Monographic Plant Systematics

Fundamental Assessment of Plant Biodiversity

Edited by

Tod F. Stuessy
Professor of Systematic and Evolutionary Botany
University of Vienna

and

H. Walter Lack
Professor and Director at
Botanic Garden and Botanical Museum Berlin-Dahlem
Freie Universität Berlin

A. R. G. Gantner Verlag K. G.

Regnum Vegetabile Volume 153
ISSN 0080-0694
ISBN 978-3-906166-98-8

Regnum Vegetabile, a series of publications for the use of plant taxonomists published under the auspices of the International Association for Plant Taxonomy, edited by Tod F. Stuessy and Franz Stadler

Published by
A.R.G. Gantner Verlag K.G., FL-9491 Ruggell

Distributed by
Koeltz Scientific Books
P.O. Box 1360
D-61453 Königstein / Germany
Phone: (+49) 6174 93720
Fax: (+49) 6174 937240
E-mail: koeltz@t-online.de
Internet: http://www.koeltz.com

Contents

Chapter 3. The significance of fieldwork in monographic studies

David M. Spooner

Introduction

The importance of taxonomic monographs in all areas of plant biology, ranging from ecology to biodiversity conservation to breeding, has long been known (Stuessy, 1975). The keys, illustrations, descriptions, localities, habitat data, distribution maps, synonymies, cytological and molecular data, and hypotheses of relationships characteristic of a complete monograph are all immensely improved as a result of access to data available in the field or in local herbaria. This is obvious to monographers who have spent years in the field, but it is interesting to recall misconceptions many of us had about field collecting before we set out on our first expedition.

The purpose of this chapter is to document the clear advantages of fieldwork for monographic studies. These advantages include: (1) ability to document published distributions better and to greatly expand these data, (2) access to taxonomic data that may be obscured on herbarium sheets (as colors, odors, glandularity, branching patterns), (3) ability to take photographs for species illustrations or habitats, (4) access to ecological and populational data useful to understand possible hybridization or isolating mechanisms, (5) access to population variation, (6) ability to collect material useful for morphological or cytological or molecular studies (as liquid-preserved collections, fixed flower buds, or silica-dried tissue), (7) ready access to herbarium collections, including types, in herbaria in countries where the plants grow, and (8) access to local experts or local residents who may lead you to new localities or provide critical data in other ways. There are so many advantages to be gained from fieldwork that it is hard to imagine writing a monograph without it.

Expanded distributional data

Distributional data are useful for a variety of applications from biogeography to biodiversity to floristic studies. Most distributions, however, are initially gathered from herbarium collections arising from general collecting, and greatly underrepresent the true distribution of the species. Fieldwork devoted to a particular group has the potential to fill in many gaps in distributions. Collectors can increase their efficiency to locate new populations by developing a "search image" in the field, learning to discriminate a target plant among a mass of surrounding vegetation (Wandersee, 2001).

Many locations on herbarium sheets are obscure because the collector used a name of a small village or hill or valley known only locally but not present on maps or in gazetteers. This presents problems for making distribution maps, and can be a particular problem for type specimens. Fieldwork can uncover such localities. For example, Spooner & al. (1992) discovered through fieldwork that the type localities of two Ecuadorian species, *Solanum correllii* Ochoa and *S. regularifolium* Correll, that initially appeared to be in different places because of different reference points on the herbarium labels, were actually the same place. In combination with morphological data, fieldwork was able to place these two names in synonymy.

Taxonomic data best observed in the field

Taxonomically important characters are often lost or obscured on herbarium sheets that are clear on living plants in the field, such as heights, branching patterns, colors, or glandularity. Ideally, characters not evident from herbarium sheets should be mentioned on the collection label (Liesner, 2010), but these notes are often missing. Fieldwork is often required to obtain more accurate assessments of such traits. For example, Spooner (1990) reported difficulty in distinguishing *Simsia amplexicaulis* (Cav.) Pers. from *S. foetida* (Cav.) S.F. Blake on herbarium sheets. These two species are clearly distinguishable in the field, however. *Simsia amplexicaulis* has leaves mostly eglandular, without conspicuous odor, green to yellow in color, and grows in cool upland habitats from 1300–2900 m. *Simsia foetida* is so densely glandular that it imparts a sticky resin to your skin, the glands emit a strong spicy odor, possesses distinctly yellowish leaves, and grows in hot lowlands from sea level to 1700 m (rarely to 2150 m). Once such clear differences were encountered in the field, I was able to establish a "Gestalt" of these differences and identification of herbarium sheets became much easier.

Photographs of species and habitats

Illustrations of representative specimens and habitats provide ideal ways to communicate in monographic treatments. As mentioned above, some traits (as colors, shapes, pubescence) are often obscured by pressed herbarium sheets. Photographs of living plants or habitats can be used alone, or as supplementary material to artists' drawings from herbarium sheets (Spooner & al., 2004). Most monographs encourage such illustrations as their book-length nature is not constrained by page length. Photographs are also invaluable for oral presentations of your work. The development of digital cameras has immeasurably increased the utility of cameras in the field by being able to download and label images to a computer every day. They allow you to cheaply and liberally take a variety of photos, discarding those that are not ideal. Photos from film cameras were expensive and made it more complicated to keep track of your photos after long field trips.

Ecological and populational data

Ecological and populational data can be useful to help define species (Van Valen, 1976), to obtain critical data relating to interspecific hybridization (Anderson, 1948), for biodiversity conservation (Shi & al., 2010), and many other applications in taxonomy (Spooner & al., 2003). For example, wild potatoes, *Solanum* sect. *Petota*, are a complicated group for many reasons, including the poor development of reproductive isolating mechanisms among many of its constituent species and interspecific hybridization bluring some species boundaries. Fieldwork provided ecological and populational data to generate initial hypotheses of the hybrid origin of the wild potato species *Solanum* ×*rechei* (Hawkes & Hjerting, 1969). It later provided corroborative populational data and germplasm for DNA extraction to test this hypothesis (Clausen & Spooner, 1998).

Populational variation

As mentioned above, herbarium sheets present critical morphological, distributional, and habitat data for writing monographs, but their paucity often precludes sufficient data to assess intra- and inter-populational variation. Perhaps the most useful aspect of fieldwork is the ability to assess such variation from large populations. Assessing such variation is such a critical aspect of effective monography that treatments lacking such data have been viewed as "myopic" (Stuessy, 1975).

My experience with *Simsia* and *Solanum* illustrates the relevance of fieldwork for assessing populational variation for effective monography, and similar examples are common throughout monographs. Both *Simsia* and *Solanum* were

"over-described," and fieldwork was able to use intra-populational data to synonymize species.

For example, *Simsia submollicoma* S.F. Blake was distinguished from *S. eurylepis* S.F. Blake by the absence of wings at the base of the petioles ("nodal discs"), in contrast to *S. eurylepis* possessing these characters. Collections from throughout the range of the species, including at or near the type localities of both entities, showed this trait to vary frequently within populations, allowing for synonymy of *S. submollicoma* under *S. eurylepis*.

Solanum subandinum F. Meigen was distinguished from its close relatives by its small stature (<2 dm tall) and lack of interstitial leaflets. Collections at the type locality of *S. subandinum* showed this morphotype and plants over 0.5 m tall, and with leaves in the upper internodes occasionally lacking interstitial leaflets (as in the type), but with lower leaves possessing them (Contreras & Spooner, 1999). They found such variation to be common throughout the range of *S. etuberosum* Lindl., and concluded that *S. subandinum* was based on a dwarf plant and with inadequate population samples to document this variation. Field observations, therefore, were critical to designate *S. subandinum* as a synonym of *S. etuberosum*.

These examples point out the need to be thoroughly familiar with your group before commencing fieldwork. Without such research before going to the field you could easily fail to assess these "species-specific" characters.

Collections useful for later morphological or cytological or molecular studies

Cytological, and more recently DNA data provide key components addressing species relationships, and are generally expected in modern monographic treatments (Stuessy, 2009). The importance of chromosome numbers has long been recognized as a critical taxonomic character and a series of bibliographic indices of chromosome counts (e.g., Goldblatt & Johnson, 2006) make it efficient to compile these data. DNA can be extracted from herbarium specimens but is of reduced quality to that of fresh material (Ames & Spooner, 2008), or material collected from leaves preserved in the field with silica gel (Chase & Hills, 1991). Fieldwork provides ample opportunities to collect flower buds, silica-dried leaves, or other useful material such as liquid-preserved structures (as heads of Compositae) useful for destructive measurements when making descriptions.

Local herbarium collections

Often, some of the most useful collections in a group may reside in local herbaria, documenting possible new species or localities not available elsewhere. It

is always good practice to schedule visits to local herbaria before collecting commences, or during early stages of the fieldwork, to be able to plan collections at such newly discovered sites.

Local botanical experts

A major benefit of collecting in another country is the opportunity to foster international collaboration (and friendships). In addition, local residents may be extremely helpful by leading you to populations if they are generally recognized as useful plants. For example, Spooner & al. (1999) used local helpers to lead them to wild potatoes, easily recognized in Peru. Local experts can be a storehouse of information not just about plant localities, but about any number of practical concerns such as logistics, places to purchase needed supplies, or access to herbarium drying facilities. It also can initiate long-term collaborations that can last a lifetime, introducing you to local students or facilities or collaborative granting opportunities. Many scientists find collaboration to be a major key to their success.

Field trip planning

One of the most important aspects of conducting a successful field trip is advance planning. Care must be taken to insure that you bring the proper collecting and herbarium specimen drying equipment, that you collect in the right area at the right time of the year, with proper permits, using appropriate transportation, and with knowledgeable assistants or collaborators to make the trip effective, efficient, and legal.

Aspects of the above planning have been the subject of many publications, from Derr & Lane's (1914) early publication on collecting agricultural specimens, to a more updated (and extremely thorough) treatment by Liesner (2010) outlining standards for collectors at the Missouri Botanical Garden. Other comprehensive recommendations for collecting include Saville (1962), Hyland (1972), Hicks & Hicks (1978), Robertson (1980), Womersley (1980), and Engelmann (1986). In addition to these general references, others recommend modified collecting protocols in certain groups for such reasons as large size, high moisture content, or the need to highlight certain taxonomically significant structures: aquatic and marsh plants (Haynes, 1984; Ceska & Ceska, 1986), Araceae (Croat, 1985), bamboos (Soderstrom & Young, 1983), begonias (Logan, 1986), cacti (Griffiths, 1907; MacDougall, 1947), bromeliads (V. Jørgensen, 1972), Cyclanthaceae (Hammel, 1987), Lecythidaceae (Mori & Prance, 1987), palms (Dransfield, 1986), Pandanaceae (Stone, 1983), or passion flowers (P.M. Jørgensen & al., 1984). Hicks & Hicks

(1978) present a thoroughly catalogued bibliography of references for field collections and herbarium curation. Not mentioned in the above publications are methods to collect DNA samples such as the use of silica gel (Chase & Hills, 1991).

Permits

Obtaining collecting and export permits is absolutely necessary, especially after international agreements arising out of the Convention on Biological Diversity (CBD). Every country has different regulations. Sometimes the class of permits differs within countries, e.g., for herbarium samples vs. DNA samples or germplasm; permits for purely research purposes vs. access to genetic resources (CBD); permits for endangered or threatened plants (Convention on International Trade in Endangered Species or CITES, and national regulations); or import and export permits related to plant health. In some countries, research permits to collect herbarium samples and permits for access to genetic resources are the same, but in others they are different. The rules governing permits and even the permitting agencies sometimes change. Unfortunately, there is no central site listing regulations, and getting permits for a multi-country collecting expedition can be difficult and time consuming. Fortunately, some large herbaria or government agencies have collecting agreements set in place with individual countries, and it may be best to contact such institutions and to work through them to obtain permits. The following websites may be useful:

- CITES site
  http://www.fws.gov/international/DMA_DSA/CITES/CITES_home.html
- Convention on Biological Diversity
  http://www.cbd.int/
- Endangered Species Act in the U.S.
  http://www.fws.gov/endangered/
- FAO International Code of Conduct for Plant Germplasm Collecting and Transfer
  http://www.fao.org/docrep/x5586e/x5586e0k.htm
- USDA Animal and Plant Health Inspection Service
  http://www.aphis.usda.gov/

The personal lure of fieldwork

On a closing personal note, all of the taxonomists I know entered this field for a love of plants, combined with the adventure of travel in foreign and exotic locales. As a child I almost lived in the woods, and all I ever wanted to be was a botanist.

I dreamt of traveling in remote mountainous areas, driving a jeep, collecting plants, and meeting indigenous peoples. I can still recall the unbelievable feeling of adventure and energy of my first field trips in Mexico and Central America, living out a dream I held all my life. Fieldwork provides taxonomists the very "stuff of life" that keeps us motivated every day in our beautiful jobs. Laboratory and herbarium work complements our work that without fieldwork would be dry and boring. Without the lure and adventure of fieldwork there would simply be far fewer taxonomists.

Acknowledgements

Ideas for this chapter arose from experience gained from: five months of fieldwork collecting *Simsia* throughout Latin America, funded by an NSF Doctoral Improvement Grant; fourteen expeditions covering thirty months collecting *Solanum* sect. *Petota* throughout Latin America funded by the U.S. Germplasm System; six weeks collecting crop germplasm in Nepal, funded by the Asia Foundation; and most recently two weeks collecting *Daucus* in Tunisia, funded by the U.S. Germplasm System. I thank Ronald Liesner of the Missouri Botanical Garden for advice, and I freely took data from his on-line publication for collecting in the field. Thanks also go to Karen Williams for information on collecting and export permits.

Literature cited

Ames, M. & Spooner, D.M. 2008. DNA from herbarium specimens settles a controversy about origins of the European potato. *Amer. J. Bot.* 95: 252–257.

Anderson, E. 1948. Hybridization of the habitat. *Evolution* 2: 1–9.

Ceska, A. & Ceska, O. 1986. More on the techniques for collecting aquatic and marsh plants. *Ann. Missouri Bot. Gard.* 73: 825–827.

Chase, M.W. & Hills, H.H. 1991. Silica gel: An ideal material for field preservation of leaf samples for DNA studies. *Taxon* 40: 215–220.

Clausen, A.M. & Spooner, D.M. 1998. Molecular support for the hybrid origin of the wild potato species *Solanum* ×*rechei* (*Solanum* sect. *Petota*). *Crop Sci.* 38: 858–865.

Contreras, A. & Spooner, D.M. 1999. Revision of *Solanum* section *Etuberosum*. Pp. 227–245 in: Nee, M., Symon, D.E. & Jessop, J.P. (eds.), *Solanaceae IV: Advances in biology and utilization.* Kew: Royal Botanic Gardens.

Croat, T.B. 1985. Collecting and preparing specimens of Araceae. *Ann. Missouri Bot. Gard.* 72: 252–258.

Derr, H.B. & Lane, C.H. 1914. Collection and preservation of plant material for use in the study of agriculture. *U.S.D.A. Farmers Bull.* 586: 1–24.

Dransfield, J. 1986. A guide to collecting palms. *Ann. Missouri Bot. Gard.* 73: 166–176.

Engelmann, G. 1986. Instructions for the collection and preservation of botanical specimens. *Ann. Missouri Bot. Gard.* 73: 504–507.

Goldblatt, P. & Johnson, D.E. (eds.). 2006. Index to plant chromosome numbers 2001–2003. *Monogr. Syst. Bot. Missouri Bot. Gard.* 106: i–x, 1–242.

Griffiths, D. 1907. Preparation of specimens of *Opuntia*. *Pl. World* 9: 278–284.
Hammel, B.E. 1987. The origami of botany: A guide to collecting and mounting specimens of Cyclanthaceae. *Ann. Missouri Bot. Gard.* 74: 897–902.
Hawkes, J.G. & Hjerting, J.P. 1969. *The potatoes of Argentina, Brazil, Paraguay and Uruguay: A biosystematic study.* Oxford: Oxford Univ. Press.
Haynes, R.R. 1984. Techniques for collecting aquatic and marsh plants. *Ann. Missouri Bot. Gard.* 71: 229–231.
Hicks, A.J. & Hicks, P.H. 1978. A selected bibliography of plant collection and herbarium curation. *Taxon* 27: 63–99.
Hyland, B.P.M. 1972. A technique for collecting botanical specimens in rain forest. *Flora Males. Bull.* 26: 2038–2040.
Jørgensen, P.M., Lawesson, J.E. & Holm-Nielsen, L.B. 1984. A guide to collecting passionflowers. *Ann. Missouri Bot. Gard.* 71: 1172–1174.
Jørgensen, V. 1972. The preparing, pressing and mounting of bromeliads. *J. Bromeliad Soc.* 23: 211–214.
Liesner, R. 2010. *Field techniques used by Missouri Botanical Garden.* http://www.mobot.org/MOBOT/molib/fieldtechbook/handbook.pdf (accessed April 2010).
Logan, J. 1986. A pre-pressing treatment for *Begonia* species and succulents. *Taxon* 35: 671.
MacDougall, T. 1947. A method for pressing cactus flowers. *Cact. Succ. J. (Los Angeles)* 19: 188.
Mori, S. & Prance, G.T. 1987. A guide to collecting Lecythidaceae. *Ann. Missouri Bot. Gard.* 74: 321–330.
Robertson, K.R. 1980. Observing, photographing and collecting plants. *Circ. Illinois Nat. Hist. Surv.* 55: 1–62.
Saville, D.B.O. 1962. Collection and care of botanical specimens. *Publ. Res. Branch Canad. Dept. Agric.* 1113: 1–124.
Shi, J., Ma, K., Wang, J., Zhao, J. & He, K. 2010. Vascular plant species richness on wetland remnants is determined by both area and habitat heterogeneity. *Biodiv. Conserv.* 19: 1279–1295.
Soderstrom, T.R. & Young, S.M. 1983. A guide to collecting bamboos. *Ann. Missouri Bot. Gard.* 70: 128–136.
Spooner, D.M. 1990. Systematics of *Simsia* (Compositae-Heliantheae). *Syst. Bot. Monogr.* 30: 1–90.
Spooner, D.M., Castillo, R. & López, L. 1992. Ecuador, 1991 potato germplasm collecting expedition: Taxonomy and new germplasm resources. *Euphytica* 60: 159–169.
Spooner, D.M., Hetterscheid, W.L.A., Van den Berg, R.G. & Brandenburg, W. 2003. Plant nomenclature and taxonomy: An horticultural and agronomic perspective. *Hort. Rev.* 28: 1–60.
Spooner, D.M., Salas, A., Huamán, Z. & Hijmans, R.J. 1999. Wild potato collecting expedition in southern Peru (Departments of Apurímac, Arequipa, Cusco, Moquegua, Puno, Tacna) in 1998: Taxonomy and new genetic resources. *Amer. J. Potato Res.* 76: 103–119.
Spooner, D.M., Van den Berg, R.G., Rodríguez, A., Bamberg, J., Hijmans, R.J. & Lara-Cabrera, S.I. 2004. Wild potatoes (*Solanum* section *Petota*) of North and Central America. *Syst. Bot. Monogr.* 68: 1–209, 9 pl.
Stone, B.C. 1983. A guide to collecting Pandanaceae (*Pandanus*, *Freycinetia*, and *Sararanga*). *Ann. Missouri Bot. Gard.* 70: 137–145.
Stuessy, T.F. 1975. The importance of revisionary studies in plant systematics. *Sida* 6: 104–113.
Stuessy, T.F. 2009. *Plant taxonomy: The systematic evaluation of comparative data*, ed. 2. New York: Columbia Univ. Press.
Van Valen, L. 1976. Ecological species, multispecies, and oaks. *Taxon* 25: 233–239.
Wandersee, J. 2001. Towards a theory of plant blindness. *Pl. Sci. Bull.* 47: 2–8.
Womersley, J.S. 1980. Manual for plant collecting and herbarium development. *FAO Field Doc.* 23: 1–147.