The Continuum of Desert Research

Benjamin T. Wilder, Carolyn O'Meara

Journal of the Southwest, Volume 57, Numbers 2 and 3, Summer-Autumn 2015, pp. 163-186 (Article)

Published by The Southwest Center, University of Arizona
DOI: 10.1353/jsw.2015.0004

The Continuum of Desert Research

Benjamin T. Wilder and Carolyn O'Meara

Resolution of the physical and biological realities of the desert lands surrounding the Gulf of California began in earnest on October 9, 1698. The iconic Jesuit padre Eusebio Francisco Kino ascended Pinacate Peak in northwestern Sonora, Mexico, to ascertain the true northern extent of the Gulf of California. From the high volcanic summit, the expansive lava fields gave way to the great sand dunes of the Gran Desierto. The waters of the Alto Golfo glistened in the distance and abruptly stopped in the vicinity of the Colorado River Delta. Baja California was clearly a peninsula and not an island (Burrus 1971). An era of formative knowledge based on exploration, careful notes, scientific collections, and collaboration with indigenous inhabitants began to lay the foundation that led to a robust and multifaceted understanding of the Sonoran Desert. It was just the beginning.

The physical locale of the Sonoran Desert and Gulf of California has captured the imagination of inquirers for centuries. We consider ourselves to be part of this fortunate group who has become fascinated with this landscape of spines and snakes, powerful monsoons, pulses of life, intense heat, brilliant light, and one of the world's most diverse seas. It is a region that resonates in our hearts and captures our imagination. The common threads throughout this special issue of *Journal of the Southwest* are people and place. It is a celebration of collaboration under the auspices of the Next Generation Sonoran Desert Researchers (N-Gen) that aims to push the arc of desert research forward. This collection of articles and the efforts of N-Gen in general intend to forge new paths of interdisciplinary research while building upon and honoring the legacy of those who have come before.

All too often the factors that connect people in time and place are overlooked. The capacity of individuals united around a common theme is underestimated. Connections are taken for granted and a sense of community is lost. The focus of N-Gen is the network of researchers who work in the Sonoran Desert and the Gulf of California, as well as

Journal of the Southwest 57, 2–3 (Summer–August 2015) : 163–186

the communities that live there. This region spans an international border, once a far more permeable frontier, where indigenous territories and a shared U.S.-Mexican culture lie. Since the terrorist attacks of September 11, 2001, there has been a redefinition of life along the U.S.-Mexico border. What was once an arbitrary line through a vast swath of desert terrain has become an increasingly fortified barrier. The border wall is an obstacle between communities and cultures, a chasm across a singular region that eclipses new ideas and discoveries. As a result, scientists, land managers, and artists, among others, from either side of the border are increasingly isolated from the work of their colleagues. The ability to work across *la línea* and the cultural connections that arise from these collaborations have been severely hampered. The Sonoran Desert community is in jeopardy of losing the cohesive fabric that has allowed it to flourish (Laird-Benner and Ingram 2011; B. Wilder et al. 2013).

The working premise of N-Gen is that a cohesive community of individuals with a shared passion yields limitless potential. The foundations for a vibrant community that were once strong were no longer in place. N-Gen strives to create the space and time to catalyze collaboration. Our observations, curiosity, and love for the Sonoran Desert unite us. Our individual stories and efforts are part of the larger continuum of desert research. This is certainly the case for us, the authors of this paper. Our two paths crossed for the first time in the center of Coyoacán, Mexico City, on the eve of Mexico's bicentennial, in 2010. Yet, that meeting was set in motion over a hundred years prior to that fall evening.

The Roots of Desert Research

As the nineteenth century waned, the University of Arizona was getting into full gear as the state's first land grant institution. The railroad connected the desert outpost of Tucson to the rest of the country. Two men from the eastern U.S., Fredrick Vernon Coville and Daniel Trembly MacDougal, came to the borderlands in search of a site to establish a research station. They were driven by a curiosity to study the physiological adaptations of plants to aridity and establish the world's first facility devoted to desert studies. They had recently received the financial support of the New York steel baron Andrew Carnegie and the Carnegie Institution (R. Bowers 1992). City of Tucson officials offered them a piece of land, 40 acres centered around Tumamoc Hill, a volcanic outcrop just to the west of what was an emerging downtown along the banks of

the perennial Santa Cruz River and Carrillo Gardens' lake and park (J. Wilder 1967; Sonnichsen 1982; Sandage et al. 2004). Coville and MacDougal accepted the city's offer and the Carnegie Desert Laboratory was established in 1903 (figure 1).

Figure 1. The Desert Laboratory of the Carnegie Institution of Washington. This photograph is from ca. 1910 and was used as part of the postcard production process by the Benham Co., Los Angeles.

The era of formative ecological and geographical knowledge of the Sonoran Desert that began with Padre Kino was succeeded by a host of researchers who revolved around the Desert Lab and the borderlands in general. Their efforts delved deeper into the biologic and social underpinnings of the region. Under the auspices of the Bureau of American Ethnology, William John McGee made journeys in 1894 and 1895 to the Sonoran Desert to "discover" the local people and document the landscapes that have been the home of the Tohono O'odham, as well as the Comcaac (Seri people), for millennia (McGee 1898, 2000). In the 1930s anthropologist Gwyneth Harrington worked on the Pima and Tohono O'odham reservations. She ventured across the border to make trips to the territory of the Comcaac where she collected material objects, which are now housed in the Arizona State Museum (Armstrong

1988), and was one of the first researchers to document the names of the items she collected in the Seri language (Cathy Moser Marlett, personal communication). The documentation of the uniqueness of the Baja California peninsula was likewise under way (Nelson 1921; Garcillán et al. 2010).

The importance of the contributions of the Desert Lab's scientists reached far beyond the station's fenced-in boundaries. The Desert Lab was a cornerstone of the founding of the discipline of ecology—the journal *Plant World* became *Ecology*, with Forrest Shreve as its first editor. Without a doubt, the Desert Lab was the birthplace of the discipline of desert ecology (McGinnies 1981). Research conducted by these pioneering field and laboratory scientists provided a synthetic analysis of the region's flora, vegetation, and physiology (e.g., Livingston 1906; Cannon 1911; Shreve 1915; Shreve and Mallery 1933; Shreve 1951). Just after the turn into the twentieth century when famous explorer and author William T. Hornaday desired to learn the wilds of the desert frontier, he turned to MacDougal and the Desert Lab. Their ramblings and exploration of the Pinacate and the Gran Desierto (Hornaday 1909) continue to capture imaginations. Sent west from the shores of England at an early age, Godfrey Sykes found his home in the desert (Sykes 1944; figure 2). The Desert Lab buildings are a legacy of his expert craftsmanship,

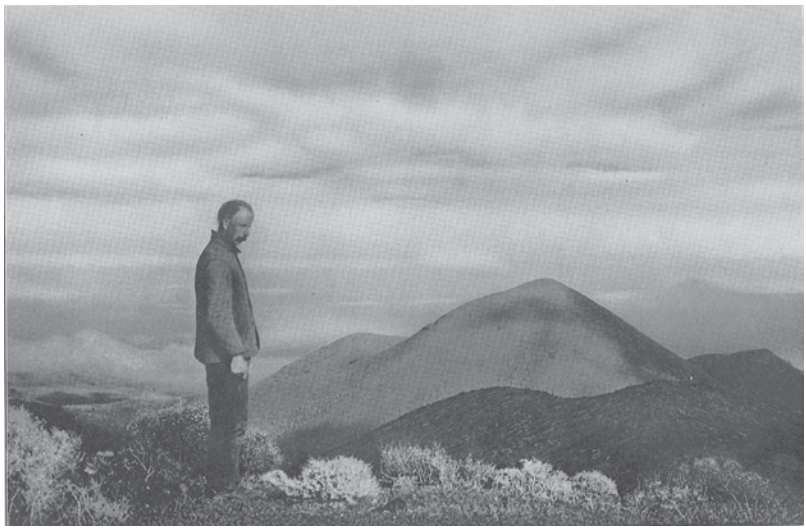

Figure 2. Godfrey Sykes on the summit of Pinacate Peak with Carnegie Peak in the background, November 1907. Photograph by J. M. Phillips from Hornaday (1909).

as is much of our early understanding of the Colorado River and its delta (Sykes 1937). Forrest Shreve, scientist at the Desert Lab starting in 1908 and director from 1928 until 1947, the year of his retirement, singularly sculpted our understanding of the desert ecosystem. He established the definition of the Sonoran Desert and its boundaries used today (Shreve 1951), illuminated the paramount importance of soil moisture and pulses to desert life, and began to decode the rhythms of the desert on decadal time scales (J. Bowers 1988). The discovery of the desert was in full swing (McGinnies 1981).

In the 1960s a new era of research began at the Desert Lab led by Paul S. Martin. With a piercingly keen eye and love for natural history and a quest for knowledge of the past, Paul pushed our understanding of the desert and indeed much of the world back in time. Tumamoc Hill once again became a center of activity and thought. Julio Betancourt, Tom Van Devender, James Irving Mead, and many others began to peel back the layers of time through paleoecological methods. They pioneered the revolutionary use of fossil packrat middens to identify vegetation communities in the last glacial period, which revealed the recent origin of the desert we see today and the implications for past climates (Betancourt et al. 1990). Paul's work also led him to establish the causational link between people and the extinction of the world's megafauna at the end of the last Ice Age (Martin 1984), a theory that is as relevant and controversial today as it was from the outset. Paul's ideas continue to galvanize and make us question baselines and our impact on the world. Equally important were the numerous student trips Paul led into the backcountry of Sonora (Karpiscak 1977), which remain fresh and vital in the memories of those fortunate participants. The exact destination was often an unspoken vision in Paul's head and a realm of wonder for the students. Excursions to the Sierra Madre, the Basaséachic waterfall in the highlands of the Sonora-Chihuahua border, and the northern fringes of tropical deciduous forests in and around Álamos opened a world of adventure and beauty to hundreds (Bowden et al. 1993; figure 3).

In 1976, although having conducted research on the Desert Lab's long-term vegetation plots since the 1950s, Raymond (Ray) Marriner Turner became a full-time presence at the Hill. Ray's work continued and expanded the careful and quantitative insights begun by the Desert Lab founders. Saguaro by saguaro, photo by photo, and plot by plot, Ray, his close collaborator Rodney (Rod) Hastings, Robert (Bob) Webb, and others documented the pace of change in the desert lands from the

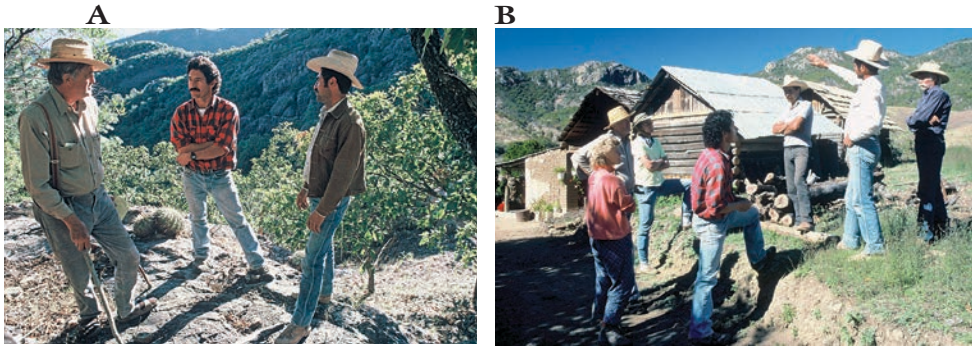

Figure 3. (a) Paul S. Martin (left) with Juan Rascón (red shirt) and a member of the Alvarez family at the head of Arroyo Santa Barbara, May 1990. (b) Left to right: Ceal Smith, Paul S. Martin (tan hat), Hommer Hanson, Juan Rascón (red shirt), and members of the Alvarez family of Rancho Santa Barbara, May 1990. Photos by and courtesy of Charles (Chip) Hedgcock.

shores of the Gulf of California to the desert's edge a mile above (see, e.g., Hastings and Turner 1965; Turner et al. 1995, 2003; Webb et al. 2007). Their work was complemented and infused by additional insights into the workings of the desert led by Janice (Jan) Emily Bowers, who had an explanation for every natural oddity one could come across wandering the desert (J. Bowers 1991, 1997).

One of the factors that has empowered and given structure to the Sonoran Desert research community is the opportunity to connect and simply enjoy each other's company. A fantastic example is the Menudo Society or, as it was originally known, the Tumamoc Hill Marching, Mescal, and Menudo Society, which consisted of, as Paul Martin said, "fiery potluck seminars, informal gatherings once held by dedicated students and foot loose faculty from various corners of the university . . . originated at the hand of former University of Arizona Professor Alan Solomon" (Martin 2005). The idea was to "march" from campus to Tumamoc Hill, sip a little of whatever, eat, and then hear the seminar. It originated in 1973 and ran continually for 18 years and at one time it was the longest-running noncredit seminar on campus (Mary Kay O'Rourke, personal communication; figure 4). It gradually yielded to busy schedules, but similar gatherings of the desert community persist. Ecologist Mark Dimmit marks the desert new year with his summer solstice celebration, and 2015 was the 36th anniversary. As Mark's invitations read, "A gathering of xerophytes, heliotherms, and other eremophiles. A celebration for plant freaks and like-minded souls who

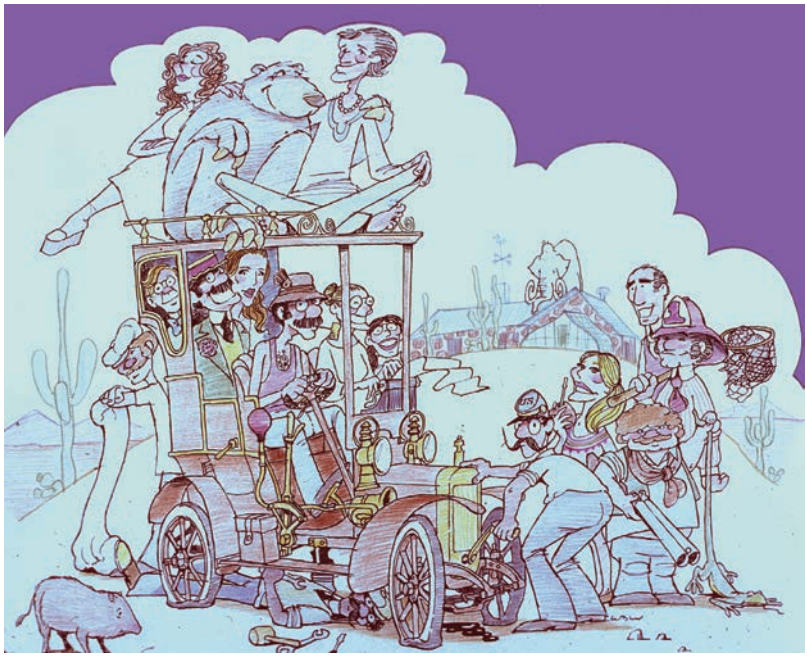

Figure 4. 1976 birthday card for Larry Gould by Wally Woolfenden. Roof: Mary Kay O'Rourke, Shasta, Paul S. Martin. Outside from left: Kevin Moodie, Gerald Kelso, Vera Markgraf, Tom Van Devender, Hector D'Antoni, Allan Solomon. Under car: Wally Woolfenden. Inside car: Art Phillips, Fred Wiseman, Martha Wiseman (Burgess), Geoff Spaulding, Betty Fink, Barb Phillips. Image courtesy of Tom Van Devender.

love the desert *because* of the summers, not in spite of them. If that describes you, then you're as welcome as desert rain!" Bill Broyles and Joan Scott bookend the summer with their "annual party for survivors of the devil's road," a gathering of great minds and people where the latest desert publications are showcased on the dining room table for all to enjoy.

Deep in the heart of Mexico another renaissance was under way. Starting around the 1950s, collaborations between local and foreign scientists led to the formal development of ecology in Mexico (Martínez et al. 2006). A generation of scientists who settled in Mexico during this time created key academic lineages. None have been more influential than José Sarukhán Kermez, who returned to Mexico in the early 1970s after obtaining his PhD abroad. At this time, and assuming the role as rector of the National Autonomous University of Mexico (Universidad

Nacional Autónoma de México, UNAM), he attracted some of the brightest scientific minds in the country (Domínguez 2014; Soberón 2014). A driven pursuit of the documentation, understanding, and conservation of Mexico's natural heritage rapidly evolved. Under Sarukhán's guidance his students and protégés identified their strengths and passions and with his support established the framework for much of Mexico's ecological knowledge.

On the eve of the 1992 Rio Earth Summit, with an eye toward the ratification of NAFTA, President Carlos Salinas de Gortari turned to Sarukhán to help him showcase Mexico's megadiversity to the world. Sarukhán, with the help of Rodolfo Dirzo, in short order convened many of the world's leading scientists for a conference to address the shortcomings of knowledge and conservation of biodiversity. It was at that event that the foundation for a government-based organization

Figure 5a. Dedication of the Pinacate Biosphere Reserve, June 10, 1993. From right to left: Manuel Arango (in glasses), then owner of Cifra; Exequiel Ezcurra (speaking), then Principal Researcher at UNAM; José Sarukhán, then Rector of UNAM; Fausto Alzati, then Director General of CONACyT; Sylvester Listo, then Chairman Tohono O'odham Nation; perhaps Emilio Lozoya Thalmann, then Secretary of Energy; Luis Carlos Ruano Angulo, then Secretary of the Navy; unidentified; Luis Donaldo Colosio Murieta, then Secretary of Social Development; Carlos Salinas Gortari, then President of Mexico; Manlio Fabio Beltrones, then Governor of Sonora; Bruce Babbitt, then U.S. Secretary of the Interior; unidentified (man in dark shirt); Alejandro Robles (white shirt and glasses), then Executive Director of the Mexico Program at Conservation International; Fife Symington, then Governor of Arizona. (Photo courtesy of the Centro Intercultural de Estudios de Desiertos y Océanos-CEDO).

Figure 5b. President Carlos Salinas Gortari (center) after ceremony. (Photo courtesy of the Centro Intercultural de Estudios de Desiertos y Océanos-CEDO)

focused on biodiversity was formed (Sarukhán and Dirzo 1992). Within days President Salinas established the National Commission for the Knowledge and Use of Biodiversity (Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, CONABIO), with Sarukhán as its leader. Sarukhán, still the president of UNAM, appointed his past student, Jorge Soberón, as its first director, who helped launch the organization (Soberón 2014). As head of UNAM, Sarukhán also helped establish the Instituto de Biología ecological research institutes at Los Tuxtlas, Veracruz, and Chamela, Jalisco, aided by Dirzo and others (Maass et al. 2014; Soberón 2014). These research stations have been critical sites not only for ecological study but also the training of many Mexican scientists (Martínez et al. 2006).

Significant actions were not confined to central and southern Mexico, however. In the early 1980s Exequiel Ezcurra was finishing his dissertation research on the vegetation of El Pinacate and the Gran Desierto (Ezcurra et al. 1987), with the hope that it would lead to the declaration of a natural protected area. Despite more than a decade of stagnation, political realities shifted and the rapidly rising politician Luis Donaldo Colosio, of Magdalena, Sonora, supported the rekindled effort to conserve these lands. The efforts of many individuals over the course of multiple years

were finally brought to fruition—patience and perseverance paid off (Ezcurra 2007). In 1993 Mexico established two spectacular protected areas by presidential proclamation: El Pinacate and El Gran Desierto de Altar Biosphere Reserve as well as the Upper Gulf of California and Delta of the Colorado River Biosphere Reserve (Felger 2000; Ezcurra et al. 2002; figure 5). Subsequently, in 2013 El Pinacate and Gran Desierto de Altar Biosphere Reserve was inscribed as a U.N.-UNESCO World Heritage Site (IUCN 2013).

In 1951 Lewis Wayne Walker published a popular article in *National Geographic* that called attention to the awe-inspiring phenomenon of hundreds of thousands of seabirds on the small desert island of Rasa in the middle of the Gulf of California (Walker 1951). Shortly thereafter, concern grew over crashing seabird populations in the late 1950s and early 1960s, largely due to excessive egg collecting. An international collaboration between Mexican and North American scientists, museum administrators, and local citizens petitioned the Mexican government to conserve Isla Rasa. Their work and pioneering science by UNAM professor Bernardo Villa culminated in the island being declared a federally protected area in 1964 by the Mexican government, the first of many decrees for the island and other islands in the Gulf of California (Velarde et al. 2014). Enriqueta Velarde has followed the lead of her advisor, Villa, in the methodical and devoted monitoring of seabird ecology on Isla Rasa (e.g., Velarde and Ezcurra 2002). Velarde's work has transformed this dot of land into a global model of ecological restoration that showcases the essential need for long-term research.

In June 1988 Alberto Búrquez and Angelina (Gela) Martínez-Yrízar returned from Cambridge with their PhD degrees. They quickly set forth from UNAM's Mexico City campus to Alberto's native Hermosillo to undertake ecological research in the north of the country at the encouragement of Daniel Piñero and José Sarukhán. In Hermosillo they set to work developing the UNAM's incipient ecology campus, where along with other researchers they continue to create a solid foothold for Sonoran Desert ecology. These are just a few examples of the expansion of Mexican-led science that is at the forefront of desert ecology and conservation today.

Meanwhile a flurry of research was afoot throughout the desert (figure 6). Julian Hayden, a self-made archaeologist, melded with the desert pavement, ancient trails, and calderas of the Pinacates (Hayden 2011). His archaeological research has helped us understand the traces of past

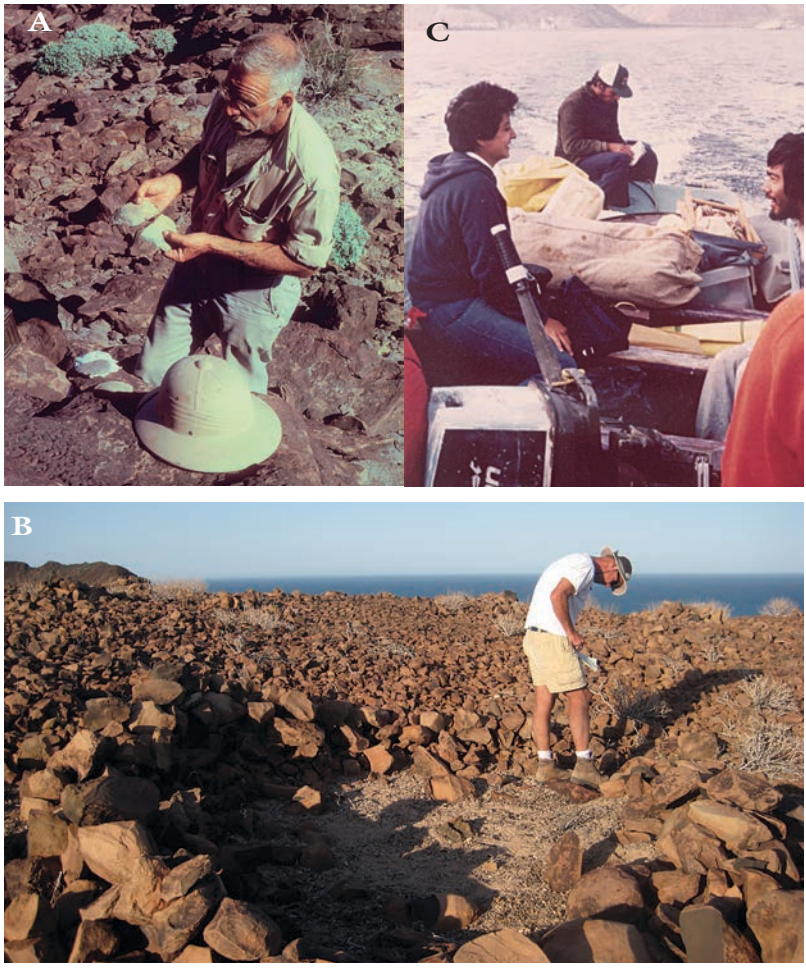

Figure 6. (a) Julian Hayden, Huarache Tanks, Sierra Pinacate, 1963, courtesy of Diane Boyer and Steve Hayden, image by and used with permission from Norman Simmons. (b) Tom Bowen, Isla Ángel de la Guarda, May 2010, photo by B. Wilder. (c) Elisa Villalpando returning from Isla San Esteban, with Alfonso Rodríguez (ENAH student, center) and Reyes Gutiérrez (fisherman and boatman, right), December 1980, photo by Ana María Álvarez, courtesy of Elisa Villalpando. (d) Richard Felger, Gran Desierto, courtesy of Bill Broyles. (e) Ed and Becky Moser, vicinity of Desemboque on the morning of their first trip, March 1951, courtesy of Cathy Moser Marlett. (f) Left to right: Rick Brusca, Ana Luisa Figueroa, and Lloyd Findley, San Diego, CA, 1990, courtesy of Rick Brusca.

peoples in the heart of the desert (Hayden 1998). Thomas Bowen conducted research on the prehistory of the Comcaac, consulting with linguist Ed Moser to combine oral tradition with his archaeological findings (Bowen 1976, 2000). Elisa Villalpando was also conducting similar ethnoarchaeological research among the Comcaac and in other parts of the Gran Chichimeca, or northern central Mexican altiplano (Villalpando 1989). Richard Felger explored the realm of coastal and insular Gulf of California and delved into the expansive knowledge that the Comcaac maintain for the flora and fauna from the desert and sea

(Felger 1976). His efforts blended with the insights of linguists Mary Beck (Becky) and Ed Moser to provide one of the richest documentations of the close connection between people and place recorded (Felger and Moser 1985). A core group from the University of Arizona championed the daunting task of describing the robust marine diversity of the Gulf of California. Their studies on the fishes (Thomson et al. 1979) and invertebrates (Brusca 1973, 1980) are as important today as when first printed.

Our Origins

This is the setting upon which Ben, Carolyn, and others at the beginning of our careers have entered. In 2004 when Ben returned from his first trip to the Seri coast and Midriff Islands filled with questions about plants and island biogeography, inquiries to Jan Bowers, Phil Jenkins, and others in the Tucson research community all quickly led to Richard Felger. Ten years later and with a comprehensive understanding of the flora and historical biogeography of these islands in hand (Felger and Wilder 2012; B. Wilder 2014), collaborative projects with the Comcaac continue. As Carolyn became increasingly interested in working on an indigenous language, she ventured out for her first trip to Desemboque with Rodrigo Rentería at the encouragement of various researchers. Upon returning from her first visit, Laurie Monti, Gary Nabhan, Steve Marlett, and Cathy Moser Marlett all provided Carolyn with logistical and academic insights that have allowed her work to flourish. It was this existing network and community that provided the conditions for our own success. Likewise, it was these individuals that led to our first meeting in Mexico City, where our worlds converged. Despite both of us being natives of Tucson and working with the Comcaac, it took years for us to meet. We shared a sense that this was an artifact of declining interest in Sonoran Desert research. Yet, it became clear to us that night that we were not just two of a diminishing kind and that the newly established culture of fear along the borderlands had not fully redefined our homeland. It seemed that maybe the Sonoran Desert community we were privileged to come of age in was indeed as strong as ever, just dormant beneath the surface. We talked about how unfortunate it was that we had not met sooner and that there was no easy way to find out who was doing what and where, both across disciplines and across borders. We needed a place to make these

connections. It was this discussion that led to the creation of the Next Generation Sonoran Desert Researchers. That initial meeting sparked an effort to link the past to the present and set the basis for the future.

We shared our nascent vision of N-Gen with Exequiel Ezcurra, Ben's advisor and director of the University of California Institute for Mexico and the United States (UC MEXUS), who immediately and enthusiastically supported our quest. Exequiel and UC MEXUS provided critical seed funding and connected us to foundations, several of which took a risk and supported our first summit to address our concerns and to inaugurate this renewed network of researchers. We were joined in organizing efforts by Nemer E. Narchi and Alfonso (Poncho) Medel Narváez. Both Nemer and Poncho were likewise, in their own way, streamlined into research in the region. Nemer started visiting the Comcaac in 2000 as an oceanography student. His excitement with the people and their place convinced him to pursue a PhD in anthropology on marine ethnomedicine among the Comcaac under the guidance of Brent Berlin. Poncho focused his early research on the cardón cactus with Francisco Molina and Jose Luis Léon de la Luz. During the weekend of Día de los Muertos in 2011 the four of us met in Mexico City to review the more than 120 responses of participants interested in attending the inaugural N-Gen Summit. The response exceeded our expectations and established a consistent trend that has permeated all N-Gen actions: roughly equal participation from Mexico and the United States.

Amidst flowering palo verdes in April 2012, members of the Sonoran Desert research community met for three days in Tucson, hosted by the Arizona-Sonora Desert Museum (figure 7). Researchers, educators, and journalists from across the region (41 from the United States, 49 from Mexico) among various disciplines participated in a plethora of self-proposed sessions. The 22 topics addressed priority issues as they pertained to conducting research, collaboration, and conservation (B. Wilder et al. 2012). The three-day summit hit a nerve among many of the participants to find a way to maintain and expand the links and ideas forged at this gathering. A desire emerged for a holistic approach to research and conservation in the Sonoran Desert. It was clear that this summit was just the beginning of a larger movement. To begin to realize the potential of this network, the founding board of directors gathered in Álamos, Sonora, in July 2013. What did we want N-Gen to be?

Discussion focused on the best manner to begin to actualize our three-part mission statement crafted in unison by the participants of the 2012 summit at the waning moments of the meeting: (1) Catalyze

Figure 7. Participants of the inaugural N-Gen Summit, Arizona-Sonora Desert Museum, April 2012. Photo by Octavio Aburto.

research and biocultural collaboration, (2) develop an innovative research and conservation agenda, and (3) influence decision makers in both countries to promote a conservation ethic that matches the grandeur of the Sonoran Desert landscape.

The core of N-Gen is science, in a holistic sense. It is the scientific excellence of the members of this community that makes this network strong. As of early summer 2015 N-Gen is 300+ members across 40 disciplines in 21 regions of the Sonoran Desert. Our role is to support work already being done, provide linkages to develop new directions, and undertake pointed projects that address gaps in knowledge or lead action that single sectors of the broad community cannot address alone. Such actions have been regionwide gatherings or summits, collaboration between the arts and sciences, field-based science courses for indigenous students, interdisciplinary research expeditions (e.g., Vanderplank et al. 2014), and position statements that reflect the vision of N-Gen (e.g., Búrquez Montijo et al. 2014). Embedded in our approach is the effort to strive from multidisciplinary dialogue toward interdisciplinary or even transdisciplinary research—that is, from separate approaches to the incorporation of outside perspectives. It is our goal to aid one another to see the Sonoran Desert through each other's eyes to affect positive change in the region we love.

This special issue is a direct result of the passion shared and ideas generated at the 2012 summit. We challenged ourselves to present a sample of the state-of-the-art, collaborative research of our community on topics centered in the Sonoran Desert and the Gulf of California. The contributions in this volume represent the synthesis and reexamination of the work that has come before. Just as our own stories are interwoven within the fabric of Sonoran Desert research, so too are each of these contributions.

Jennifer N. Duberstein and Andrés Lira-Noriega take an analytical look at the beginnings of the N-Gen network through a social network analysis. Their synopsis provides a baseline to measure future growth and shows us the multiple ways this community is both interconnected and strengthened by a platform for collaboration.

Cathy Moser Marlett has followed in the footsteps of her parents, Ed and Becky Moser, linguistic pioneers. She continues to follow the threads of knowledge embedded in every facet of Seri culture (Marlett 2000, 2014). In her contribution to this special issue, she describes the *Trooqui Treen*, which serves as a poignant metaphor for the meeting of foreign cultures. The image of a smoke-bellowing trainlike vehicle making its way through the coastal desert toward Kino Bay with Mexicans and Seris drinking moonshine and dancing in unison captures the collision and vibrancy of cultures that continue today.

John Carpenter, Guadalupe Sánchez, James Watson, and Elisa Villalpando unfold the intricate archaeological history of the La Playa site in Sonora, a true project of passion. Little by little the four authors and a host of friends, students, numerous volunteers, and fellow colleagues began to decipher the puzzles they unearthed in the middle of the desert. Persistent work carried out intermittently on long weekends and holidays has documented connections to all corners of the Pimería Alta, told here in whole for the first time.

Paul Mirocha et al. help tell the story of Tumamoc Hill through the lens of art, featuring both visual pieces as well as poetry and prose. Their contribution evokes the significance of this site and helps us see science from a different angle. Their efforts push us in the essential direction of uniting art and science to better showcase the beauty and wonders of the Sonoran Desert.

Nemer E. Narchi, Alberto Búrquez, Sarah Trainer, and Rodrigo Rentería direct our focus to the iconic symbol of Sonoran culture, *carne asada*, and push us to reassess the origins of its cultural dominance and ecological impacts. This elegant essay captures the rise and branding of

Sonora by means of carne asada and the wheat used to make flour tortillas, both of which were introduced in the Sonoran Desert region during the era of the Jesuits. At the same time, this article documents the ecological footprint left in the wake of its widespread consumption. The authors' contribution greatly expands the social and biological concepts of a core aspect of borderlands culture.

The PANGAS team provides a thorough and honest assessment of what it is to create a new model and framework for a science-based assessment of small-scale, community-led fishing. Their careful assessment shows us what it is to work across borders and institutions, to investigate artisanal fishing practices, and what is needed for future efforts. This article will surely be essential reading to help guide the next era of marine conservation in the Gulf of California and similar research-conservation models in faraway regions.

Greer Dolby and her fellow geologists, geneticists, and biogeographers emerged from a session that Scott Bennett chaired at the 2012 N-Gen Summit with a sense of the need to link their respective fields to explain how geology shaped the biodiversity of the desert surrounding the Gulf of California. This multi-layered presentation of the stages of the opening of the Gulf of California and its impact on the biology of the region is a strong representation of the merging of perspectives that comes through a cohesive community.

The idea of a catalog of the plant biotic interactions of the Sonoran Desert and a way to identify those in danger of degradation or to identify threatened interactions emerged from a session that Brigitte Marazzi chaired at the 2012 N-Gen Summit. Brigitte and her coauthors provide an overview of the plant biotic interactions in the Sonoran Desert to shine light on often overlooked but ecologically relevant relationships.

Scott Warren, Kevin E. McHugh, and Jason Roehner visually capture a harsh reality of the borderlands. Their images of objects in the desert left by migrants force us to reflect upon a social and political system that pushes hundreds of thousands of people north to seek a better life and in the process thrusts them across the Camino del Diablo. Their understated lens provides a sharp juxtaposition between the struggle for a better life, global politics, and the often severe Sonoran Desert landscape.

These articles are the seeds in the sand that continue to refine our knowledge and identify next directions. They are coauthored by researchers of diverse disciplines and represent the increasing parity between Mexico and the United States. While each article possesses

new and novel research or artwork that can stand on its own, together this special issue helps us recognize who we are as a community—specifically, who we are as a place-based community and not one that is based on a particular discipline or perspective.

A cohesive network as varied and beautiful as the landscapes we study has never been more important. N-Gen aims to maintain and extend the links that are fundamental to our next steps, both in research and in conservation. We need a space to dream and create. Much has been accomplished, but much remains. We aim to create a space for individuals from all backgrounds. Together we can create a supportive environment to combat adversity and diversify our narrative. It is our duty to continue what our heroes started and recognize the contiguous protected areas in the United States and Mexico, the dry borders, in a formal and meaningful binational manner. The waters of the Gulf of California continue to be depleted by unsustainable harvesting of the once abundant marine life. Diminishing water and accentuated climate extremes will test desert societies and demand answers and leadership from scientists. The challenges are great, yet a unified voice can celebrate and communicate the wonders of the desert and Gulf of California. This voice can shine a light on the treasures of the desert as it can identify and oppose the injustice that erodes a functioning environment for flora, fauna, and cultures alike. Above all, we need to continue to connect people and place to honor and perpetuate the legacy of understanding and respect for the region that drives our passion. For those who love the Sonoran Desert, this is your community. ✣

References

Armstrong, J. 1988. Deserts and Dreams: The Life of Gwyneth Harrington (1894–1978). *Journal of the Southwest* 30(4): 522–534.

Betancourt J. L., T. R. Van Devender, and P. S. Martin. 1990. *Packrat Middens: The Last 40,000 Years of Biotic Change*. Tucson: University of Arizona Press.

Bowden, C., J. Dykinga, and P. S. Martin. 1993. *The Secret Forest*. Albuquerque: University of New Mexico Press.

Bowen, T. 1976. Seri Prehistory. In *The Archaeology of the Central Coast of Sonora, Mexico*. Tucson: University of Arizona Press.

Bowen, T. 2000. *Unknown Island. Seri Indians, Europeans, and San Esteban Island in the Gulf of California*. Tucson: University of Arizona Press.

Bowers, J. E. 1988. *A Sense of Place: The Life and Work of Forrest Shreve*. Tucson: University of Arizona Press.

Bowers, J. E. 1991. *The Mountains Next Door*. Tucson: University of Arizona Press.

Bowers, J. E. 1997. *Fear Falls Away: And Other Essays from Hard and Rocky Places*. Tucson: University of Arizona Press.

Bowers, R. 1992. *Mr. Carnegie's Plant Biologists: The Ancestry of Carnegie Institution's DPB*. Washington, D.C.: Carnegie Institution of Washington.

Brusca, R. C. 1973. *A Handbook to the Common Intertidal Invertebrates of the Gulf of California*. Tucson: University of Arizona Press.

Brusca, R. C. 1980. *Common Intertidal Invertebrates of the Gulf of California*. 2nd edition. Tucson: University of Arizona Press.

Búrquez Montijo, A., N. E. Narchi, and B. T. Wilder. 2014. Development at Any Cost: A False Premise. Next Generation Sonoran Desert Researchers, http://nextgensd.com/development-at-any-cost-a-false-premise/.

Burrus, E. J. 1971. *Kino and Manje: Explorers of Sonora and Arizona*. Rome and St. Louis: Jesuit Historical Institute.

Campbell, T. J. 1920. Eusebio Kino 1644–1711. *Catholic Historical Review* 5(4): 353–376.

Cannon, W. A. 1911. *The Root Habits of Desert Plants*. Washington, D.C.: Carnegie Institution of Washington.

Domínguez, C. A. 2014. Sobre Hombros de Gigantes.... *Oikos*= 12:21. http://web.ecologia.unam.mx/oikos3.0/index.php/oikos-historico/numeros-anteriores/121-sobre-hombros-de-gigantes.

Ezcurra, E. 2007. Afuera del Muro. In *Una Barrera a Nuestro Ambiente Compartido: El Muro Fronterizo entre México y Estados Unidos* (edited by A. Córdova and C. de la Parra Renteria), pp. 49–56. Mexico City: Instituto Nacional de Ecología.

Ezcurra, E., M. Equihua, and J. López-Portillo. 1987. The Desert Vegetation of El Pinacate, Sonora, Mexico. *Vegetatio* 71: 49–61.

Ezcurra E., L. Bourillón, A. Cantú, M. E. Martínez, and A. Robles. 2002. Ecological Conservation. In *A New Island Biogeography of the Sea of Cortés* (edited by T. J. Case, M. L. Cody, and E. Ezcurra), pp. 417–444. New York: Oxford University Press.

Felger, R. S. 1976. Gulf of California: An Ethno-Ecological Perspective. *Natural Resources Journal* 16(3): 451–464.

Felger, R. S. 2000. *Flora of the Gran Desierto and Río Colorado of Northwestern Mexico*. Tucson: University of Arizona Press.

Felger, R. S., and M. B. Moser. 1985. *People of the Desert and Sea: Ethnobotany of the Seri Indians*. Tucson: University of Arizona Press.

Felger, R. S., and B. T. Wilder in collaboration with H. Romero-Morales. 2012. *Plant Life of a Desert Archipelago: Flora of the Sonoran Islands in the Gulf of California*. Tucson: University of Arizona Press.

Garcillán, P. P., C. E. González Abraham, and E. Ezcurra. 2010. The Cartographers of Life: Two Centuries of Mapping the Natural History of Baja California. *Journal of the Southwest* 52: 1–40.

Hampton, S. E., and T. A. Wheeler. 2012. Fostering the Rebirth of Natural History. *Biology Letters* 8: 161–163.

Hastings, J. R., and R. M. Turner. 1965. *The Changing Mile*. Tucson: University of Arizona Press.

Hayden, J. 1998. *The Sierra Pinacate*. Tucson: University of Arizona Press.

Hayden, J., edited by B. Broyles and D. E. Boyer. 2011. *Field Man: Life as a Desert Archaeologist*. Tucson: University of Arizona Press.

Hornaday, W. T. 1909. *Camp Fires on Desert and Lava*. New York: Charles Scribner's Sons.

IUCN. 2013. Evaluation of El Pinacate and Gran Desierto de Altar Biosphere Reserve. In *IUCN Evaluations of Nominations of Natural and Mixed Properties to the World Heritage List*. WHC-13/37.COM/INF.8B2. Gland, Switzerland.

Karpiscak, M. M. (ed.). 1977. Transect of the Sierra Madre: Obregon, Sonora to La Junta, Chihuahua. Unpublished report (copy in library of B. T. Wilder).

Laird-Benner, W., and H. Ingram. 2011. Sonoran Desert Network Weavers: Surprising Environmental Successes on the U.S./Mexico Border. *Environment* 53(1): 7–16.

Lejano, R., M. Ingram, and H. Ingram. 2013. *The Power of Narrative in Environmental Networks.* Cambridge, MA: MIT Press.

Livingston, B. E. 1906. *The Relation of Desert Plants to Soil Moisture and to Evaporation*. Washington, D.C.: Carnegie Institution of Washington.

Maass, M., A. Martínez-Yrízar, and V. Jaramillo. 2014. El Dr. José Sarukhán a 40 Años de Su Regreso al País: Su Vena Ecosistémica. *Oikos*= 12:27–30, http://web.ecologia.unam.mx/oikos3.0/index.php/oikos-historico/numeros-anteriores/109-el-dr-jose-sarukhan-a-40-anos-de-su-regreso-al-pais-su-vena-ecosistemica.

Marlett, C. M. 2000. A Desemboque Childhood. *Journal of the Southwest* 42(3): 411–426.

Marlett, C. M. 2014. *Shells on a Desert Shore: Mollusks in the Seri World*. Tucson: University of Arizona Press.

Martin, P. S. 1984. Prehistoric Overkill: The Global Model. In *Quaternary Extinctions: A Prehistoric Revolution* (edited by P. S. Martin and R. G. Klein), pp. 354–403. Tucson: University of Arizona Press.

Martin, P. S. 2005. *Twilight of the Mammoths: Ice Age Extinctions and the Rewilding of America*. Berkeley: University of California Press.

Martínez, M. L., R. H. Manson, P. Balvanera, R. Dirzo, J. Soberon, L. García-Barrios, M. Martínez-Ramos, P. Moreno-Casasola, L. Rosenzweig, and J. Sarukhán. 2006. The Evolution of Ecology in Mexico: Facing Challenges and Preparing for the Future. *Frontiers in Ecology and the Environment* 4: 259–267.

McGee, W. J. 1898. *The Seri Indians.* In *Seventeenth Annual Report*, part 1, pp. 1–344. Washington, D.C.: Bureau of American Ethnology.

McGee, W. J. 2000. *Trails to Tiburon: The 1894 and 1895 Field Diaries of W J McGee*. Tucson: University of Arizona Press (Anthropological Papers, 27).

McGinnies, W. G. 1981. *Discovering the Desert: Legacy of the Carnegie Desert Botanical Laboratory.* Tucson: University of Arizona Press.

Moser, M. B., and S. A. Marlett, compilers. 2010. *Comcaac quih yaza quih hant ihiip hac: Diccionario Seri-Español-Inglés,* 2nd edition. Hermosillo and México, DF: Editorial UniSon and Plaza y Valdés Editores.

Nelson, E. W. 1921. *Lower California and Its Natural Resources.* Washington, D.C.: National Academy of Sciences.

Owen, H. 2008. *Open Space Technology: A Users Guide*. San Francisco, CA: Berrett-Koehler.

Sandage, A., L. Brown, and P. P. Craig. 2004. *Centennial History of the Carnegie Institution of Washington*. Vol. 4, *The Department of Plant Biology.* Cambridge: Cambridge University Press.

Sarukhán, J., and R. Dirzo (eds.). 1992. *México ante los Retos de la Biodiversidad*. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad. Presidencia de la República, México.

Shreve, F. 1915. *The Vegetation of a Desert Mountain Range as Conditioned by Climatic Factors.* Washington, D.C.: Carnegie Institution of Washington.

Shreve, F. 1951. *Vegetation of the Sonoran Desert.* Washington, D.C.: Carnegie Institution of Washington, publication no. 951.

Shreve, F., and T. D. Mallery. 1933. The Relation of Caliche to Desert Plants. *Soil Science* 35: 99–114.

Soberón, J. 2014. José Sarukhán y el Desarrollo de la Ecología en México: Algunas Reflexiones Personales. *Oikos*= 12:22–26. http://web.ecologia.unam.mx/oikos3.0/index.php/oikos-historico/numeros-anteriores/107-desarrollo-de-la-ecologia-en-mexico.

Sonnichsen, C. L. 1982. *Tucson: The Life and Times of an American City.* Norman: University of Oklahoma Press.

Sykes, G. 1937. *The Colorado Delta*. American Geographical Society Special Publication 19. Washington, D.C.: Carnegie Institution of Washington and the American Geographical Society of New York.

Sykes, G. 1944. *A Westerly Trend: Being a Veracious Chronicle of More than Sixty Years of Joyous Wanderings, Mainly in Search of Space and Sunshine*. Tucson: Arizona Pioneers Historical Society.

Thomson, D. A., L. T. Findley, and A. N. Kerstitch. 1979. *Reef Fishes of the Sea of Cortez: The Rocky-Shore Fishes of the Gulf of California.*

New York: Wiley. (Revised edition published 2000 by University of Texas Press, Austin.)

Turner, R. M., J. E. Bowers, and T. L. Burgess. 1995. *Sonoran Desert Plants: An Ecological Atlas.* Tucson: University of Arizona Press.

Turner, R. M., R. H. Webb, J. E. Bowers, and J. R. Hastings. 2003. *The Changing Mile Revisited*. Tucson: University of Arizona Press.

Vanderplank, S. E., B. T. Wilder, and E. Ezcurra. 2014. Descubriendo la Biodiversidad Terrestre en la Región de Cabo Pulmo/ Uncovering the Dryland Biodiversity of the Cabo Pulmo Region. Botanical Research Institute of Texas, Next Generation Sonoran Desert Researchers, and UC MEXUS, U.S.A., http://nextgensd.com/uncovering-the-dryland-biodiversity-of-the-cabo-pulmo-region/.

Velarde, E., and E. Ezcurra. 2002. Breeding Dynamics of the Heermann's Gull. In *A New Island Biogeography of the Sea of Cortés* (edited by T. J. Case, M. L. Cody, and E. Ezcurra), pp. 313–325. New York: Oxford University Press.

Velarde, E., B. T. Wilder, R. S. Felger, and E. Ezcurra. 2014. Floristic Diversity and Dynamics of Isla Rasa, Gulf of California, Mexico: A Globally Important Seabird Site. *Botanical Sciences* 92(1): 89–101.

Villalpando, E. 1989. *Los que Viven en las Montañas: Correlación Aqueológico-Etnográfica en la Isla San Esteban, Sonora, México.* Hermosillo: INAH-Centro Regional de Sonora (Noroeste de México, 8).

Walker, L. W. 1951. Sea Birds of Isla Raza. *National Geographic* 99: 239–248.

Webb, R. H., S. A. Leake, and R. M. Turner. 2007. *The Ribbon of Green*. Tucson: University of Arizona Press.

Wilder, B. T. 2014. Historical Biogeography of the Midriff Islands in the Gulf of California, Mexico. PhD dissertation, UC Riverside.

Wilder, B. T., C. O'Meara, A. Medel Narváez, and N. Narchi. 2012. Next Generation Sonoran Desert Researchers 2012 Summit: The Beginning of a Movement. Next Generation Sonoran Desert Researchers, http://nextgensd.com/resources/.

Wilder, B. T., C. O'Meara, N. Narchi, A. Medel Narváez, and O. Aburto-Oropeza. 2013. The Need for a Next Generation of Sonoran Desert Researchers. *Conservation Biology* 27: 243–244.

Wilder, J. 1967. The Years of a Desert Laboratory. *Journal of Arizona History* 8(3): 179–199.