CANOTIA

Volume 8, Issue 2

Contents

Lentibulariaceae Bladderwort Family
Barry Rice. 54

Thirty New Localities for *Eriogonum jonesii*
Teague M. Embrey, Joslyn Curtis, Shannon E. Henke, Karin J. Edwards, Kathryn A. Prengaman, Sarah M. Schmid, and Scott R. Abella. 59

New Records for the Flora of Arizona. 65
Brassicaceae
Michelle Caisse. 65
Malvaceae
Sarah Hunkins and Kevin Smith. 66

A New Plant Mapping Program for Arizona
Daryl L. Lafferty and Leslie R. Landrum. 68

Charles Mason (1918-2012), Curator Emeritus of the University Herbarium Remembered. 72

November 2012
Vascular Plant Herbarium
School of Life Sciences, Arizona State University

CANOTIA

Editor: Leslie R. Landrum
School of Life Sciences
Arizona State University
PO Box 874501
Tempe, AZ 85287-4501
les.landrum@asu.edu

Associate Editor: Obelia R. Robinson
Botany Department
California Academy of Sciences
875 Howard Street
San Francisco, CA 94103-3009
orobinson@calacademy.org

Production Editor: Cindy D. Zisner
Global Institute of Sustainability
Arizona State University
PO Box 875402
Tempe, AZ 852087-5402
cindy.zisner@asu.edu

Canotia Webmaster: Scott T. Bates
University of Colorado at Boulder
Rm 318 – CIRES Bldg
Boulder, CO 80309
scott.thomas.bates@gmail.com

Canotia publishes botanical an mycological papers related to Arizona. These may include contributions to the Vascular Plants of Arizona project, checklists, local floras, new records for Arizona and ecological studies. All manuscripts are peer-reviewed by specialists. Acceptance for publication will be at the discretion of the editor. At least 30 printed copies of each issue are distributed to libraries in the United States, Europe, and Latin America. Anyone may download copies free of charge at http://www.canotia.org.

Canotia is named for *Canotia holacantha* Torr. (Celeastraceae), a spiny shrub or small tree nearly endemic to Arizona.

ISSN 1931-3616

LENTIBULARIACEAE BLADDERWORT FAMILY

Barry Rice
Center for Plant Diversity, Department of Plant Sciences, University of California,
1 Shields Avenue, Davis CA 95616

Perennial and annual herbs, carnivorous, of moist or aquatic situations. ROOTS subsucculent, present only in *Pinguicula*. STEM a caudex, or stoloniferous, branching and rootlike. LEAVES simple, entire (*Pinguicula*, *Genlisea*, some *Utricularia*), or variously dissected, often into threadlike segments (*Utricularia*). CARNIVOROUS TRAPS leaf-borne bladders (*Utricularia*), sticky leaves (*Pinguicula*), modified leaf eel trap chambers (*Genlisea*). INFLORESCENCE a scapose raceme bearing one to many flowers; bracts present or not. FLOWERS perfect, zygomorphic; calyx lobes 2, 4, or 5; corolla spurred at base, lower lip flat or arched upward, both lips clearly or obscurely lobed; ovary superior; chamber 1; placenta generally free-central; stigma unequally 2-lobed, more or less sessile; stamens 2. FRUIT a capsule, round to ovoid, variably dehiscent; seeds generally many, small. –3 genera; 360+ species, worldwide, especially tropics.

Utricularia L. Bladderwort

Delicate perennial and annual herbs, epiphytic, terrestrial or aquatic, variable in size. ROOTS absent; small descending rootlike rhizoids sometimes associated with inflorescence bases. STEMS stoloniferous and rootlike, floating freely in water or descending into the substrate; caudex usually absent. LEAVES simple and entire, or variously dissected, often into threadlike segments; leaf segment margins and tips bearing minute bristles (setula) or not. BLADDERS (0.5-) 1–4 (-10) mm in diameter, borne on leaves; quadrifid glands (Fig. 1) inside bladders consist of 2 pairs of oppositely directed arms, the angles of divergence useful in verifying specific identity (view at 150×). INFLORESCENCE: bracts present. FLOWERS with 2 or 4 calyx lobes; corolla lower lip clearly or obscurely 3-lobed, the upper lip clearly or obscurely 2-lobed. Cytology variable and uncertain, X = 7–24. More than 235 species; worldwide distribution, especially tropics. Taylor, P. 1989. *Kew Bull. Add. Ser.* 14: 1–724.

Utricularia intermedia Hayne is unlikely in Arizona but should be looked for in high elevation fens; its preferred habitat is similar to that of *U. minor*. This species has a large floral spur, but can be differentiated from *U. macrorhiza* by strongly dimorphic stems, 20 ultimate leaf segments or fewer, and leaf segments strongly flattened.

Utricularia is a carnivorous genus, capturing and digesting prey by its bladders. The bladder walls normally bulge outwards, but the internal quadrifid glands pump water out of the traps, causing an overall negative internal pressure. Small aquatic organisms trigger the bladder valve to open, and in rushing water sucks the prey into the plant. Corrosive enzymes then digest the prey.

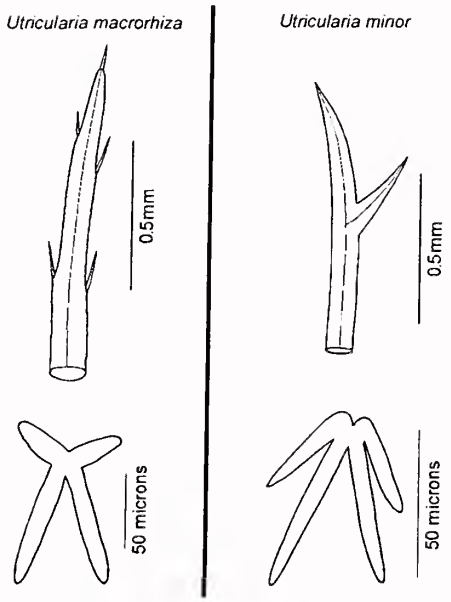
1. Flower 1-2 cm long; spur approximately as long as corolla lower lip, narrowly cylindrical, the apex acute, hooked upwards at tip; stems of 1 kind, not dimorphic; ultimate leaf segments usually more than 30, with marginal bristles 0.1-0.3 mm long . . . . . ***U. macrorhiza***

Vascular Plants of Arizona: Lentibulariaceae: Bladderwort Family. *CANOTIA* 8(2):54–58, 2012.

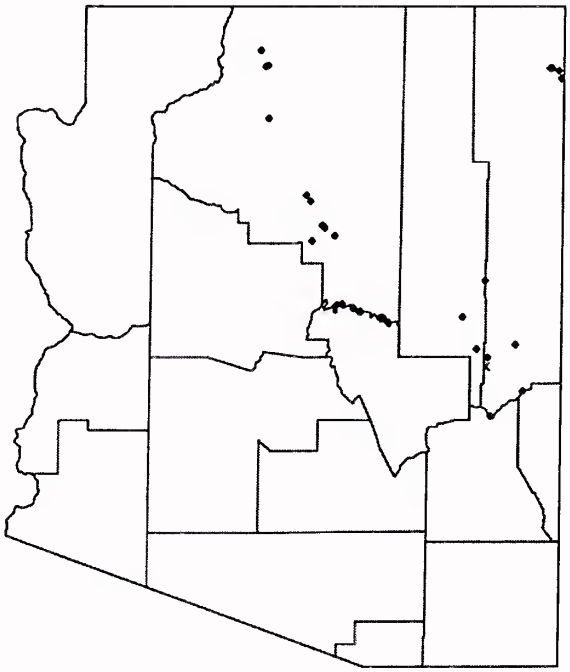
1' Flower 6-8 mm long; spur much shorter than corolla lower lip, broadly conical to saccate or even nearly absent; stems weakly to strongly dimorphic; ultimate leaf segments usually 7–22, without bristles. . . . . ***U. minor***

Utricularia macrorhiza Leconte (large roots). Common Bladderwort. – Floating aquatic herbs. STEM a well-defined, green, weakly branching stolon 30–150 cm long, bearing alternate leaves, not dimorphic; winter buds 1–2 cm, bristly. LEAVES 1.5–9 cm long, 1–2 parted at base, each part multiply pinnately dissected into 30–150 capillary segments (fewer in highly depauperate specimens), the ultimate segments bearing lateral and apical bristles 0.1–0.3 mm long. BLADDERS 1.5–5 mm long, those near the leaf base larger than those near leaf tip; quadrifid glands with long arm-pair parallel or diverging slightly, the short arm-pair diverging by 90–180°. INFLORESCENCE: 5–20-flowered; peduncle 10–60 cm, 1–3 mm diameter. FLOWER corolla 1–2 cm, clear yellow, variously marked with brown; cylindric spur hooked upward near tip. SEED 4–6-sided, winged; $2n$ = ca. 40. –Quiet, shallow or deep, rarely flowing, acidic or neutral waters. Apache, Coconino, Navajo cos; 1850–2750 m (6000–9000 ft), may be elsewhere n of the Mogollon Rim, especially when protected from cattle damage; Jul-Aug. N. Amer. except se; ne Mex.; east Asia. Formerly treated as *Utricularia vulgaris* L. (or an infraspecific taxon of that species), but now considered to be distinct. Plants can be dwarfed or modified by abnormal conditions (such as alkaline waters), and be misidentified as *U. minor*. The presence or absence of marginal bristles is highly reliable in identifications.

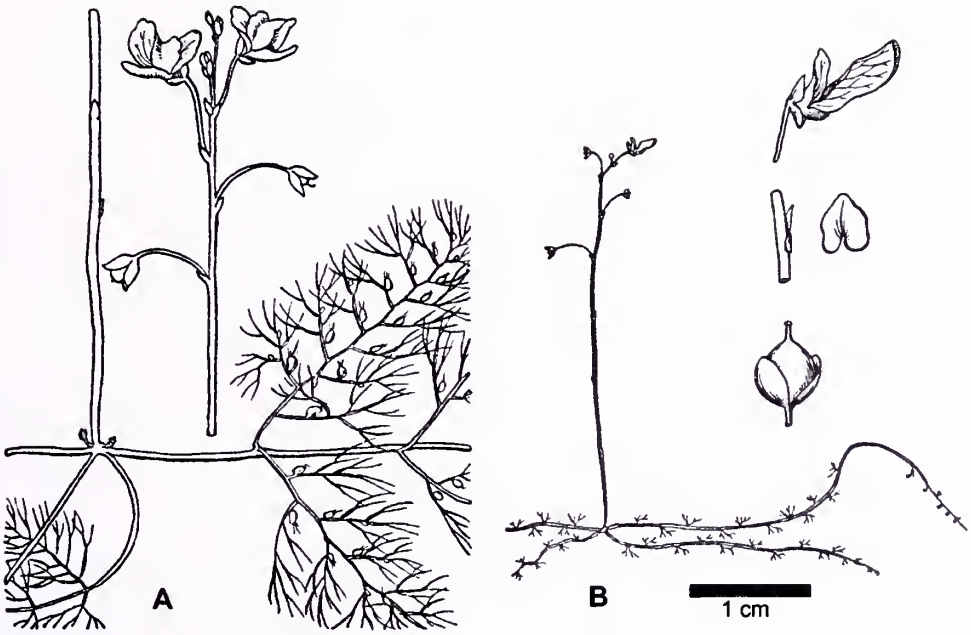
Utricularia minor L. (small). Small Bladderwort, Mud Bladderwort. –Affixed or floating aquatic herbs. STEM a tangled network, weakly to strongly dimorphic, the first form green with many leaves and some bladders, the second form pale white with few leaves and many bladders (collections frequently do not include the second kind of shoot, as they are fragile, descend into the muck, and break off during the collection process); winter buds less than 5 mm long, glabrous. LEAVES 3–20 mm long, 3-parted at base, variously dissected above to 7–22 thread-like to flattened ultimate segments, the ultimate segments bearing no bristles nor microscopic bristles. BLADDERS 0.5–2 mm long; those on descending shoots are frequently larger than on green shoots; quadrifid glands with the long arm-pair diverging slightly, the short arm-pair diverging by 270–300°. INFLORESCENCE: 2–6-flowered; pedunele 3–25 cm, less than 0.5 mm diameter. FLOWER corolla 6–8 mm, pale yellow, variously marked with brown; lower lip more than twice the length of the sac-like spur. SEED 4–6-sided, scarcely winged; $2n$ = ca. 40. –Quiet, shallow, acidic or neutral waters, mucky fens. Apache Co.; 2150 m (7100 ft), documented only from Woolsey Lake in AZ (ARIZ: *Rice 960701 & 960702*; other reports previous to 1996 were misidentified *U. macrorhiza*); not yet observed in flower (probably Jun-Jul). Across n U.S. to AK, Can; circumboreal.



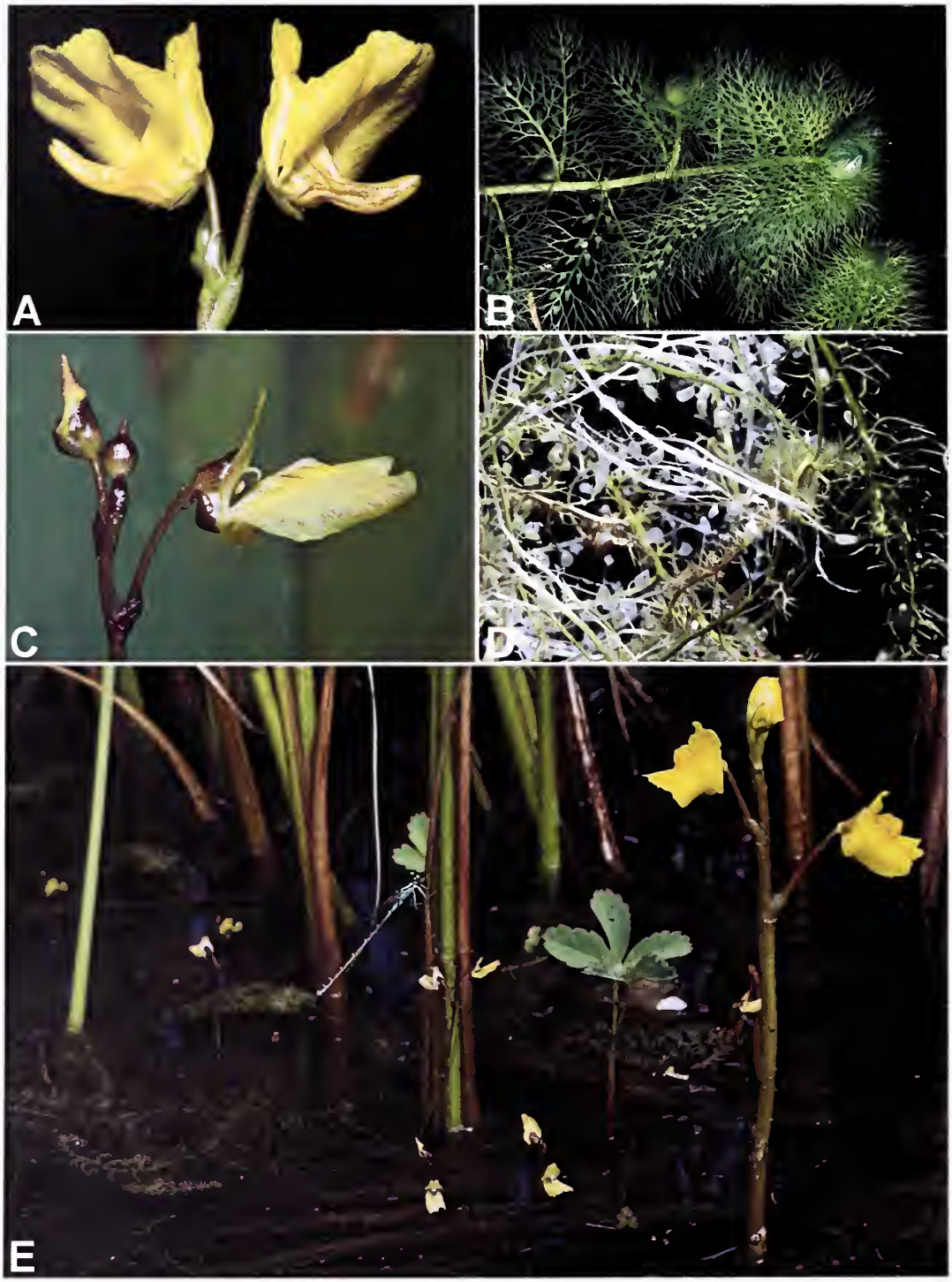
Lentibulariaceae Figure 1. Ultimate leaf segments (top) and four-armed quadrifid bladder glands (bottom) for *Utricularia macrorhiza* and *U. minor*. Note the presence of bristles on the *U. macrorhiza* leaf segment.



Lentibulariaceae Figure 2. Map of *Utricularia macrorhiza* (dots) and *U. minor* (X) in Arizona.



Lentibulariaceae Figure 3. *Utricularia macrorhiza* (A) and *U. minor* (B) reproduced from *An illustrated Flora of the Northern United States and Canada* by N. L. Britton and A. Brown (1913).



Lentibulariaceae Figure 4. A–B, *Utricularia macrorhiza*: (A) flowers; (B) leafy shoot with bladders borne throughout. (C–D) *Utricularia minor*: (C) flower; (D) green bladder-bearing leafy shoots and white bladder-only shoots. (E) Both species growing together for comparison. Images C, E, show plants growing in Idaho. All photos by Barry Rice.

THIRTY NEW LOCALITIES FOR *ERIOGONUM JONESII*

Teague M. Embrey, Joslyn Curtis, Shannon E. Henke, Karin J. Edwards, Kathryn A. Prengaman, Sarah M. Schmid, and Scott R. Abella
Department of Environmental and Occupational Health, University of Nevada Las Vegas, Las Vegas, Nevada 89154-3064

This study was supported by a grant from the University of Arizona Herbarium who awarded this project through Endangered Species Act Section 6 funding from the U.S. Fish and Wildlife Service. It allowed us the opportunity to survey for the rare plant *Eriogonum jonesii* S. Watson. We here list thirty new localities (Table 1) and show them on a map in Figure 1, along with four previously known localities.

Table 1. Location and descriptions of *Eriogonum jonesii* sites.

Site	Latitude	Longitude	Number of Plants	Association*	Geology
k002	35.906372	-113.932915	25–100	Colram	Sandstone
k005	35.905757	-113.949709	25–100	Yucbre/Colram	Sandstone
k006	35.907270	-113.948802	100+	Pinmon-Yucbre/Colram	Limestone
k008	35.910642	-113.947143	25–100	Colram	Limestone
k009	35.911915	-113.948143	100+	Pinmon/Erijon/Muhpor	Obscured
k013	35.920640	-113.917621	100+	Junost	Obscured
k015	35.909009	-113.929635	100+	Pinmon-Junost/Aripur	Limestone
k019	35.920913	-113.938472	100+	Colram-mixed shrub	Limestone
s2	36.540992	-113.742610	25–100	Yucbre/Colram	Sandstone
s02	36.559245	-113.766156	100+	Colram/Brorub	Sandstone
s03	36.512562	-113.662818	100+	Encvir-Gutsar/Brorub	Sandstone
s04	36.498327	-113.660634	100+	Pinmon-Junost/Gutsar	Sandstone
s05	36.479740	-113.674438	100+	Arttri	Limestone
s06	36.456590	-113.787906	100+	Gutsar-Erijon/Brorub	Limestone
s07	36.454586	-113.787440	25–100	Colram-Gutsar	Limestone
t002	35.910921	-113.975536	100+	Colram-Gutsar	Limestone
t004	35.902869	-113.976065	200+	Yucbac-Nolmic-Gutsar	Sandstone

Thirty new localities for *Eriogonum jonesii*. *CANOTIA* 8(2):59-64, 2012.

Table 1. Location and descriptions of *Eriogonum jonesii* sites.

Site	Latitude	Longitude	Number of Plants	Association*	Geology
t005	35.904717	-113.976057	1–24	Colram	Sandstone
t006	35.916130	-113.971677	100+	Colram	Limestone
t007	35.919337	-113.978500	100+	Pinmon/Colram-Gutsar	Limestone
t008	35.908968	-113.932414	25–100	Pinmon-Junost/Falpar	Limestone
t009	35.915269	-113.934906	1–24	Colram-Erimic	Limestone
t010	35.916118	-113.935957	25–100	Junost/Aripur-Muhpor	Obscured
t011	35.918587	-113.938541	100+	Colram-Erijon	Limestone
t012	35.901353	-114.019904	100+	Yucbre/Colram	Limestone
t013	35.902981	-114.019023	100+	Colram	Limestone and granite
t014	36.562551	-113.751103	25–100	Pinmon/Colram	Sandstone
t015	36.536287	-113.661421	25–100	Falpar-Erijon	Limestone
t016	36.536313	-113.669072	100+	Junost	Limestone
t017	36.484549	-113.688989	25–100	Pinmon-Junost/Colram	Limestone

* Plant associations follow the United States National Vegetation Classification System described in text. Plant codes are: Arttri: *Artemisia tridentata* Nutt.; Aripur: *Aristida purpurea* Nutt.; Brorub: *Bromus rubens* L.; Colram: *Coleogyne ramosissima* Torr.; Encvir: *Encelia virginensis* A. Nelson; Erijon: *Eriogonum jonesii* Cronquist; Erimic: *Eriogonum microthecum* Nutt.; Falpar: *Fallugia paradoxa* (D. Don) Endl. ex Torr.; Gutsar: *Gutierrezia sarothrae* (Pursh) Britton & Rusby; Junost: *Juniperus osteosperma* (Torr.) Little; Muhpor: *Muhlenbergia porter* Scribn. ex Beal; Nolmic: *Nolina microcarpa* S. Watson; Pinmon: *Pinus monophylla* Torr. & Frem.; Yucbac: *Yucca baccata* Torr.; Yucbre: *Yucca brevifolia* Engelm.

These new sites triple the known sites within Mohave County for this rare species and extend the westward range south of the Colorado River by 65 km. The westward range of *Eriogonum jonesii* also appears to coincide with the western edge of the Grand Wash Cliffs. In the Hidden Canyon corridor, the two closest sites were 700 m apart, while the next closest sites were 1.4 km apart. Sites within Grapevine Canyon occurred much closer to each other, with several sites within 150 m of each other. Although close together, these sites were considered separate from one another due to the terrain surrounding them and site-specific vegetation. For example, although sites t010 and k008 are within 150 m of each other, the two sites are dominated by different vegetation associations (Table 1). The terrain here offers small-scale vegetation differences with changes in aspect and elevation occurring within relatively short distances over the landscape.

Although *Eriogonum jonesii* is more common and widespread than previously known, we believe that it still deserves protection because it is certainly restricted to specific substrate types. Additionally, the Grapevine Canyon corridor is witnessing a high degree of vehicular traffic as the Diamond Bar Road is the entryway to the Grand Canyon Skywalk. Our observations in the field on geology, pollinators, vegetation type/fire and threats follow.

GEOLOGY

Two dominant substrate types occurred at *Eriogonum jonesii* sites: limestone and sandstone. Limestone was recorded at 18 of 30 sites, sandstone at 9 sites, and the geology at the remaining sites was obscured by soil. One site (t013) occurring at the western edge of the lower Grand Wash Cliffs contained limestone at the upper edge of the site while the lower portion consisted of granite. This was the only time *E. jonesii* was found growing with granite as the underlying geologic type.

POLLINATORS

Eriogonum jonesii appears to be visited by many insects. These were seen on flowers in well over half of the sites visited (20 sites out of the 30 sampled). Of the insects seen, bees, particularly honeybees (*Apis mellifera*), were present at the most sites (11 of 30 sites). Butterflies and tarantula hawks (*Pepsis* sp.) were also seen frequently and in high numbers (Fig. 2A).

VEGETATION TYPE/FIRE

The community in which *Eriogonum jonesii* occurred was described following the United States National Vegetation Classification System, a system intended to describe vegetation types at the national level (Grossman et al. 1998). Within this system, the lowest vegetation level described is the association, defined by naming the dominant or co-dominant plants within a specific area. The vegetation stratum is taken into account within this description, so site descriptions often have a tree, shrub, and/or herbaceous component to them (strata are separated by a '/', while co-dominant plants within the same stratum are shown by using a '-' within the name).

Of the community types *Eriogonum jonesii* was found growing in, the association with *Coleogyne ramosissima* was the most prevalent (18 sites had *C. ramosissima* as part of the association name) (Table 1). *Coleogyne ramosissima* (blackbrush) shrubland (Fig. 2D) is a common community type found in the geographic and corresponding elevation range of the areas we surveyed (Phillips 1975). This survey is the first to document *E. jonesii* within *Yucca brevifolia* (Joshua tree) woodland, placing it within the transition zone between the Mojave Desert and Colorado Plateau.

One of the more interesting facets regarding the ecology of *Eriogonum jonesii* we gleaned from this study is the frequency in which it occurs in previously burned areas (Fig. 2B). We found *E. jonesii* in denser patches where the total vegetation cover was not so high, and where the communities were in the process of recovery from fire. Several of the burned sites (s06, s07, t004, t006) contained a high percentage of *Gutierrezia sarothrae* coverage, in addition to a high number of *E. jonesii* individuals. *Gutierrezia sarothrae* is a native plant known to invade areas after disturbance events. Whether or

not *E. jonesii* was found at these sites in such dense numbers (or at all) before the fires is unknown, though it is clear that there is a correlation between the presence of *E. jonesii* and disturbed areas.

However, we also encountered sites (t011, t012, k002) with high *Eriogonum. jonesii* numbers within dense blackbrush stands. This suggests *E. jonesii* may be part of intermediary successional stages, and its presence may suggest a past disturbance event within the area.

THREATS

The main potential threats encountered at our survey sites are all anthropogenic-related. These potential threats include cattle, vehicular traffic, dust (Fig. 2C), and infestations of non-native species, chiefly *Bromus rubens* (Fig. 2B).

Of the potential threats to *Eriogonum jonesii* occurrences, *Bromus rubens* may be the most hazardous. Both *E. jonesii* and *B. rubens* occupy disturbed sites; in a scenario where a fire burns through a site where both species are established, it may be that *B. rubens* could out compete *E. jonesii* for space as *B. rubens* is a highly competitive annual that can occur in high densities (Brooks 2000).

Although cattle signs were present at approximately 25% of the newly described *E. jonesii* sites, the visible damage caused to plants was minimal.

ACKNOWLEDGMENTS

We thank the University of Arizona Herbarium and the U.S. Fish and Wildlife Service. We also thank Lake Mead National Recreation Area, Grand Canyon National Park, and the Bureau of Land Management for facilitating this study, Sharon Altman (University of Nevada Las Vegas) for helping with project logistics and formatting the figures, and Ryan Porter (University of Arizona) for assisting with the map.

LITERATURE CITED

BROOKS, M. L. 2000. Competition between alien annual grasses and native annual plants in the Mojave Desert. *American Midland Naturalist* 144: 92–108.

GROSSMAN, D. H., D. FABER-LANGENDOEN, A. S. WEAKLEY, M. ANDERSEN, P. BOUGEREN, R. CRAWFORD, K. GOODIN, S. LANDAAL, K. METZLER, K. D. PATTERSON, M. PYNE, M. REID, and L. SNEDDON. 1998. *International Classification of Ecological Communities: Terrestrial Vegetation of the United States. Volume 1: the National Classification System: Development, Status, and Applications*. The Nature Conservancy, Arlington, VA.

PHILLIPS, A. M., III. 1975. Flora of the Rampart Cave Area, Lower Grand Canyon, Arizona. *Journal of the Arizona Academy of Science* 10:148–159.

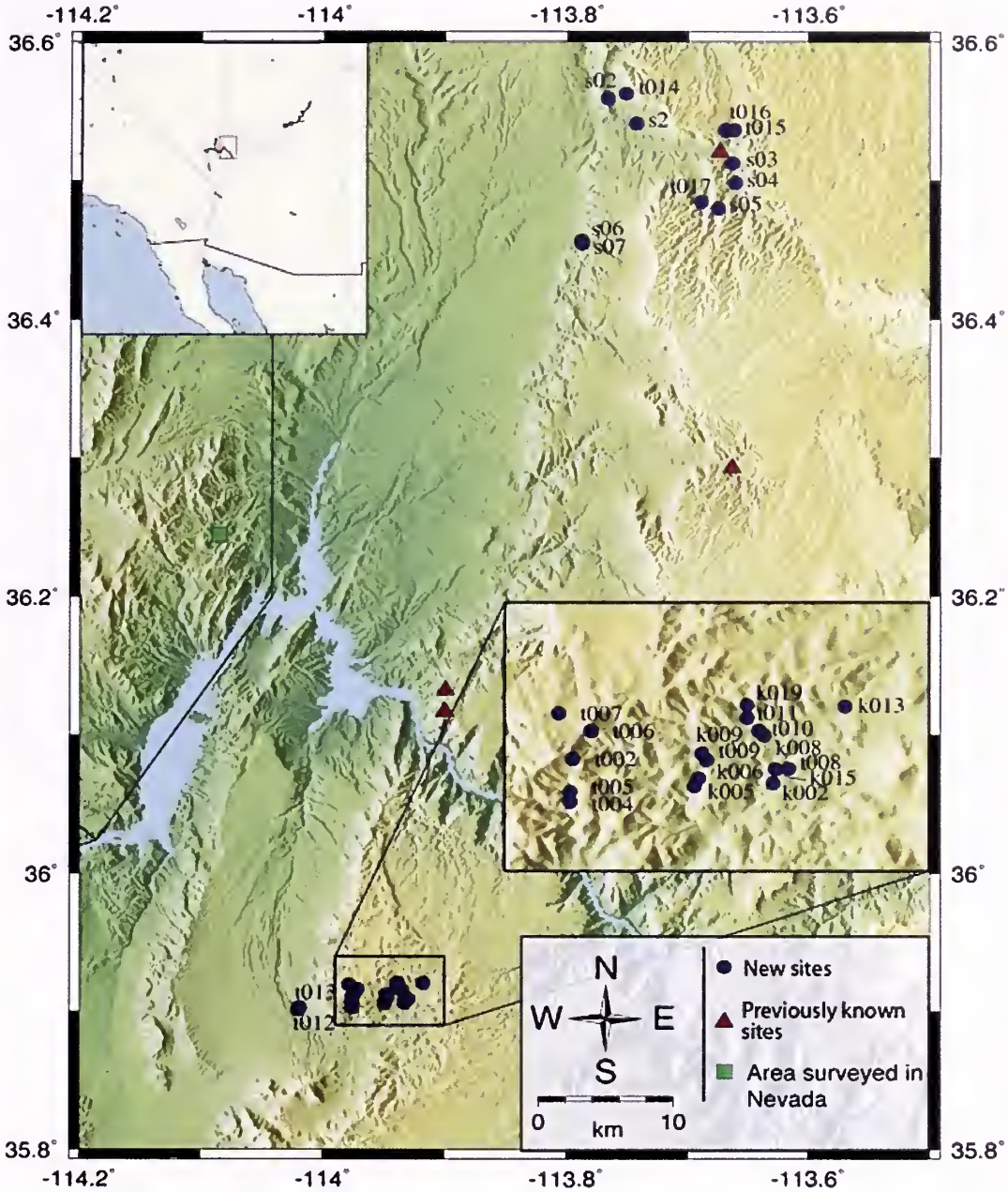


Figure 1. Map of the study area showing distribution of *Eriogonum jonesii*. Dot, new sites; triangle, previously known sites; square, locality in Nevada where no population was found.

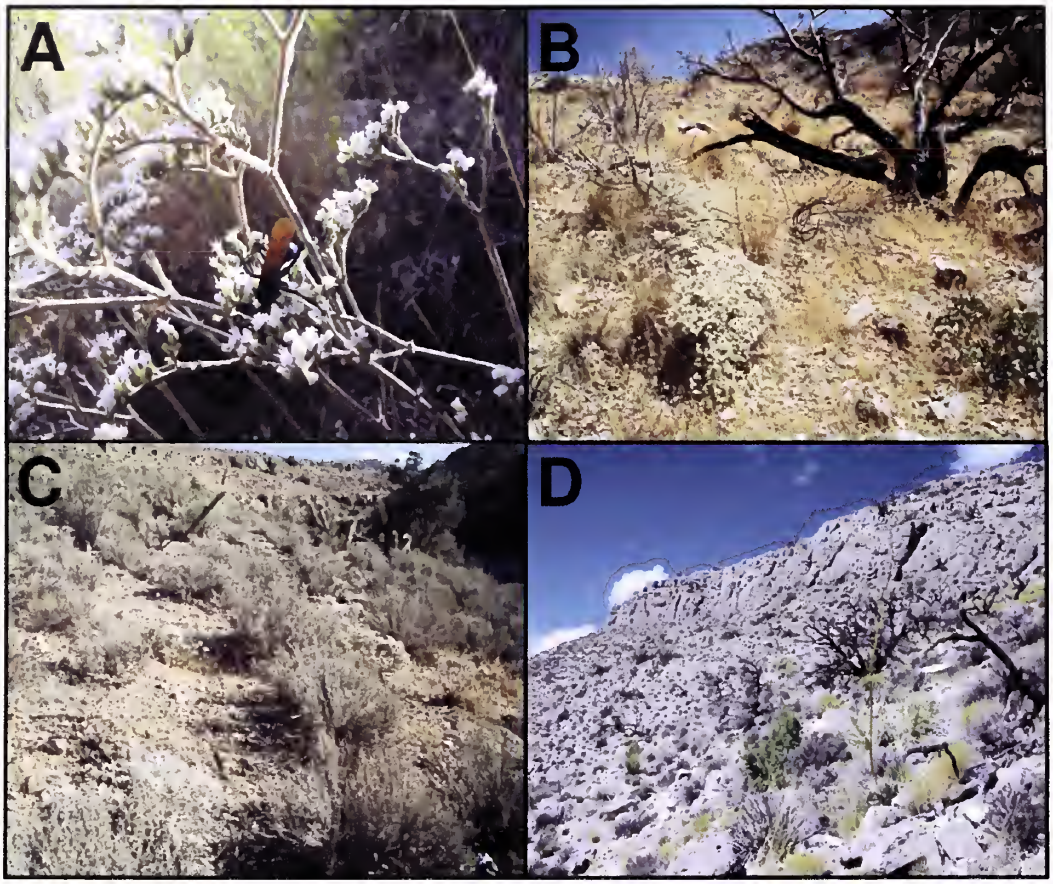


Figure 2. (A) Tarantula hawk visiting an *Eriogonum jonesii* inflorescence; (B) A burned site with *E. jonesii* and a high density of the annual invasive grass *Bromus rubens*; (C) Plants coated with dust along the Diamond Bar Road, which can just barely be seen in the background; (D) *E. jonesii* occurring in blackbrush shrubland in the lower Grand Wash Cliffs.

New Records for the Flora of Arizona

Brassicaceae

Nerisyrenia camporum (A. Gray) Greene (Fig. 1). This species has been found as a volunteer in a residential yard in Mesa, Arizona. This Chihuahuan Desert native has not been previously reported in Arizona. While other *Nerisyrenia* species are limited to gypsum soils, *N. camporum* is more widespread and tolerates a variety of soil types. Its reported range extends from southeastern New Mexico and southern Texas, to the Mexican states of Chihuahua, Coahuila, Durango, and Nuevo León (Bacon 1978).

The single plant has flourished over two growing seasons on natural rainfall in native desert soil, flowering prolifically from early spring until the advent of summer heat. It is apparently an obligate out-crosser, since it sets no seed. When I first observed the plant, it was about 20 cm high and wide, with neat, attractive flowers and grey foliage. In its third spring, it has reached over a meter across with stems up to 7.4 decimeters. A voucher specimen (*M. Caisse s.n.*, 6 May 2011) is deposited at ASU.

How the seed from which this plant grew arrived in this location is a mystery. The small size of the seed and lack of long-distance dispersal mechanisms argues for human dispersal, probably accidental and possibly through the import of some product from the native range of the species.

Acknowledgments

I am grateful to Leslie Landrum and Andrew Salywon for assistance with identification.

Literature Cited

BACON, J.D. 1978. Taxonomy of *Nerisyrenia* (Cruciferae). *Rhodora* 80:159–227.

—Michelle Caisse, Mesa, Arizona, michelle@caisse.us

Figure 1. *Nerisyrenia camporum*. A, close up of flowers. B, habit.

MALVACEAE

Malacothamnus fasciculatus (Nutt. ex Torr. & A. Gray) Greene - chaparral mallow or bush mallow (Fig. 2). This species is known from the coastal ranges of California, in coastal-sage scrub and chaparral, and northern Baja California and Sonora, Mexico, in dry matorral (Bates 1993, Fryxell 1988). It was collected at Spur Cross Raneh Conservation Area, in Maricopa County, in Sonoran Descrt Scrub, Arizona Upland habitat. One individual was found April 29, 2010, on an island in Cottonwood Creek, N33°53.655' W111°56.669, elevation 729 m (2,392 ft) (*S. Hunkins & K. Smith 717*, DES). Three more plants were found June 18, 2011, approximately 0.8 km (0.5 mi) downstream from the first site, at the confluence with Cave Creek (*S. Hunkins & K. Smith 740,* DES). Associated species include *Prosopis velutina* Wooton, *Acacia greggii* A. Gray, *Celtis pallida* Torr., *Ambrosia monogyra* (Torr. & A. Gray) Strother & B.G. Baldw., *A. ambrosioides* (Cav.) Payne, *Sphaeralcea ambigua* A. Gray, *Lycium exsertum* A. Gray, *Artemisia ludoviciana* Nutt., *Avena fatua* L., *Bromus rubens* L., *B. diandrus* Roth, and *Cynodon dactylon* (L.) Pers. Steven R. Hill, specialist in Malvaceae, confirmed the identification.

With its pink to lavender flowers *Malacothamnus fasciculatus* resembles *Sphaeralcea ambigua* ssp. *rosacea* (Munz & Johnston) Kearney. The two can be distinguished mainly by their fruits. *Malacothamnus fasciculatus* has 1-seeded, smooth-sided, completely dehiscent fruit segments, while the other taxon has 2-seeded fruit segments that are smooth and dehiscent above and net-veined and indehiscent below. A less reliable difference, but one helpful in field identification, is in the leaf shape. The leaves of *M. fasciculatus* tend to be round in outline, while the leaves of *S. ambigua* ssp. *rosacea* tend towards triangular.

The nearest known collection, from an area where this species still occurs, is approximately 400 km (250 mi) west, in the vicinity of Riverside, California. Specimens were also collected in the Santa Cruz Valley, Sonora, Mexico (*C. V. Hartman 44, G. Thurber 700 & 709*) in the mid to late 1800's but no collections appear to have been made in that area since that time. The genus, *Malacothamnus*, as well as the species, *M. fasciculatus* have not been previously reported in Arizona (Shreve and Wiggins 1964, Kearney and Peebles 1969, Fryxell 1994, SEINet 2011, USDA NRCS 2011, pers. comm. curators of ARIZ, ASC, ASDM, ASU, CCH, DES, GCNP, MNA, NAVA, and TEUI 2011).

LITERATURE CITED

BATES, D. M. 1993. *The Jepson Manual: Higher Plants of California.* University of California Press, Berkeley, Los Angeles and London.

FRYXELL, P. A. 1988. Malvaceae of Mexico. *Systematic Botany Monographs* 25:271–273.

FRYXELL, P. A. 1994. Vascular Plants of Arizona: Malvaceae. *Journal of the Arizona-Nevada Academy of Science* 27(2): 222–236.

KEARNEY, T. H., R. H. PEEBLES and COLLABORATORS. 1969. *Arizona Flora*. 2nd edition. University of California Press, Berkeley and Los Angeles.

SHREVE, F. and I. L. WIGGINS. 1964. *Vegetation and Flora of the Sonoran Desert.* Stanford University Press, Stanford, CA.

SOUTHWEST ENVIRONMENTAL INFORMATION NETWORK. 2011. *SEINet.* <http://swbiodiversity.org/seinet/index.php>. Accessed in May.

UNITED STATES DEPARTMENT OF AGRICULTURE, NATURAL RESOURCES CONSERVATION SERVICE. 2011. *The PLANTS Database.* <http://plants.usda.gov/>.

— Sarah Hunkins, Herbarium, School of Plant Sciences, University of Arizona, Tucson, Arizona 85721-0035; and Kevin Smith, Spur Cross Ranch Conservation Area, 37622 N. Cave Creek Rd., Cave Creek, Arizona 85331- 8612

Figure 2. *Malacothamnus fasciculatus*. A, habit. B, close up of flower.

A New Plant Mapping Program for Arizona

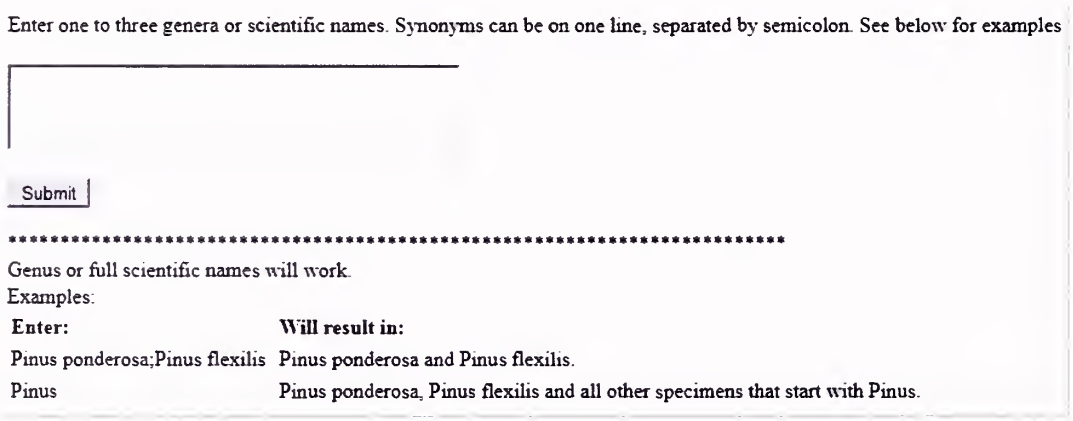
Daryl L. Lafferty and Leslie R. Landrum
Arizona State University Herbarium
School of Life Sciences
Tempe, AZ 85287-4501

Distribution mapping is one of the most common uses of the SEINet (Southwest Environmental Information Network 2009) database, which uses Symbiota software (http://symbiota.org/tiki/tiki-index.php) to make Google maps. These are satisfactory for many purposes, but they usually are not appropriate for publications. For instance, for the family treatments in the Vascular Plants of Arizona project, we needed an outline base map showing all the counties. Daryl Lafferty has created a web-based program that generates these maps. The maps in turn can easily be copied into a manuscript. We are able to query the SEINet database of over 2 million specimens for its 400,000+ Arizona records that have been georeferenced.

Once this goal had been accomplished other ideas occurred to us. How about plotting the dots of distribution onto a relief map or a map of biotic communities? This proved interesting as distributions often coincided with topography or community type. How about mapping multiple species at once to see if their distributions are similar or complementary? This we can already do with SEINet but not with multiple map backgrounds. How about plotting several species of a particular vegetation type (e.g., mixed conifers or chaparral) together as a group so as to produce a map of a vegetation type?

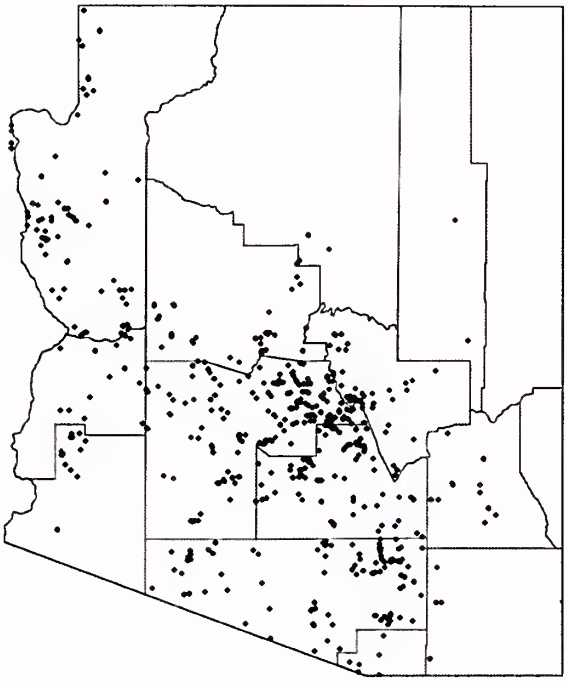
These goals have been accomplished and maps can now be made; we provide instructions here.

1. Go to http://daryllafferty.com/PlantMap/ and you will see this screen:



2. In the rectangle in the upper left corner you can enter a name or names. For instance we might enter "Lupinus sparsiflorus" (author not included, name not in italics). Then click on submit and shortly a screen appears with an outline base map of this

A new mapping program for Arizona. *Canotia* 8(2):68–71, 2012. ©2012 D. L. Lafferty and L. R. Landrum.



A New Plant Mapping Program for Arizona. Figure 1. Distribution of *Lupinus sparsiflorus* in Arizona according to the SEINet database.

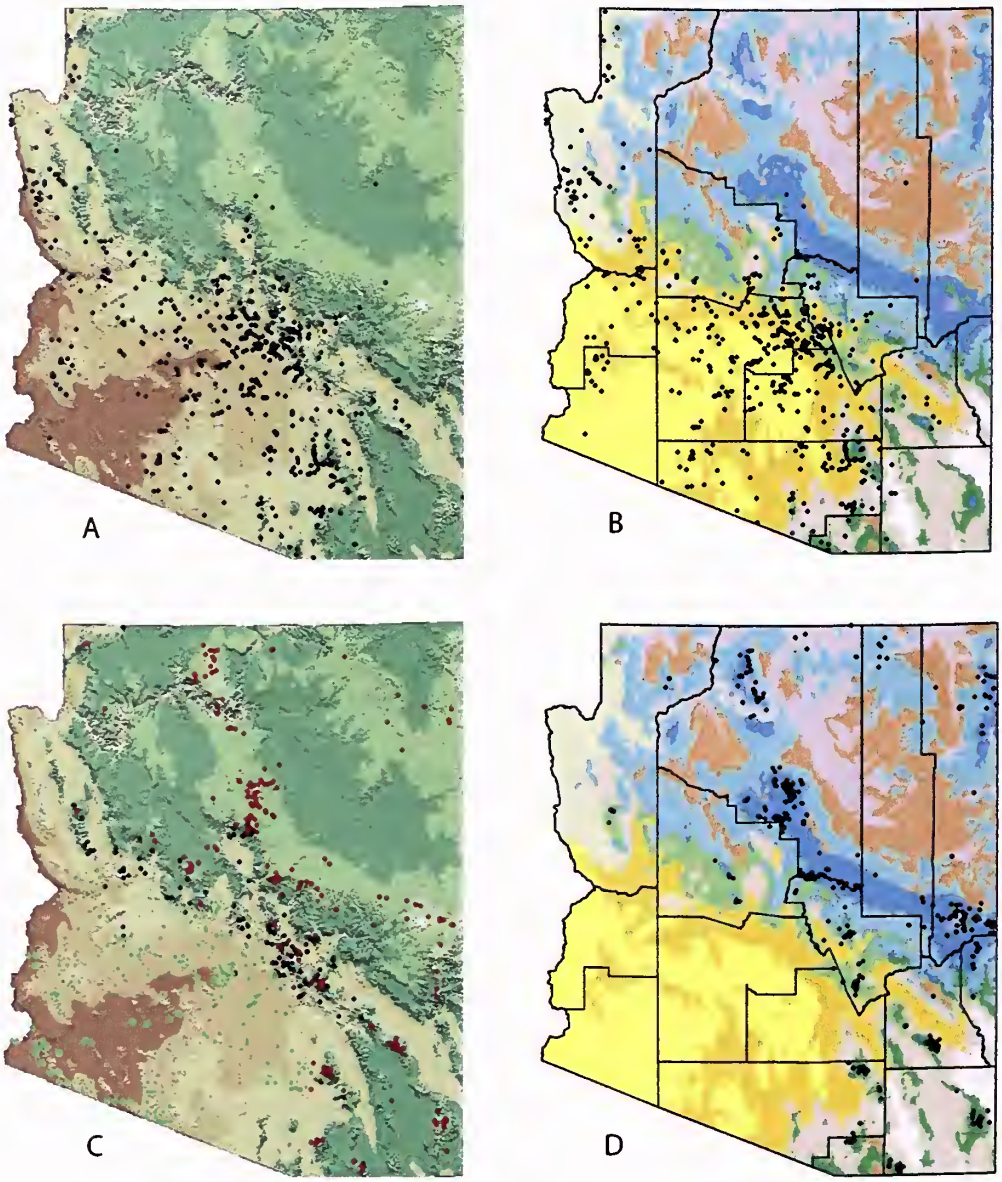
species (Fig. 1). You can also use a generic name, for example, "Pinus" and all the species of *Pinus* will be mapped together with a single dot color.

Click on "Relief" or "Biotic Communities" below this base outline map and the maps in Fig. 2, A & B appear for *Lupinus sparsiflorus*. For more information about the biotic communities map see Brown et al. (2007).

In Fig. 2C we entered three species on separate lines in the program and mapped them on the relief map. These are *Pinus ponderosa* (red), *Rhus ovata* (black), and *Olneya tesota* (green) - upland forest, chaparral, and Sonoran Desert species respectively. In Fig. 2D, we have put a list of 10 species of high elevations on a single line separated by semicolons: *Picea engelmannii*; *Picea pungens*; *Abies lasicarpa*; *Abies bifolia*; *Pinus aristata*; *Populus tremuloides*; *Salix scouleriana*; *Pseudotsuga menziesii*; *Pinus strobiformis*; *Pinus flexilis*. Some of these names may be synonyms of each other, but it is necessary to use them in order to find all the specimens of a species that might be under either name. We used the biotic communities map and it is clear that these upland species correspond in many areas with the higher elevation biotic communities. When the objective is to show one to three distributions on a single map, each with its own color, put the names on separate lines. When the objective is to show a group of species of a particular vegetation type, put them on a single line, separated by semicolons. One line of names will wrap around in the box when it is long.

There is no limit to the number of dots that may appear on a map, but if there are multiple specimens from the same input line indicating a single locality, only the first specimen found in the database will be used. This prevents downloading redundant data

that will not be visible anyway. Specimens at the same location but from separate input lines, however, will be displayed, sometimes shifted incrementally to be made visible.



A New Plant Mapping Program for Arizona. Figure 2. A & B, distribution of *Lupinus sparsiflorus* in Arizona according to SEINet database on the relief map (A) and the biotic communities map (B); C, distributions of *Olneya tesota* (green), *Rhus ovata* (black), and *Pinus ponderosa* (red) on the relief map; D, distribution of various high-elevation species on the biotic communities map.

Any user of this program needs to know that there are occasional errors in georeferencing or identification and for a taxonomic or ecological publication it is important to confirm the validity of the dots. If you suspect a dot is misplaced or a specimen misidentified you can "mouse over" it and information about collector, number, herbarium, locality and date will appear. You may want to disregard some suspect dots or correct some georeferencing mistakes. Contact the curator of the collection in question (e.g., ASU, ASC, ARIZ, DES, etc.) if you are interested in making corrections.

We hope you find this program enjoyable and educational.

LITERATURE CITED

BROWN, D. E., T. C. BRENNAN, and P. J. UNMACK. 2007. A digitized biotic community map. *CANOTIA* 3(1):1–12,

SOUTHWEST ENVIRONMENTAL INFORMATION NETWORK. 2009. SEINet. http://swbiodiversity.org/seinet/index.php. Accessed October 2012.

APPENDIX 1.

List of scientific names used in this paper including authors. *Abies bifolia* A. Muir, *Abies lasicarpa* (Hook.) Nutt., *Lupinus sparsiflorus* Benth., *Olneya tesota* A. Gray, *Picea engelmannii* Parry ex Engelm., *Picea pungens* Engelm., *Pinus aristata* Engelm., *Pinus flexilis* James, *Pinus ponderosa* P. & C. Lawson, *Pinus strobiformis* Engelm., *Populus tremuloides* Michx., *Pseudotsuga menziesii* (Mirb.) Franco, *Rhus ovata* S. Wats., *Salix scouleriana* Barratt ex Hook.

Charles Mason (1918-2012), Curator Emeritus of the University Herbarium Remembered

We lost our colleague Charles Mason this last spring on March 7, 2012. He was one of the preeminent botanists of Arizona for more than 50 years and was honored with the Arizona Botanists Award in 2007. On that occasion some of his students and colleagues wrote short pieces on their association with Chuck. We here reprint those remembrances and a short biographical sketch as our way of paying tribute to our colleague and his career.

Charles Thomas Mason Jr. was born on 26 March, 1918, in Joliet, Illinois. After undergraduate work at the University of Chicago, Chuck headed west and became a product of the University of California's fine tradition of graduate education in botany. Chuck completed a Masters Degree at Berkeley in 1942 and a Ph.D. in 1949. Along the way he got married to his wonderful wife, Patricia, in 1943. His dissertation focused on biosystematics of the endemic North American angiosperm family, Limnanthaceae, and led to publications on embryo sac development in Limnanthes as well as a monograph of the genus. His major professor was Lincoln Constance, but his development as a botanist also was influenced heavily by the rest of his graduate committee, G. Ledyard Stebbins and Herbert L. Mason (his uncle). The curator of the UC Herbarium, Annetta Carter, taught him how to run an herbarium, which would serve Chuck in good stead throughout his career.

After completing his doctorate in 1949, Dr. Mason accepted an instructorship in botany at the University of Wisconsin at Madison. During his four years there, Chuck began his taxonomic studies of perennial North American gentians, which became a lasting research focus. He arrived at the University of Arizona in 1953 to begin a professorship in the Plant Sciences Department and to assume the curatorship of the University of Arizona Herbarium.

When Chuck arrived at the herbarium, things were in a state of disarray. Emphasis during the "Thornber era" had been on adding new specimens, but little had been done since to organize and curate the collections, and the herbarium was not particularly active in other ways. Chuck threw himself into a career-long endeavor to create a museum of regional and international importance for both its historical and newer accessions. He soon set out on his own botanical explorations in Arizona and Mexico and began publishing additions to the Arizona Flora by 1960. The herbarium became an integral part of arid lands research, range science, and plant science at the university and also became more heavily utilized by students and professors in what later became the Ecology and Evolutionary Biology Department. The herbarium developed a reputation among govern-

Chuck working in the ARIZ herbarium, probably in the 1960's.

ment agencies and other organizations for its public service plant identification program and for its other outreach, such as responding to queries from the Arizona Poison Control Center and various county extension agents. At the same time the herbarium continued to acquire important new collections, such as the herbaria of Thomas Kearney, Robert Peebles, Robert Hoshaw, and Howard Scott Gentry, and also developed a strong exchange program with other institutions around the world. Most importantly, the herbarium became a gathering place for a large and diverse group of loosely affiliated amateurs and professionals with broad interests in ethnobotany, horticulture, agriculture, ecology, climatology, conservation, taxonomy, and various other disciplines. This unique environment of interchange and academic ferment, so lacking in many other herbaria, has led to numerous lasting friendships and the development of many shared research projects over the years.

To his many former students, Chuck has been a supportive mentor and outstanding teacher. With his bow tie (later, a bola tie), dry wit, and engaging teaching style, Chuck won over many undergraduates into the field of botany. Among his graduate students who have gone on to careers in botany have been Barbara Phillips, Wesley Niles, Richard Halse, and George Yatskievych. In addition, Chuck has been active in several honor societies, including Sigma Xi, Phi Kappa Phi, and Gamma Sigma Delta, and has contributed to the development of numerous young scholars through these groups.

During Chuck's association with the University of Arizona Herbarium of over 50 years the collection has grown from about 100,000 to nearly 300,000 vascular plant specimens.

Chuck and one of his students, Carole Jenkins, on a fieldtrip to the Cabeza Prieta in southwestern Arizona, March 1979.

REMEMBRANCES OF STUDENTS AND COLLEAGUES

I found Dr. Mason to be a great advisor and mentor. I was new to graduate school and did not know exactly what to expect. He helped me enormously in adjusting to graduate school and in developing my thesis project. I was interested in doing a floristic study and he provided me with a great opportunity to do just that – a floristic study of Canyon de Chelly National Monument. I remember him as a great teacher. He was willing to meet with me at any time to answer questions and give advice. He was kind, considerate and helpful – basically an ideal mentor as far as I was concerned. I do recall that morning coffee breaks in the herbarium were well attended by graduate students and faculty. Donuts, and other goodies were often provided as well as companionship and interesting discussions on all the various topics of the day – including botanical ones. I was on several field trips with him and his knowledge of the Arizona Flora always amazed me. Especially being able to drive several miles an hour down a road and he was able to recognize all the plants in the ditches. The field trips were lots of fun and he has a great sense of humor. He certainly encouraged me to continue on with my studies in botany and without that I would not be a professional botanist today.

— *Richard R. Halse, Oregon State University*

I came to Arizona in 1986 to work as Curator of the Arizona State University Herbarium. I had heard a little about the new Vascular Plants of Arizona project and was very interested. I didn't quite feel like committing myself to the project completely, but was interested enough that I would attend organizational meetings. Finally Chuck announced that he believed that I should be a part of the Editorial Committee and then there was no way I could get out of it. The project, which has published many family treatments in the *Journal of the Arizona-Nevada Academy of Science* and now *Canotia*, continues on today. Largely a grass-roots effort, it has depended on the good will of the contributors and editors. Chuck has been a major force in pushing it forward.

— *Les Landrum, Arizona State University*

I have known Dr. Mason as a teacher, mentor, colleague, and friend for nearly 42 years. Through his leadership the University of Arizona Herbarium developed into a premier collection of Southwestern and Mexican plants, and through the incorporation of other important collections it became an invaluable historical reference for regional vegetation change. Over the years we have shared many memorable collecting trips from the Arizona Strip to southern Mexico. I'll never forget getting covered by Bursera sap while hacking down trees with a machete in Puebla for Pharmacy College research, or getting lost on the myriad of roads while plant collecting in the Grand Wash Cliffs area of northern Mohave County. Dr. Mason and Pat were always the most gracious of hosts in sharing their beautiful home with grad students. Dr. Mason is a legend in the history of Arizona botany, and he is richly deserving of the Outstanding Arizona Botanist award.

— *Art Phillips, Eckert, Colorado*

Let me set the stage – a new young graduate student comes in out of the bright Arizona sun, descends stairs to the basement of the Agricultural Sciences Building and goes through the double doors into a huge room filled with steel cases and clear glass pipes hanging from the ceiling. A slight man in a white shirt and bow tie greets me and offers a cup of coffee. People emerge from all parts of the room, gather 'round, and suddenly the air is filled with plant collecting trip stories, exclamations of amazement, and questions about this plant or that (much in Latin!). What an exciting place to be a grad student! Day after day, year after year a room full of steel cabinets of dead plants and mothballs became the center of this grad student's universe: for a few brief years only – but the warm memories of the camaraderie and friendships developed there last a lifetime. How wonderful the professor who created such a nurturing atmosphere – each student empowered individually to pursue her/his own goals and discover the fascinating hidden world of plants!

— Barbara Goodrich Phillips, Zone Botanist, Coconino, Kaibab and Prescott National Forests

I was first introduced to Chuck Mason in 1977, during my sophomore year at Arizona. At the time, I was not a model student, with a not-so-great GPA and a bad attitude about school. The turning point in my life was a change in advisors to Bob Hoshaw, who taught my first real botany course (plant morphology) and who responded to my newfound enthusiasm for plants by quickly introducing me to Dr. Mason. Soon I was collecting plants in southern Arizona on weekends and hanging around the herbarium at all hours, teaching myself how to identify my finds and sponging up tidbits of knowledge from the staff and visitors. The introductory plant taxonomy course that Chuck taught occupied me the following semester, and by then I was hooked.

During my junior year, Chuck sponsored my independent study project on ferns in part of the Huachuca Mountains, which led to my first botanical publication (in *Desert Plants*). By my senior year I was already working part time in the herbarium. Imagine, getting paid to do things like keying plants and poking around the collections! I was amazed. When it came time to graduate, I was still unsure about how to develop a career in botany, so Chuck wisely got me into the Master's program in the Plant Sciences Department at the U of A. He further facilitated my transition into a plant taxonomist by offering me an assistantship in the herbarium throughout my studies. Weekly trips during spring semester to gather plant samples all around the area for the plant taxonomy labs became a highlight of my schedule.

When it became apparent that I would need to undertake extensive field work in Mexico to collect samples of my odd little study group, the parasitic Lennoaceae, Chuck not only helped me to gain funding, but also led a trip into remote portions of Baja California with me and then arranged for a colleague of his, Alan Beetle, to help me with field work farther south in Mexico. Although it would have been comfortable to continue on for a Ph.D. at the U of A, it was Chuck who advised me to continue to broaden my horizons, and it was he who sold his Master's student to other taxonomists at the schools to which I applied. My move from Arizona to the Midwest for doctoral studies was a sad day in my

life, and the dark, quiet, underutilized herbarium at my next university only reinforced how special my experiences at the U of A herbarium had been.

Chuck was my co-author on some of my earliest papers in refereed journals and reviewed all of my early research before it was submitted. He knew that completing small projects unrelated to the thesis research was an important way to transform an upcoming student into a professional. I am pleased to have had the chance to continue collaborating with him very recently on a treatment of the family Crossosomataceae to be published in an upcoming volume of the Flora of North America series. Chuck's influence continues to be a part of my career more than 25 years after I left the desert for greener pastures in the Midwest.

— *George Yatskievych, Missouri Botanical Garden*

INDEX TO FAMILIES OF THE VASCULAR PLANTS OF ARIZONA

Bolded treatments are published in volumes 26, 27, 29, 30, 32, 33, and 35 of the *Journal of the Arizona-Nevada Academy of Science* (JANAS) or in subsequent volumes (e.g., 1–8) of CANOTIA. Unbolded entries indicate families with no treatments published to date. Figure numbers refer to illustrations in the "Key to Families of Vascular Plants in Arizona" in JANAS 35(2). Selected VPA treatments originally published in JANAS are also available as pdf files online (http://www.canotia.org/vpa_project.html).

Acanthaceae (Fig. 3)
Aceraceae JANAS 29(1):2. 1995. (L.R. Landrum)
Adiantaceae (Fig. 1)
Agavaceae Part 1: *Agave* JANAS 32(1):1. 1999. (W. Hodgson)
Aizoaceae Alismataceae Amaranthaceae (Fig. 4)
Anacardiaceae CANOTIA 3(2):13. 2007. (J.L. Anderson)
Apiaceae (Fig. 5)
Apocynaceae JANAS 27(2):164. 1994. (S.P. McLaughlin)
Araceae
Araliaceae
Arecaceae JANAS 32(1):22. 1999. (C.T. Mason, Jr.)
Aristolochiaceae JANAS 32(1):24. 1999. (C.T. Mason, Jr.)
Asclepiadaceae JANAS 27(2):169. 1994. (E. Sundell)
Aspleniaceae Asteraceae (Figs. 6–7)
Azollaceae CANOTIA 4(2):31. 2008. (G. Yatskievych and M.D. Windham)
Berberidaceae JANAS 26(1):2. 1992. (J.E. LaFerriere; Fig. 9)
Betulaceae JANAS 33(1):1. 2001. (J.W. Brasher)
Bignoniaceae JANAS 32(1):26. 1999. (C.T. Mason, Jr.)
Bixaceae JANAS 27(2):188. 1994. (W. Hodgson)
Blechnaceae CANOTIA 4(2):35. 2008. (G. Yatskievych and M.D. Windham; Fig. 1)
Boraginaceae (Fig. 9)
Brassicaceae
Bromeliaceae CANOTIA 3(2):23. 2007. (R. Gutierrez, Jr.)
Buddlejaceae JANAS 26(1):5. 1992. (E.M. Norman)
Burseraceae JANAS 32(1):29. 1999. (A. Salywon)
Cactaceae Part One: The Cereoid Cacti JANAS 29(1):6. 1995. (D.J. Pinkava)
Cactaceae Part Two: *Echinocactus* JANAS 29(1):13. 1995. (M. Chamberland)
Cactaceae Part Three: *Cylindropuntia* JANAS 32(1):32. 1999. (D.J. Pinkava)
Cactaceae Part Four: *Grusonia* JANAS 32(1):48. 1999. (D.J. Pinkava)
Cactaceae Part Five: *Pediocactus* and *Sclerocactus* JANAS 33(1):9. 2001. (K.D. Heil and J.M. Porter)
Cactaceae Part Six: *Opuntia* JANAS 35(2):137. 2003. (D.J. Pinkava).
Callitrichaceae JANAS 29(1):15. 1995. (J. Rieketson)
Campanulaceae
Cannabaceae JANAS 32(1):53. 1999. (C.T. Mason, Jr.)
Capparaceae (Fig. 8)
Caprifoliaceae (Fig. 10)
Caryophyllaceae (Fig. 10)
Celastraceae JANAS 30(2):57. 1998. (J.W. Brasher)
Ceratophyllaceae JANAS 29(1):17. 1995. (J. Ricketson)
Chenopodiaceae (Fig. 9)
Clusiaceae
Commelinaceae JANAS 33(1):19. 2001. (R. Puente and R. Faden)
Convolvulaceae JANAS 30(2):61. 1998. (D.F. Austin)
Cornaceae
Crassulaceae JANAS 27(2):190. 1994. (R. Moran)
Crossosomataceae JANAS 26(1):7. 1992. (C. Mason)
Cucurbitaceae (Fig. 10)
Cupressaceae JANAS 27(2):195. 1994. (J. Bartel)
Cuscutaceae
Cyperaceae (Fig. 18)
Dennstaedtiaceae CANOTIA 4(2):38. 2008. (G. Yatskievych and M.D. Windham; Fig. 1)
Dipsaceae JANAS 27(2):201. 1994. (J.E. LaFerriere)
Dryopteridaceae (Fig. 1)
Elaeagnaceae
Elatinaceae
Ephedraceae (Fig. 2)
Ericaceae CANOTIA 4(2):21. 2008. (J.L. Anderson; Fig. 11)
Euphorbiaceae Part One: *Acalypha* and *Cnidoscolus* JANAS 29(1):18. 1995. (G.A. Levin)
Equisetaceae CANOTIA 4(2):41. 2008. (G. Yatskievych and M.D. Windham)
Fabaceae Part One: *Errazuria, Marina, Parryella,* and *Psorothamnus* CANOTIA 7:1. 2011 (S. Rhodes, J. Beasley, and T. Ayers; Figs. 12–13)
Fagaceae JANAS 27(2):203. 1994. (L.R. Landrum)
Fouquieriaceae JANAS 32(1):55. 1999. (C.T. Mason, Jr.)
Fumariaceae JANAS 33(1):27. 2001. (S. Holiday and A. Perez)
Garryaceae JANAS 33(1):31. 2001. (R. Puente and T.F. Daniel)
Gentianaceae JANAS 30(2):84. 1998. (C.T. Mason, Jr.)
Geraniaceae (Fig. 14)
Grossulariaceae
Haloragaceae
Hippuridaceae JANAS 29(1):25. 1995. (J. Ricketson)
Hydrangeaceae
Hydrocharitaceae
Hydrophyllaceae (Fig. 14)
Iridaceae Part One: *Sisyrinchium* JANAS 27(2):215. 1994. (A.F. Cholewa and D.M. Henderson)
Iridaceae Part Two: *Iris* and *Nemastylis* JANAS 33(1):35. 2001. (C.T. Mason, Jr.)
Isoëtaceae CANOTIA 5(1):27. 2009. (G. Yatskievych and M.D. Windham)
Juglandaceae JANAS 27(2):219. 1994. (J.E. LaFerriere)
Juncaceae (Fig. 19)
Juncaginaceae
Key to Families of Vascular Plants in Arizona JANAS 35(2):88. 2003. (D.J. Keil)
Krameriaceae JANAS 32(1):57. 1999. (B.B. Simpson and A. Salywon)
Lamiaceae Part One: *Agastache, Hyptis, Lamium, Leonurus, Marrubium, Monarda, Monardella, Nepeta, Salazaria, Stachys, Teucrium, and Trichostema* JANAS 35(2):151. 2003. (C.M. Christy, D.Z. Damrel, A. Henry, A. Trauth- Nare, R. Puente-Martinez, and G. Walters)
Lemnaceae JANAS 26(1):10. 1992. (E. Landolt)
Lennoaceae JANAS 27(2):220. 1994. (G. Yatskievych)
Lentibulariaceae CANOTIA 8(2):54-58. 2012. (B. Rice)

Liliaceae (Fig. 19)
Linaceae
Loasaceae JANAS 30(2):96. 1998. (C.M. Christy)
Lythraceae
Malpighiaceae
Malvaceae Part One: All genera except *Sphaeralcea*. JANAS 27(2):222. 1994. (P.A. Fryxell)
Marsileaceae CANOTIA 5(1):30. 2009. (G. Yatskievych and M.D. Windham)
Martyniaceae CANOTIA 3(2):26. 2007. (R. Gutierrez, Jr.)
Meliaceae
Menispermaceae JANAS 27(2):237. 1994. (J.E. LaFerriere)
Menyanthaceae JANAS 33(1):38. 2001. (C.T. Mason, Jr.)
Monotropaceae JANAS 26(1):15. 1992. (E. Haber)
Molluginaceae JANAS 30(2):112. 1998. (C.M. Christy)
Moraceae
Najadaceae
Nyctaginaceae (Fig. 14)
Nymphaeaceae JANAS 29(1):26. 1995. (J. Ricketson)
Oleaceae (Fig. 15)
Onagraceae (Fig. 15)
Ophioglossaceae
Orchidaceae
Orobanchaceae
Oxalidaceae JANAS 30(2):115. 1998. (R. Ornduff and M. Denton)
Papaveraceae JANAS 30(2):120. 1998. (G.B. Ownbey with contributions by J.W. Brasher and C. Clark)
Passifloraceae JANAS 33(1):41. 2001. (J.M. MacDougal)
Phytolaccaceae JANAS 33(1):46. 2001. (V. Steinmann)
Pinaceae
Plantaginaceae JANAS 32(1):62. 1999. (K.D. Huisinga and T.J. Ayers)
Platanaceae JANAS 27(2):238. 1994. (J.E. LaFerriere)
Plumbaginaceae Poaceae (Fig. 20)
Polemoniaceae CANOTIA 1:1. 2005. (D. Wilken and M. Porter)
Polygalaceae
Polygonaceae (Fig. 15)
Polypodiaceae CANOTIA 5(1):34. 2009. (G. Yatskievych and M.D. Windham; Fig. 1)
Pontederiaceae JANAS 30(2):133. 1998. (C.N. Horn)
Portulacaceae CANOTIA 2(1):1. 2006. (A. Bair, M. Howe, D. Roth, R. Taylor, T. Ayers, and R.W. Kiger)
Potamogetonaceae
Primulaceae JANAS 26(1):17. 1992. (A.F. Cholewa; Fig. 16)
Psilotaceae CANOTIA 3(2):32. 2007. (R. Gutierrez, Jr.)
Pyrolaceae JANAS 26(1):22. 1992. (E. Haber)
Rafflesiaceae JANAS 27(2):239. 1994. (G. Yatskievych)
Ranunculaceae (Fig 15)
Resedaceae
Rhamnaceae CANOTIA 2(1):23. 2006. (K. Christie, M. Currie, L. Smith Davis, M-E. Hill, S. Neal, and T. Ayers)
Rosaceae Part One: *Rubus*. JANAS 33(1):50. 2001. (J.W. Brasher)
Rubiaceae JANAS 29(1):29. 1995. (L. Dempster and E.T. Terrell; Fig. 16)
Ruppiaceae
Rutaceae
Salicaceae Part One: *Populus*. JANAS 26(1):29. 1992. (J.E. Eckenwalder)
Salicaceae Part Two. *Salix*. JANAS 29(1):39. 1995. (G.W. Argus)
Salviniaceae CANOTIA 4(2):50. 2008. (G. Yatskievych and M.D. Windham)
Santalaceae JANAS 27(2):240. 1994. (J.E. LaFerriere)
Sapindaceae JANAS 32(1):76. 1999. (A. Salywon)
Sapotaceae JANAS 26(1):34. 1992. (L.R. Landrum)
Saururaceae JANAS 32(1):83. 1999. (C.T. Mason, Jr.)
Saxifragaceae JANAS 26(1):36. 1992. (P. Elvander; Fig. 16)
Scrophulariaceae (Fig. 17)
Selaginellaceae CANOTIA 5(1):39. 2009. (G. Yatskievych and M.D. Windham)
Simaroubaceae JANAS 32(1):85. 1999. (J.W. Brasher)
Simmondsiaceae JANAS 29(1):63. 1995. (J. Rebman)
Solanaceae Part One: *Datura*. JANAS 33(1):58. 2001. (R. Bye)
Solanaceae Part Two: Key to the Genera and *Solanum*. CANOTIA 5(1):1. 2009. (S.T. Bates, F. Farruggia, E. Gilbert R. Gutierrez, D. Jenke, E. Makings, E. Manton, D. Newton, and L.R. Landrum)
Solanaceae Part Three: *Lycium*. CANOTIA 5(1):17. 2009. (F. Chiang and L.R. Landrum)
Sparganiaceae JANAS 33(1):65. 2001. (J. Ricketson)
Sterculiaceae
Tamaricaceae
Thelypteridaceae CANOTIA 5(1):49. 2009. (G. Yatskievych and M.D. Windham)
Tiliaceae
Typhaceae JANAS 33(1):69. 2001. (J. Ricketson)
Ulmaceae JANAS 35(2):170. 2003. (J.W. Brasher)
Urticaceae JANAS 26(1):42. 1992. (D. Boufford)
Valerianaceae
Verbenaceae
Violaceae. JANAS 33(1):73. 2001. (R.J. Little; Fig. 17)
Viscaceae JANAS 27(2):241. 1994. (F.G. Hawksworth and D. Wiens)
Vitaceae
Zannichelliaceae
Zygophyllaceae (Fig. 17)