ENRICHMENT AND FRUSTRATION IN FIELDWORK

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It was before 7:00 A.M., and already the temperature was in the low nineties. We were at least 50 miles from the nearest settlement, on a deeply rutted dirt road, bound for a remote cactus population to collect data for my master's thesis. We rounded a bend, only to find a roost with dozens of black vultures in bare trees, silhouetted against the early-morning sun. It seemed a portent of events to come. Later that day I found myself extracting spines from my backside after I tangled with a cactus that seemed to hurl its weapons at the closest bystander. We then discovered that our target cactus population was too sparse to measure with our sampling protocol. To make matters worse, a piece of critical equipment we had left in the closed car while we scouted the population had literally melted. Such were the adversities of my first field season as a biogeographer, collecting data for a study of columnar cactus distribution and demography in the northern Sonoran Desert (Figure 1). Despite numerous logistical challenges and physical discomfort, that fateful summer twenty-five years ago was the start of my lifelong love of field research.

Since that summer I have spent part of nearly every year in the American West or Florida, collecting field data for various studies. Although most projects have focused primarily on biogeographical questions, they have been varied in other respects. The scale of inquiry has ranged from local to regional. Some projects were small, cramped by a shoestring budget and funded with only personal financial resources; others received generous external support and involved multiple principal investigators. Methodologies have included a broad array of procedures and equipment: basic censusing or sampling for distributional and demographic studies of both plants and birds, tree-core extraction for dendroecological and dendroclimatic work, collection of plant-tissue samples to analyze population genetic structure, and soil-profile description and microclimatic monitoring to relate vegetation patterns to environmental parameters. Throughout these approaches, several key themes have proved fundamental to successful field investigation, and these are the focus of this essay.

Expect the Unexpected

A basic tenet of field research is that unforeseen difficulties will arise during data collection. These seem inevitable, even with thorough reconnaissance; and methodologies often have to be adjusted to accommodate unanticipated field scenarios. I remember well a frantic call to my doctoral adviser from Death Valley, California, one of the intended field sites for my dissertation research, as I fretted about how I would census birds when there was insufficient vegetation at the lowest elevations even to support a resident bird community! In that case, minor site-selection ad-

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justments rescued the project. A less fortunate colleague of mine avoided fieldwork for the majority of his career after methodological problems rendered useless six months of field data collection for his dissertation project.

Such surprises need not derail a project or redirect a career. Steps taken can reduce the probability of their occurrence and minimize their impact if they do occur. Thorough reconnaissance of potential study sites before starting data collection helps reduce unexpected problems. Merely seeing an area is not enough, however; potential study sites should be viewed with a specific research project in mind. Often, eyes that observe a landscape in a general context do not discern subtleties that are ideally perceived and registered during reconnaissance. My problems with the low elevations of Death Valley for a study site would have been avoided had I examined potential sites beforehand from the perspective of research on vegetation–bird community relationships.

For many projects, and not just in physical geography, reconnaissance includes laying the necessary groundwork with appropriate governmental agencies and private landowners before data collection begins, in order to secure permission to use a study area and to arrange for logistical support. In an analysis of genetic structure in sand pine, we had planned to collect foliar tissue samples from relatively tall pines with a shotgun where possible—a commonly used protocol for such studies. Although we had cleared our proposal with the federal and state agencies that administered the land on which our sites were situated, we had provided insufficient detail about our sample-collecting procedures in our communications with the appropriate officials of one agency. Not surprisingly, in retrospect, given the existence of residential areas within earshot of our site, when agency personnel learned the details of our protocol two days before our intended shotgun use, they denied us permission to shoot down tissue samples. This resulted in last-minute retrenching to adopt a workable, though much more physically challenging, backup collecting protocol. We could have minimized this problem through more complete advance communication with all of the agencies involved.

Another way to prevent surprises during field data collection is by conducting a small pilot project, verifying that the methodology is practical and that the envisioned data are indeed obtainable with the intended methodology. In dendrochronological studies, preliminary examination of a small sample of tree cores ensures that a particular species has annual rings that are identifiable with standard dendrochronological procedures. Similarly, in genetic work, preliminary analysis of tissue samples indicates whether allozyme loci for a certain plant species are resolvable with standard electrophoretic techniques and are sufficiently variable for meaningful analysis. Even though I have had years of experience with basic vegetation sampling, I try to sample a few test plots whenever I work in a new area, in order to adjust such details as sampling quadrat size, sampling intensity, and vegetation parameters measured, given the density and growth form of plants in that particular area. Beyond making the actual data collection run more smoothly, conducting a pilot study has the added benefit of providing preliminary results that often strengthen an external funding proposal. Preliminary findings may allow a move from merely posing research questions to formulating research hypotheses; these help focus the data analysis to truly address the original questions. Even tentative findings give proposal reviewers assurance that an intended methodology will effectively address the proposed research questions.

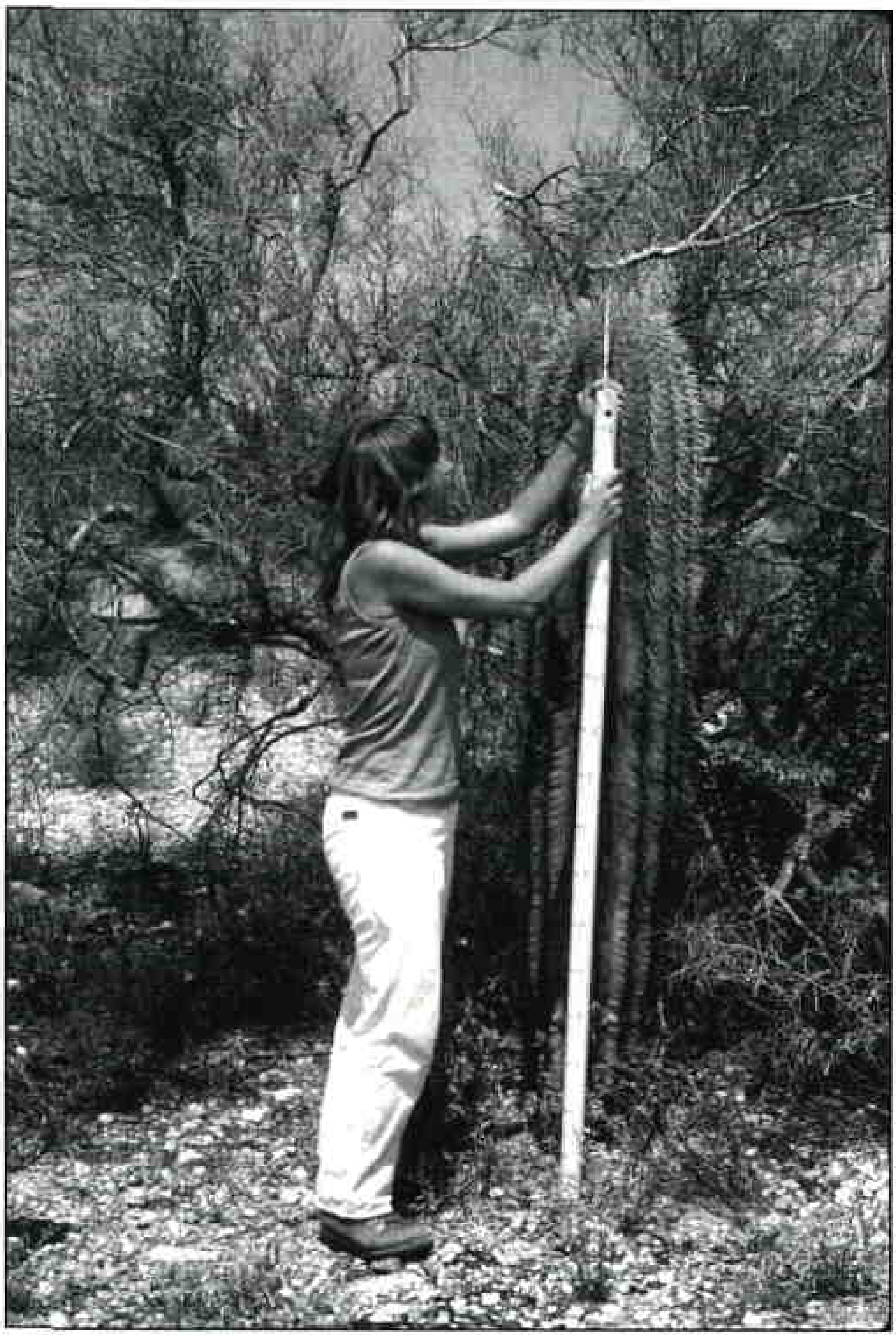

FIG. 1—Field data collection for a study of cactus population dynamics in Organ Pipe Cactus National Monument, Arizona. (Photograph by Albert J. Parker, July 1986)

Sometimes, even with the best reconnaissance or a successful pilot study, unforeseen problems emerge in the field during data collection. Over the years my graduate students and I have had numerous surprises in the field. A landfalling tropical storm kept one doctoral student from collecting salt traps he had set out to measure salt spray on difficult-to-access barrier islands off the Georgia coast. Another doctoral student, measuring depth to the water table, had a power auger fail to cut effectively through clay, after it had performed admirably in coarser sediments during a pilot study. Historically unprecedented drought lowered water levels, keeping a master's student from reaching sites by boat for a study of sturgeon spawning habitats, in a normally navigable stream. Upon returning to collect tissue samples from a cactus population I had mapped two months earlier for a genetic study, I discovered that a recent flash flood had severely eroded the banks of a wash, in the process also removing several mapped individuals.

In each case we could adjust the methodology slightly without compromising the scientific soundness of the study. Although as scientists we often have an ideal in mind for collecting the perfect data set, the contingencies of fieldwork often sabotage such absolutist thinking, and we fall somewhat short of our ideal. One of the challenges field scientists face is differentiating between surprises that are fatal flaws and those that still allow the project to yield scientifically sound results. Unforeseen problems can turn out to be serendipitous. Despite the removal of mapped individuals from my cactus sample, the erosion of several mature cacti by floodwaters gave me valuable insights into the dispersal ecology of cacti that I would not have had otherwise.

Envision All Phases of the Project Beforehand

A second theme that emerges after years of conducting field research is that the most successful projects are typically those that are clearly conceived from start to finish, before data are collected. A possible exception to this would be exploratory studies that investigate a topic so little known that hypotheses are difficult to formulate and potential data outcomes hard to envision. In most cases, though, thinking projects through before heading into the field, from the initial research questions through data collection and analysis to interpretation, helps ensure the success of a study. Otherwise, the data painstakingly gathered in the field may not actually address the initial research questions in an unambiguous way; they may not permit conclusive answers. How often I review proposals that raise fascinating and important research questions, without offering any clear methodology for answering them! Once a doctoral student and I submitted a proposal for a study of forest invasion in which we detailed our field and analytical procedures but neglected to reach closure by telling how the data would inform our research questions; luckily, we were only required to provide that in an addendum. Being forced to consider how we would formulate conclusions based on potential outcomes of the data proved very beneficial, because it helped us fine-tune the information we collected in the field so that the data more conclusively addressed our research questions.

Statistical procedures that may be used for data analysis often have certain requirements that must be met during the sampling process; awareness of these enables the investigator to design field methodologies to accommodate them. Most statistical procedures assume that populations have been sampled in a random manner; nonrandom sampling will typically invalidate inferences made from tests that assume a random sample. Analysis may require stratification of the data; failing to recognize this before data collection may mean that sample sizes within certain strata are too small for the most appropriate statistical analysis. If defining the relationship between two variables is the focus of a study, the range of values for those variables within the data set collected must be great enough for that relationship to be apparent. I have been involved in several studies, either as investigator or adviser, that have dealt with some aspect of the habitat distribution of a particular plant or animal species. In general, environmental relationships have been less obvious in studies where sampling is restricted to places where the species thrives and reaches high densities. Examining marginal populations as well gives a more complete gradient of conditions and helps identify factors that may limit the species occurrence.

Sometimes research projects are doomed because they are merely "fishing expeditions," in which the investigator has no clear questions. With creativity, solid grounding in the scientific literature, and a little serendipity, such studies *may* wind up successfully. While I was still in graduate school, a fellow student and I collected data on an unusually sharp ecotone in the Rocky Mountains, having only a broad question about the characteristics of the vegetation transition at the outset of our field sampling. Only with a great deal of reading and thought after our fieldwork were we able to turn our data into a publishable study. Not all such projects have a positive outcome. Regrettably, I also remember collecting data for a study early in my career that explored some aspect of columnar cactus architecture. After spending a week or two in the hot desert sun measuring cacti, I ended up lacking either a clear context or critical information needed for a meaningful study, and the data were relegated to a file drawer. Had I mustered the mental discipline to formulate focused research questions and think through the data analysis before I embarked on data collection, I would have either recognized the folly of my questions and abandoned the study before investing the effort to collect data or grounded my questions more effectively and gathered additional data to make the analysis more conclusive.

Sampling at an appropriate scale and resolution for the phenomenon of interest is critical to a sound methodology; otherwise, important patterns and their underlying processes may not be apparent. I recently completed a project that examined spatial genetic structuring within sand pine, a species virtually endemic to Florida, at three different scales. Although broad scale differences in genetic structure were apparent, my collaborators and I were most interested in differences among populations in their degree of local scale structuring. Unfortunately, gene movement is sufficiently great and populations sufficiently dense in this species that our local scale sampling was too spatially restricted to detect differences in structure among populations at this narrowest scale. Ideally, we would have sampled at a slightly broader scale, so that these contrasts could emerge (though habitat fragmentation made this impossible); missing this more intermediate scale has left unanswered one of our initial questions.

Nothing Can Replace Keen Field Observation

A third theme apparent after extensive field experience is that the most successful projects are those incorporating thorough and insightful observation during field data collection. Obviously, acute observation by an investigator is of paramount importance in qualitative studies, but even in research that is statistically oriented or based on remotely sensed data, sharp observation in the field is fundamental to the success of a project. Observing firsthand in the field a phenomenon being studied can provide keen insights that help in interpretation of more quantitative results. Our study of sand-pine gene movement would not have benefited from insights gained about the scale of pollen and seed dispersal if I had not been in the field, recording detailed notes about the landscape matrix in which our study populations were embedded.

In studies that use remotely sensed data, ground truthing is critical to check the validity of the data and to gain an impression of relationships and details that may not be evident on the images. Field observation can suggest aspects of the study to be pursued in more detail; it may reveal new questions that have to be answered before the main research goals are fully addressed. Our sand-pine genetics work was designed to be conducted in two distinct phases. The first was intended to provide an overview of genetic variability for the species. We planned to use patterns observed during this phase to guide our selection of populations to sample and environmental parameters to measure for the second phase of the project.

The social and physical sciences have experienced several recent methodological changes that often diminish the role played by simple observation in the field. Not so long ago, small-scale projects based on observations of one or two scholars were the norm in field studies. Without the more technologically advanced research tools currently available, investigators relied on personal observation and relatively simple measurement and experimentation in the field. I think of the desert ecologist Forrest Shreve as the epitome of this era in one of my own areas of specialization. Working in the first half of the twentieth century, Shreve scrutinized the desert landscape with a well-honed eye; his keen observations, which often pointed him down new but related avenues of inquiry, form the foundation of much of modern desert ecology (Bowers 1988).

In contrast to this earlier era, we have of late acquired new tools in our methodological arsenal (complex statistical analyses and techniques to acquire data remotely) that often shift emphasis away from simple field observation. New methodologies can even remove an investigator from the field altogether. Technological advances come as science is becoming more big business–like. Large research projects involving multiple scholars with diverse specializations, each of whom examines a different aspect of a single broad research question, are routine now. The two changes are related. Scientists are more narrowly specialized today than they were in the past, in part because of the complexities of new methodologies (Gober 2000). Fewer scholars can alone provide the breadth that a large project requires; broader insight may instead be provided collectively through the coordinated efforts of many specialists. Request-for-proposal grant guidelines often require that work be divided among several—or many—institutions (and even states), which increases the number of collaborators. Although such integrated studies open the door for exciting collaborations among people of disparate expertise and perspectives, the risk of disconnect among the various investigators is greater. No one individual will have the opportunity to observe personally all of the focal processes and relationships in the field; consequently, investigators are more removed from the patterns and processes they are interpreting. Such projects require strong leadership and careful coordination of individual investigators working on subsets of the project. Thorough communication among participants about key observations and results and integration of those diverse threads by a project leader are critical for a successful study that meets its overall objectives in a coherent manner.

The Rewards

Regardless of specialization, fieldwork can be a richly rewarding experience with benefits that far outweigh any adversity. Collecting data in the field has given me the opportunity to study and experience firsthand desert and forest environments. Through any methodological and logistical obstacles, being in the field has provided insights that would have eluded me had I been working with secondary data sets or remotely sensed data, unaugmented by field observation. On a more personal level, field-based research has allowed me to study natural areas and biological resources and to contribute to their conservation—one of the reasons I became a geographer. Added benefits of fieldwork are the places it has taken me and the phenomena I have observed that otherwise I would not have known. As I reflect on my life in academia, I often remember in vivid detail events of individual days in the field that occurred more than twenty years ago; this contrasts with entire months that may pass "back at the office" without any noteworthy details standing out to mark the passage of time. In this sense, I feel that field research has shaped my professional career and has had a profound influence on my life.

References

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