; *Dichaea panamensis* Lindl. (Orchidaceae), *Whitten 2348* (FLAS), 2003, 10, 1, 3, 1, 1; *Dichaea* Lindl. (Orchidaceae), *Whitten 2329* (FLAS), 2003, 10, 1, 3, 1, 1; *Elleanthus aurantiacus* (Lindl.) Rchb. f. (Orchidaceae), *Whitten 2355* (FLAS), 2003, 10, 1, 2, 3, 1; *Epidendrum* L. (Orchidaceae), *Whitten 2336* (FLAS), 2003, 10, 1, 3, 1, 1; *Epidendrum* L. (Orchidaceae), *Whitten 2345* (FLAS), 2003, 10, 1, 3, 1, 1; *Epidendrum* L. (Orchidaceae), *Whitten 2351* (FLAS), 2003, 10, 1, 3, 1, 1; *Erycina pumilio* (Rchb. f.) N.H. Williams & M.W. Chase (Orchidaceae), *Whitten 2341* (FLAS), 2003, 10, 1, 3, 1, 1; *Ionopsis utricularioides* (Sw.) Lindl. (Orchidaceae), *Whitten 2346* (FLAS), 2003, 10, 1, 3, 2, 1; *Koellensteinia graminea* (Lindl.) Rchb. f. (Orchidaceae), *Whitten 2319* (FLAS), 2003, 10, 1, 3, 1, 1; *Konantzia minutiflora* Dodson & N.H. Williams (Orchidaceae), *Whitten 2371* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria angustissima* Ames, F.T. Hubb. & C. Schweinf. (Orchidaceae), *Whitten 2338* (FLAS), 2003, 10, 0, 1, 1, 1; *Maxillaria angustissima* Ames, F.T. Hubb. & C. Schweinf. (Orchidaceae), *Whitten 2361* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria aurea* (Poepp. & Endl.) L.O. Williams (Orchidaceae), *Whitten 2316* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria auyantepuiensis* Foldats (Orchidaceae), *Whitten 2347* (FLAS), 2003, 10, 1, 3, 2, 1; *Maxillaria auyantepuiensis* Foldats (Orchidaceae), *Whitten 2360* (FLAS), 2003, 10, 1, 3, 2, 1; *Maxillaria bolivarensis* C. Schweinf. (Orchidaceae), *Whitten 2365* (FLAS), 2003, 10, 0, 0, 0, 0; *Maxillaria confusa* Ames & C. Schweinf. (Orchidaceae), *Whitten 2367* (FLAS), 2003, 10, 1, 3, 2, 1; *Maxillaria cryptobulbon* Carnevali & J.T. Atwood (Orchidaceae), *Whitten 2300* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria cucullata* Lindl. (Orchidaceae), *Whitten 2301* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria discolor* (G. Lodd. ex Lindl.) Rchb. f. (Orchidaceae), *Whitten 2350* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria diuturna* Ames & C. Schweinf. (Orchidaceae), *Whitten 2305* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria equitans* (Schltr.) Garay (Orchidaceae), *Whitten 2309* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria exaltata* (Kraenzl.) C. Schweinf. (Orchidaceae), *Whitten 2332* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria exaltata* (Kraenzl.) C. Schweinf. (Orchidaceae), *Whitten 2333* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria gracilis* Lodd. (Orchidaceae), *Whitten 2303* (FLAS), 2003, 10, 1, 3, 1, 1; *Sauvetrea laevilabris* (Lindl.) M.A. Blanco (Orchidaceae), *Whitten 2358* (FLAS), 2003, 10, 1, 3, 1, 1; *Sauvetrea laevilabris* (Lindl.) M.A. Blanco (Orchidaceae), *Whitten 2372* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria nardoides* Kraenzl. (Orchidaceae), *Whitten 2359* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria nigrescens* Lindl. (Orchidaceae), *Whitten 2302* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria phoenicanthera* Barb. Rodr. (Orchidaceae), *Whitten 2304* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria ponerantha* Rchb. f. (Orchidaceae), *Whitten 2363* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria pseudoreichenheimiana* Dodson (Orchidaceae), *Whitten 2330* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria pseudoreichenheimiana* Dodson (Orchidaceae), *Whitten 2335* (FLAS), 2003, 10, 1, 3, 1, 1; *Mormolyca richii* (Dodson) M.A. Blanco (Orchidaceae), *Whitten 2362* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria* Ruiz & Pav. (Orchidaceae), *Whitten 2317* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria* Ruiz & Pav. (Orchidaceae), *Whitten 2318* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria* Ruiz & Pav. (Orchidaceae), *Whitten 2337* (FLAS), 2003, 10, 0, 1, 1, 1; *Maxillaria* Ruiz & Pav. (Orchidaceae), *Whitten 2368* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria* Ruiz & Pav. (Orchidaceae), *Whitten 2373* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria triloris* E. Morren (Orchidaceae), *Whitten 2366* (FLAS), 2003, 10, 1, 3, 1, 1; *Maxillaria whittenii* Dodson (Orchidaceae), *Whitten 2364* (FLAS), 2003, 10, 1, 3, 2, 1; *Oncidium adamsii* (Dodson) M.W. Chase & N.H. Williams (Orchidaceae), *Whitten 2339* (FLAS), 2003, 10, 1, 3, 1, 1; *Oncidium obryzatoides* Kraenzl. (Orchidaceae), *Whitten 2343* (FLAS), 2003, 10, 1, 3, 1, 1; *Oncidium* Sw. (Orchidaceae), *Whitten 2331* (FLAS), 2003, 10, 1, 3, 1, 1; *Oncidium* Sw. (Orchidaceae), *Whitten 2340* (FLAS), 2003, 10, 1, 3, 1, 1; *Oncidium weinmannianum* (Königer) M.W. Chase & N.H. Williams (Orchidaceae), *Whitten 2328* (FLAS), 2003, 10, 1, 3, 1, 1; *Ornithocephalus bicornis* Lindl. ex Benth. (Orchidaceae), *Whitten 2375* (FLAS), 2003, 10, 1, 1, 1, 1; *Ornithocephalus kruegeri* Rchb. f. (Orchidaceae), *Whitten 2370* (FLAS), 2003, 10, 1, 3, 1, 1; *Ornithocephalus* Hook. (Orchidaceae), *Whitten 2369* (FLAS), 2003, 10, 1, 1, 1, 1; *Ornithocephalus suarezii* Dodson (Orchidaceae), *Whitten 2374* (FLAS), 2003, 10, 1, 1, 1, 1; *Pachyphyllum* Kunth (Orchidaceae), *Whitten 2313* (FLAS), 2003, 10, 1, 3, 1, 1; *Rodriguezia lehmannii* Rchb. f. (Orchidaceae), *Whitten 2342* (FLAS), 2003, 10, 1, 3, 1, 1; *Trichoceros antennifer* (Bonpl.) Kunth (Orchidaceae), *Whitten 2353* (FLAS), 2003, 10, 1, 3, 2, 1; *Metadacrydium araucarioides* (Brong. & Gris.) Baum.-Bod. ex Melikyan & A.V. Bobrov (Podocarpaceae), *Plunkett 4675* (NA), 1997, 16, 1, 2, 1, 3; *NA* (Podocarpaceae), *Plunkett 4683* (NA), 1997, 16, 0, 1, 1, 1; *Monnina crassifolia* (Bonpl.) Kunth (Polygalaceae), *Whitten 2357* (FLAS), 2003, 10, 1, 3, 1, 2; *Monnina subspeciosa* Chodat (Polygalaceae), *Whitten 2356* (FLAS), 2003, 10, 0, 0, 0, 0; *Austrotaxus spicata* (R. Br.) Compton (Taxaceae), *Plunkett 4724*

(NA), 1997, 16, 0, 1, 1, 2.

D) Samples for comparison of freshly collected, new extraction of old silica, and original extractions: *Brassia* R. Br. (Orchidaceae), *Williams N519* (FLAS), 2001, 12, 1, 1, 1, 1; *Brassia* R. Br. (Orchidaceae), *Williams N519* (FLAS), 2013, 0, 1, 3, 1, 1; *Cochleanthes flabelliformis* (Sw.) R.E. Schult. & Garay (Orchidaceae), *Whitten 3025* (FLAS), 2013, 0, 1, 3, 2, 1; *Cochleanthes flabelliformis* (Sw.) R.E. Schult. & Garay (Orchidaceae), *Whitten 3025* (FLAS), 2005, 8, 1, 3, 1, 1; *Maxillaria crassifolia* (Lindl.) Rchb. f. (Orchidaceae), *Whitten 2544* (FLAS), 2013, 0, 1, 3, 1, 1; *Maxillaria crassifolia* (Lindl.) Rchb. f. (Orchidaceae), *Whitten 2544* (FLAS), 2003, 10, 1, 3, 2, 1; *Inti* M.A. Blanco (Orchidaceae), *Whitten 2752* (FLAS), 2004, 9, 1, 3, 1, 1; *Inti* M.A. Blanco (Orchidaceae), *Whitten 2752* (FLAS), 2013, 0, 1, 3, 1, 1; *Maxillaria luteoalba* Lindl. (Orchidaceae), *Whitten 2998* (FLAS), 2005, 8, 1, 3, 2, 1; *Maxillaria luteoalba* Lindl. (Orchidaceae), *Whitten 2998* (FLAS), 2013, 0, 1, 3, 1, 1; *Maxillaria* Ruiz & Pav. (Orchidaceae), *Whitten 3230* (FLAS), 2006, 7, 1, 3, 1, 1; *Maxillaria* Ruiz & Pav. (Orchidaceae), *Whitten 3230* (FLAS), 2013, 0, 1, 3, 1, 1; *Mormolyca ringens* (Lindl.) Schltr. (Orchidaceae), *Whitten 2858* (FLAS), 2004, 9, 0, 1, 1, 1; *Mormolyca ringens* (Lindl.) Schltr. (Orchidaceae), *Whitten 2858* (FLAS), 2013, 0, 1, 3, 1, 1; *Oncidium leucochilum* Bateman ex Lindl. (Orchidaceae), *Whitten 2961* (FLAS), 2005, 8, 1, 3, 1, 1; *Oncidium leucochilum* Bateman ex Lindl. (Orchidaceae), *Whitten 2961* (FLAS), 2013, 0, 1, 3, 1, 1; *Stanhopea anfracta* Rolfe (Orchidaceae), *Whitten 3244* (FLAS), 2006, 7, 1, 3, 1, 1; *Stanhopea anfracta* Rolfe (Orchidaceae), *Whitten 3244* (FLAS), 2013, 0, 1, 3, 2, 1; *Stanhopea grandiflo[ra]* (Lodd.) Lindl. (Orchidaceae), *Whitten 3012* (FLAS), 2005, 8, 1, 3, 1, 1; *Stanhopea grandiflora* (Lodd.) Lindl. (Orchidaceae), *Whitten 3012* (FLAS), 2013, 0, 1, 3, 1, 1; *Stanhopea oculata* (G. Lodd.) Lindl. (Orchidaceae), *Whitten 3306* (FLAS), 2006, 7, 1, 3, 2, 1; *Stanhopea oculata* (G. Lodd.) Lindl. (Orchidaceae), *Whitten 3306* (FLAS), 2013, 0, 1, 3, 1, 1; *Stanhopea* Frost ex Hook. (Orchidaceae), *Whitten 2984* (FLAS), 2005, 8, 1, 3, 1, 1; *Stanhopea tigrina* Bateman ex Lindl. (Orchidaceae), *Whitten 3007* (FLAS), 2005, 8, 1, 3, 1, 1; *Stanhopea tigrina* Bateman ex Lindl. (Orchidaceae), *Whitten 3007* (FLAS), 2013, 0, 1, 3, 1, 1; *Stanhopea tricornis* Lindl. (Orchidaceae), *Whitten 2985* (FLAS), 2005, 8, 0, 1, 1, 1; *Stanhopea tricornis* Lindl. (Orchidaceae), *Whitten 2985* (FLAS), 2013, 0, 1, 3, 1, 1; *Trichopilia turialbae* Rchb. f. (Orchidaceae), *Whitten 2947* (FLAS), 2006, 7, 1, 3, 1, 1; *Trichopilia turialbae* Rchb. f. (Orchidaceae), *Whitten 2947* (FLAS), 2013, 0, 1, 3, 1, 1.

E) Silica-dried, photobleached samples: *Catasetum* Rich. ex Kunth (Orchidaceae), *NA* (NA), 1998, 15, 0, 1, 1, 1; *Catasetum* Rich. ex Kunth (Orchidaceae), *NA* (NA), 1998, 15, 1, 3, 1, 1; *Catasetum* Rich. ex Kunth (Orchidaceae), *NA* (NA), 1998, 15, 1, 1, 1, 1; *Catasetum* Rich. ex Kunth (Orchidaceae), *NA* (NA), 1998, 15, 1, 3, 1, 2; *Catasetum* Rich. ex Kunth (Orchidaceae), *NA* (NA), 1998, 15, 1, 3, 1, 2; *Catasetum* Rich. ex Kunth (Orchidaceae), *NA* (NA), 1998, 15, 1, 3, 1, 1; *Catasetum* Rich. ex Kunth (Orchidaceae), *NA* (NA), 1998, 15, 1, 1, 1, 2; *Catasetum* Rich. ex Kunth (Orchidaceae), *NA* (NA), 1998, 15, 1, 3, 1, 2.