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Carne Asada: Imaginaries at Play

Arriving for the first time to Hermosillo airport is a unique experience, in large part because of the ways in which local gastronomy dominates the retail spaces. Normally, airport shops throughout Mexico carry mass-produced keepsakes, some local handcrafts, tequila shot glasses, and mass-produced apparel. Hermosillo's airport is different. While the shops carry some ironwood figurines, most of the products—including handmade chiltepin mortars, sweet-salty coyota pastries, and giant wheat-flour tortillas—are representative of a gastronomy that is distinctly from northern Mexico. Perhaps the most extravagant of the food-centered shops in the Hermosillo airport are the shops selling cardboard briefcases with legends that say "Producto Artesanal de Sonora" ("Artisan Product of Sonora"), "Patrimonio Cultural de Sonora" ("Sonoran Cultural Heritage"), and similar slogans. These outlets have freezers full of Sonoran-raised beef, and the 6-pound cardboard briefcases are designed to carry prime cuts of beef for up to 6 hours unrefrigerated. Airport authorities will even allow passengers to take these briefcases with them as carry-on items when flying within Mexico.

The importance that locally raised Sonoran beef plays in the Hermosillo airport illustrates the central role that the raising, preparing, and eating of beef now has in regional constructions of cultural identity throughout the Mexican northwest. It is, however, in the state of Sonora where beef is most deeply associated with daily cultural practices and consumption. The importance of beef is so entrenched in local sociocultural frameworks that cattle ranching is part of the state's official coat of arms, despite the fact that the introduction of the first cattle herds did not take place until

the mid seventeenth century (Hernández-Moreno and Meléndez-Torres, 2012). Carne asada roots in Sonora are therefore not particularly ancient: The dish itself, as well as its consumption and the discourse surrounding it, typically centers on grilled beef and tortillas de harina (wheat-flour tortillas), food items that date back only to the period when Jesuit missionaries introduced wheat and cattle during the colonial expansion of the northern frontier. Carne asada is thus a very recent culinary practice derived directly from European contact, which has taken deep root in the local imaginary, as well as in the local ecology.

Today, the practice of carne asada mobilizes a whole industry centered around the production and distribution of meat and charcoal for its urban consumption, whether in the form of meat boutiques, high-end restaurants, street vendor taqueros, butchers, or family grills. The reliance on beef and charcoal, the twin demands that underpin the industry, has created strong social and environmental pressures. For instance, charcoal used in traditional carne asada grilling in Hermosillo is obtained from raw wood (mainly mesquite) that has been processed into lump charcoal or charwood. This translates into a continuous demand for wood that is consumed entirely after its first use. Most of that wood comes from trees within desert ecosystems, including highly vulnerable riparian desert communities (Yetman, 1999).

In this article we review Sonora's beef culture from both an ecological and an anthropological perspective, while acknowledging the occasional tension between the theoretical approaches used in these two disciplines. We argue that beef and European crops such as wheat were introduced to the northern areas of Mexico as part of a strategy that aimed to colonize the region by transforming it into a landscape intelligible to European conceptualizations of nature and intended to pacify the nomadic indigenous groups living there. In other words, the introduction of European domestic animals and crops helped the conquistadores to transform a landscape that they viewed as barren into productive farms, missions, villages, and towns. At the same time, the introduction of winter crops facilitated the process of forcibly settling former mobile groups of indigenous peoples that had previously roamed the desert in the seasonally dependent pursuit of indigenous edible resources. Once converted to sedentary communities, local labor was used to develop towns (Braniff, 2001).

We divided this paper into three overarching sections. In the first section, we combine information gathered from historical documents

and contemporary research in order to situate current practices and attitudes toward carne asada within the historical context of the region.[1]

In the second section, we rely on current research and our own participant observation and targeted interviews in Hermosillo to analyze the socioenvironmental origins of beef production in Sonora, discussing the private use of beef in carne asada in family gatherings, as well as its transformation into a public event and commercial product: the street taco.[2] The street taco, now a popular and ubiquitous product throughout Sonora and even beyond, has become a central element of carne asada. We trace the ways in which carne asada consumption, both in private homes and in street tacos, has spread and transformed through space and time; examine the structural reforms that have undermined small-scale family farming in Sonora; and explore the urbanization of Sonora's rural settings in order to understand the ways in which all of these processes have modified the social consumption of carne asada.

In the third section, using information gathered from historical and contemporary research, as well as our own participant observation in the state of Sonora, we analyze the environmental impact that changing patterns of carne asada consumption have exerted on the Sonoran Desert biome.[3] We first contextualize the structural and landscape transformations that the government-led reforms of the 1990s have brought, not just to the Sonoran Desert but also to its farmland. Then, we produce an inventory of the most essential biotic resources needed to produce one taco de carne asada, thus illustrating the associated environmental consequences. Finally, we calculate how many resources are consumed in order to produce 1 kilogram of beef, revealing that many aspects of this ingrained cultural practice are unsustainable from an ecological standpoint.[4]

Wheat and Cattle in Sonora: A Historical Perspective

North of the Yaqui River, the history of colonial Sonora was shaped by the mission system established by Jesuit priests at the end of the sixteenth century. The changes brought by the missionaries, and in particular by Eusebio Francisco Kino, were so profound, despite the early expulsion of the Jesuits in 1767, that many continue to resonate today within the local populations and ecology of the area (Bahre, 1991;

Phillips and Comus, 2000; Sheridan, 1988, 1992, 1999, 2006). The colonization of the Pimeria Alta—as Father Kino named the vast extensions of desert plains that were home to the Pima (O'odham) people north of the Río Sonora—was aimed not just at saving the souls of the native population but also at incorporating them as labor for the mission system (Bannon, 1955; Bolton, 1984; Brenneman, 2009). By successfully subjugating the local O'odham population, the Jesuit missionaries hoped to propel the Spanish Empire across the Pimeria Alta to the Gila River and beyond, a pragmatic and political goal that meshed with a more altruistic aim to reduce the inhumane treatment of native tribes by European settlers through assimilation (Bolton, 1984; Greer, 2000). To achieve their goals, the Jesuits rewrote the very foundations of Pima society by turning pagans into Christians, desert dwellers into town dwellers, and free men and women into vassals. To accomplish assimilation, the introduction of wheat and cattle proved more effective than the many military interventions held against the native people (Jackson, 1994; Radding, 1997; Sheridan, 1988, 2006).

Ultimately, the history of the Sonoran province was determined as much, if not more, by the microbes, seeds, and animals that were brought by the colonial settlers than by the rigid hierarchical social structures ingrained in the Spanish mindset at the time (Carrillo-Trueba, 1991). In this context, cattle and wheat constituted crucial agents in the expansion of the colonial empire throughout the northern frontiers. Wheat served as a means to close the agricultural gap by extending the availability of food into winter, fostering sedentarism and native incorporation into the mission system, while cattle became an agent of territorial expansion for the incoming non-indigenous settlers, a source of food rich in fat and protein for settlers and indigenous people alike, and a means of upward mobility for Spaniards (Sheridan, 1988, 2006; Yetman, 2012).

The bidirectional flow of non-human entities (plants, animals, and other organisms) across the Atlantic Ocean, as well as its unintended effects, known as the Columbian Exchange (Crosby, 1972), is a complex, far-ranging process that drastically transformed the social and ecological landscape of Eurasia and the Americas. As an intrinsic part of the process of colonization, nature had to be transformed into an environment intelligible for the new settlers, through the drastic reshaping of the fauna and flora of the New World into the image and likeness of Europe (Ezcurra, 2003; O'Mack and Statistical Research, 2000). The Pimeria

Alta is a textbook case study. Along with their colonial mindset, the Europeans brought the cattle, sheep, horses, and goats that had been domesticated for centuries in the Old World, and countless species of new crops; by 1600, all of Europe's main farm plants were already being cultivated in the Americas[5] (Crosby, 2004). These Old World staples became part of new local farming practices that would gradually displace previous sources of food and allow for the creation of new culinary traditions in Sonora and its neighboring provinces.

By the time the Spanish arrived in Sonora, the O'odham people had already developed sophisticated horticultural techniques that enabled them to grow different varieties of beans, corn, and squash (Erickson, 1994; Phillips and Comus, 2000). None of these crops, however, were able to survive the harsh winter frost. This meant Pimas living in the desert basins that extended from present-day Hermosillo to Tucson and beyond could not cultivate their fields from November through March, when frost was an ever-present danger. The desert people were therefore constantly moving from summer to winter camps (Radding, 1997; Sheridan, 1988, 1992). This pattern changed profoundly with the arrival of the missionaries, for a crucial aspect of the relationship that the Jesuits fostered with the local populations depended on the gifts of seeds, nursery stock, and animals they provided. In time, lentils, chickpeas, fava beans, cabbage, onions, leeks, garlic, cowpeas, sugarcane, mustard, anise, mint, peppers, melons, apples, plums, and figs all flourished on Sonoran farms, as "thousands of years of Old World agricultural experiences were suddenly placed in O'odham hands" (Sheridan, 1988: 157).

Out of all the numerous species introduced by the missionaries, the most important by far was winter wheat, which could flourish during the months when corn and beans would have shriveled from the cold. Winter wheat filled a gap in the Piman agricultural cycle, allowing the O'odham to farm year-round (Carrillo-Trueba, 1991; Sheridan, 1988; O'Mack and Statistical Research, 2000). The policies established by the viceroyal of New Spain were intended to make the colonies self-sufficient in terms of wheat; otherwise, the imports from Spain would have been too expensive and the whole colonial enterprise economically unsustainable (Carrillo-Trueba, 1991). Furthermore, by introducing wheat cultivation, the missionaries were able to funnel the historically scattered indigenous populations into permanent settlements, incorporating them along the way as laborers on farms and in urban settings within the colonial system. In turn, the establishment of more compact villages constituted an

important defensive measure, as Apache raiding intensified during the eighteenth and nineteenth centuries. Ironically, the increase in Apache raids was, in turn, a response to another alteration in the local ecosystem—the raids were targeted at gaining access to cattle and horses (Sheridan 1988; O'Mack and Statistical Research, 2000).

Spanish cattle were perhaps Kino's most spectacular addition to the native food supply of Sonora. Horses and cattle did not exist in the Pimeria prior to the arrival of the Spanish missionaries. Indeed, these Old World species were introduced to the Americas as part of the Columbian Exchange.[6] Although horses were perhaps considered the most valuable currency in the northern provinces at this time, it was cattle that propelled the territorial expansion of the colonial project. In subsequent centuries, the influx of cattle into an area inevitably preceded a more overt Spanish occupation. The establishment of new cattle ranches allowed deeper encroachment by the colonial empire into indigenous land, particularly when cattle-related disputes arose and needed arbitration and resolution (Bowen, 2000; Hadley, 2009; Sheridan, 1992, 1999). For indigenous groups, on the other hand, cattle became a new food source and allowed for the development of a new sporting event (cattle rustling became a new version of old hunting techniques), as well as a viable coping strategy for surviving the destruction that cattle herds caused to indigenous cornfields (Yetman, 2012). Cattle rustling, along with the continued seasonal availability of native food resources, helped many indigenous groups native to Sonora to cycle in and out of missionary life, retaining a greater degree of flexibility than the missionaries had originally envisioned or desired. As native people increasingly incorporated cattle into their lifestyles and diets—often via unorthodox means—the European settlers responded through the use of direct violence, conducting wars of extermination against native populations perceived as recalcitrant and stubbornly unassimilated (Bannon, 1955; Jackson, 1994; Sheridan, 1992, 1999, 2006; Yetman, 2012).

In addition to its political usefulness in the Sonoran context, cattle ranching also suited (at least in the short term) the xeric environment, an area so dry that only a few varieties of crops could be grown there successfully. Sources of protein had been notoriously lacking across many communities in the region before the arrival of the Jesuit-run missions. The demand for protein not available from grains was another factor encouraging colonizers to introduce the Spanish cow, which successfully adapted to the pasturelands available in the Mexican northwest (Camou-

Healy, 2012). By 1699, herds had spread as far north as Mission San Xavier del Bac (today, just south of Tucson, Arizona) (Sheridan 1988; O'Mack and Statistical Research, 2000; Turner et al. 2003). In later centuries, the cattle industry would become the quintessential (non-mining) activity of the region, playing a pivotal role in the construction of the "Wild West" of cowboys and caballeros in the imaginaries of people living on both sides of the Mexican-American border (Sheridan, 2012; Turner et al. 2003).

The spread of cattle in Sonora also offered local Spaniards previously categorized as lower socioeconomic status (within the strict hierarchies of Spanish society) the opportunity to abandon crop-based farming in favor of cattle ranching. Thanks to the immense social prestige connected to cattle ranching in Spanish (and other European) sociocultural frameworks, this change in occupation allowed the new ranchers to move up the socioeconomic ladder, transforming them in the eyes of their peers from commoners and small farmers into gentlemen capable of owning livestock (Pérez, 1992, 1993; Sheridan 2006; Zycherman, 2008). Such social mobility linked to cattle farming is not exclusive to Sonora, for it is a common trend in the Americas. The emergence of Sonoran vaqueros, Argentinian gauchos, and Texas gentleman farmers was a direct response to the unprecedentedly easy opportunities to climb previously entrenched and intractable social hierarchies imported from Europe (Guy and Sheridan, 1998). Eventually, these "cattle-are-wealth" families, with the help of a local market bolstered by the arrival of immigrant miners all clamoring for beef products, played a fundamental part in the creation of a beef-centered culture in the New World (Sheridan 2006; Yetman, 1999, 2012).

In the early days of beef production, slaughter, and consumption, technological limitations imposed restrictions on the distribution and commercialization of fresh beef. As a result, low-tech methods of preservation were essential and few methods of preservation were more efficient than the dry weather and the scorching sun of the Sonoran Desert (Camou-Healy, 1998; Camou-Healy and Hinjosa, 1990; Camou-Healy and Pérez-López, 1991; Hernández-Moreno and Meléndez-Torres, 2012). The slaughtering of cattle (figure 1) and the subsequent production of dried meat (jerky) soon became the foundational act for one of the most deeply ingrained cultural practices in Sonora: the creation and celebration of carne asada. On slaughter day, ranchers and butchers, with the help of their families, would leave some animal parts for

themselves, grilling these parts over hot coals. Women would prepare tortillas and salsas and men would gather around the grill. From this ad hoc set of rituals, the local tradition of organizing a carne-asada-based celebration developed and solidified, becoming an expected and integral part of most major family and community events (Camou-Healy, 1998; Camou-Healy and Hinjosa, 1990; Camou-Healy and Pérez-López, 1991; Hernández-Moreno and Meléndez-Torres, 2012).

Although beef was given primacy of place in the previous depiction

Figure 1. An image of an animal sacrificed in the highlands of Sonora (in the Macaurawee region) to be consumed at a ceremony called Yumar. Photo courtesy of Alejandro Aguilar Zeleny.

of carne asada production, the making of tortillas was an equally important component of this process and the mention of tortillas brings us full circle in our discussion. In particular, this brings us back to our original point that cattle and wheat farming, taken together, were the two essential agricultural strategies in the incorporation of northern Mexico into the domains of the Spanish crown. The introduction of wheat gave Sonoran gastronomy another of its most prized food products: flour tortillas. The widespread use of a thin flatbread made from finely ground maize predates the Spanish arrival in Mexico by centuries; the Spanish, however, gave

the flatbread its current name—"tortilla"—and introduced tortillas made from wheat flour as an alternative to the traditional ones made from maize (Davidson, 2014; Pilcher, 1998). In Sonora, tortillas de harina became popular at the time that indigenous groups were reduced into the mission system. In this context, the social and ecological relevance of Kino's innovation lies in the fact that at a time in which people were facing upheaval and change to their basic ways of life, tortillas de harina dominated people's preferences at the expense of maize-based tortillas, despite the established history of corn cultivation in the region and the centuries of pre-Exchange prominence that corn had enjoyed in local diets (Sheridan 2006). Much of this surge in popularity stemmed from the fact that the missions heavily promoted winter wheat production (as discussed above), but its popularity was also bolstered by the perception throughout New Spain that the consumption of food items identified as "Spanish" and "European" denoted higher socioeconomic status (Davidson, 2014; Pilcher 1998). Elements of this attitude still linger today, combining with current perceptions in Sonora that link food, identity, and tradition with a notion of modernity that directly impacts consumption of tacos de carne asada on flour tortillas.

Sonora's Tacos: From Family Celebration to Public Consumption

Many pre-Hispanic dishes survived European contact and still remain vital constituents of what we now commonly identify as Mexico's national cuisine and/or distinctive regional cuisines (e.g., Oaxacan cuisine). Foods now identified as quintessentially "Mexican" by Mexicans and non-Mexicans alike but whose roots extend back centuries before the conquistadores arrived in Mexico include pozole, tlacoyo, ahuautli, escamole, huauzontle, michimole, atole, papatzul, and tamal. Yet, arguably the most iconic and easily recognized "Mexican" food, the taco, has a relatively short pedigree when compared to these other nutritionally and symbolically important foods (Herrera-Sobek, 2012). Pilcher (2006, 2012) has linked the rise of tacos as distinctive food items in their own right with the late nineteenth-century processes of modernization that brought rural peoples into the urban environments of cities, particularly into Mexico's capital.[7] Tacos, initially constructed for and consumed by the working class, underwent a process of social

refinement after the 1950s, and soon spread throughout Mexico and beyond (García-Garza, 2010; Pilcher, 2006, 2012).

We have showed that Sonora's predilection for carne asada was in place relatively early on in the incorporation of northern Mexico into New Spain. However, the modern, commercial taco de carne asada, developed much later, dependent, as we noted earlier, on increasing urbanization, development, and industrialization (Pilcher, 2006, 2012). According to a local blog, *La Gotita de José Luis* (Bojórquez, 2010), for example, tacos de carne asada were born in the wooden huts of the Red Light District of Hermosillo, consumed in order to restore the depleted energy of men patronizing the dance floors and prostitutes there. This same blog credits a young entrepreneur, Ventura Sierra, with introducing tacos de carne asada to the mainstream gastronomic market of Hermosillo. With the aid of small tortillas and the use of thinly chopped meat, Ventura Sierra allegedly managed to convince his new customers that tacos de carne asada were the perfect snack food: filling, fast, and involving foods (e.g., beef and white flour) that are associated with higher socioeconomic status and modern European style (Pilcher, 1998; Sheridan, 2006). The explanation put forth by *La Gotita de José Luis* (Bojórquez, 2010) perfectly illustrates the mythology surrounding the origins of tacos de carne asada. Pilcher (2012) makes the argument that the Sonoran phenomenon of tacos de carne asada grew out of constructed nostalgia among locals faced with the influx of processed Westernized foods in the latter half of the twentieth century.

The importance given to beef in the instantiation of the taco de carne asada in Sonora combines a number of interesting strands, some old and some more recent. The Spanish conquistadores prioritized European-introduced food items over "indigenous peasant" crops in order to mark wealth, prestige, and an overall higher status, which, as a consequence, produced a culture that prized beef as a luxury item (Pérez, 1992, 1993; Pilcher, 1998; Sheridan 2006; Zycherman, 2008). This was especially pronounced in the north where cattle ranching was ubiquitous. Sonora, however, shares a border with the United States, and this geographic proximity has also impacted Sonoran conceptualizations of meat and modernity. Insisting on the importance of tacos de carne asada as a counteraction to the encroachment by U.S. retail (e.g., Walmart), U.S. media, and U.S. fast food chains on the Sonoran landscape may be one such reaction, as Pilcher (2012) suggests. Nevertheless, the U.S. ideal, as a "modern" industrialized state, still has immense power in Sonora.

Frequent consumption of red meat is now a hallmark of U.S. diets but is also perceived by many other countries as an index of affluence and modernity (Popkin, 2009; WHO, 2002).[8] Based on our ethnographic data, we conclude that Sonorans tend to believe (often fervently, to a level approximating religious fervor) that red meat consumption does indicate health, power, food security, and modernity. Indeed, foreign travelers to Sonora, as well as Mexicans who come from the south, often castigate the north as being "too Americanized," but at the same time "too primitive": When the philosopher Vasconselos remarked that "upon arriving in Sonora one 'abandons culture' and is greeted only by 'grilled meat' " (as quoted in Alvarez, 2010), he was simply echoing a commonly held stereotype that non-Sonorans hold about the region and its people. Thus, eating beef in Sonora indexes modernity, but also regional distinctiveness and tradition in a fascinating, albeit contradictory way.

A similar pattern emerges when we consider tortilla preferences in modern Sonora. Today, we see tortillas de harina routinely preferred over maize-based ones in tacos de carne asada throughout the contemporary U.S.-Mexico borderlands. As we documented in the preceding section, maize-based tortillas have a historical advantage: They have been eaten by indigenous groups in Mexico for thousands of years (Sheridan 2006). Tortillas de harina, however, have the advantage of prestige in the minds of many locals, a prestige that once again invokes a non-indigenous, cosmopolitan modernity for many consumers that dates back to the ideas introduced by the Spanish about the superiority of European foods. At the same time, consuming tortillas de harina is also an ordinary, everyday activity that allows Sonorans to claim local affiliation and identity and to invoke local tradition and heritage (Alvarez, 2010, 2014). Alvarez (2010) argues, for example, "After grilled meat (carne asada), the second most emblematic sign of Sonoran identity is the tortilla de harina (wheat flour tortilla)," a claim made not only by other scholars (e.g. León-Portilla, 1972), but also by the general public. Ironically, globalization (and the preferences of foreign visitors in search of "true" Mexican cuisine) is bringing the maize-based tortilla back into circulation in Sonora, and now many taquerías offer (sometimes with disdain) tortillas de maíz. For many people in Sonora, however, a true taco de carne asada must involve a flour tortilla. The taquería owners we interviewed for this project agreed that carne asada pairs best with tortillas de harina. Berenice, for instance, a small owner of a taco restaurant in Hermosillo and native to Durango, said that when she first came to

Hermosillo, she did not like tacos de carne asada as presented in the local fashion. She had grown up eating tacos with tortillas de maíz. Nevertheless, after years of living in Hermosillo, she reported that wheat-flour tortillas had "seduced" her and she became a convert.

We noticed other trends with respect to perspectives and opinions of carne asada during the course of our ethnographic research among the taqueros in Hermosillo. For instance, all of them agreed that the expansion of taco stands generally stems from the recession cycles of the Mexican economy and the recurrent devaluation of the country's currency. Armando, for example, an owner of a taquería, told us: "My father started this business in 1986. He was left without a job and had few monies, but given that he was a butcher, he knew many of the sellers inside the beef business, he had their trust, and started selling tacos on a little cart." Alonso, owner of another taquería, shared a similar story: "My dad was a butcher and because my uncles ventured into the taco business, he realized that the salary was better selling tacos than chopping beef. With some savings, he opened his own business in 1988." Luis, who worked as a manager of a taquería, was raised in rural Sonora. He went to Hermosillo to study and soon became the compadre (friend) of the original owner of the taquería he was managing at the time of our interview. Soon after his arrival in Hermosillo, Luis started working in the taco industry himself. Luis informed us: "The boom in taco stands comes along with downturns in the economy. This was especially evident during the Salinas administration." Other interviews also revealed the links between macro-level political and economic policies and how this affects individual decisions with respect to economic and employment choices.

With the decline of agriculture and the substitution of tertiary economic activities over the past fifty years, the state of Sonora has undergone significant structural changes in its economy (Lara et al., 2007). This economic shift, similar to the one that occurred in Mexico in the nineteenth century, has fostered the consumption of tacos in mobile stands (carretas) and restaurants in the city. People who used to work in agriculture and cattle ranching started integrating into the urban manufacturing and service industries from the 1970s onward and this created both a new labor pool for the taquerías and restaurants springing up everywhere and a vast market of potential consumers of commercially made tacos de carne asada.

Currently, Sonora's urban population represents 86% of the state's 2,662,480 inhabitants and close to 30% of these are urban dwellers who

live in Hermosillo (INEGI, 2010). The residents of Hermosillo, like most of the inhabitants of big cities in Mexico, are extremely mobile and spend quite a bit of time commuting from their homes to their jobs and vice versa. Thus, the lifestyle of these urban dwellers demands a supply of fast food, provided by an ever-increasing number of transnational fast food giants (e.g., McDonald's and Pizza Hut) (Godoy and Camarena-Gómez, 2012). Yet, carne asada, especially when stuffed into tacos, remains the food of choice when it comes to meals consumed outside of the home in all of the Mexican northwest (Taddei et al., 2012). Alonso reported: "People come for a taco because they like their food to be done fast." Anibal, son of one of the taco pioneers in Hermosillo and current owner of a taquería, claimed: "The secret is that people want it to-go from the grill to their mouth. This is why they prefer carne asada: there is no waiting in the making and there is nothing that can compare to eating a hot, freshly made taco."

Anibal's hypothesis aside, we are compelled to agree with Meléndez and Cañez (2012) that the modernization of food patterns in Mexico mimics U.S. trends, in which food is industrially produced to satisfy a capitalized market that encroaches on and ultimately displaces traditional foods and means of production. Tacos de carne asada as they are being produced today in the factories and taquerías of Hermosillo have, in many respects, quite a bit in common with a hamburger from Burger King. As part of our fieldwork, we visited the new Sonora Factory Grill, Hermosillo's first fully automated taco drive-through. The owners of this fast food version of a carne asada stand have gambled that optimizing the time of delivery after the food is ordered will be key to their success. Their non-charcoal line of production, ending in a drive-through window, is capable of grilling 6 kilograms of meat in 4 minutes, thanks to twenty-four ceramic burners. Yet, tacos de carne asada invoke issues of Sonoran identity and nostalgia for Sonoran consumers (Alvarez, 2010; Pilcher, 2012) in a way that a hamburger never will. Berenice, for example, stated: "Taquerías in Hermosillo are a place for families to get together and enjoy."

Overall, despite the various permutations and interpretations that carne asada has experienced throughout the years, it remains a pivotal symbolic expression of the sociohistoric relations involved in creating the modern state of Sonora and its patchwork cultural heritage. In other words, taking a bite of a taco de carne asada is nothing less than tasting all of the disparate cultural, social, and historic interactions of the area. Moreover, given that these interactions have occurred in a particular

geographic area—and an extremely delicate one, at that—the rise and maintenance of carne asada in the local gastronomy have also resulted in severe transformations of landscapes and biota for the region.

A Socioecological Perspective on Carne Asada: Transforming the Desert

We have traced, in the previous sections, the initial development and the subsequent increase in the social and ideological importance of carne asada and tortillas de harina. This socially constructed demand for carne asada in Sonora is fed by a number of federal and state-led policies, large-scale retailers and processers, and, of course, most directly by ranchers and taqueros. While we were unable to explore the complicated dimensions and repercussions of eating tortillas de harina during this phase of fieldwork (in part because tracing the number of tortillas consumed is very difficult and in part because tortillas are not necessarily made locally in Sonora currently), we were able to combine our ethnographic research with existing ecological research to explore the ecological impacts of the beef production necessitated by carne asada via two measures: (1) the environmental impact of ranching and beef production and (2) the ecological costs associated with the production of fuel for grilling carne asada.

Cattle in Sonora

The introduction of cattle into the Mexican northwest created new and easily available ecological niches for the agricultural and hunter-gatherer peoples in Sonora, who realized how easy it was to hunt down cows and bulls in comparison to native fauna. The herds then became a source of conflict between the newly arrived European pastoralists and native farmers, mainly because cattle do not recognize borders and tend to naturally range far and wide, foraging on crops and leaving devastation in their wake (Baroni, 1991; Perez, 1992, 1993; Camou-Healy and Pérez-López, 1991; Yetman, 2012).

The use of arid lands for beef production has extensive ramifications. Until the twentieth century, raids by indigenous locals and issues involving water kept cattle concentrated into highly localized areas, usually in ranches where water and corrals were readily available (Turner et al.

2003). Machado (1981) also notes that during the Mexican Revolution, herds drastically declined, allowing for the recovery of former rangeland. Over the last century, however, increased security together with better technology related to providing artificial watering holes allowed the extensive exploitation of dry lands (Baroni, 1991; Pérez, 1992, 1993; Camou-Healy and Pérez-López, 1991; Yetman, 2012). Larger and larger herds transformed the balance between grassland and desert scrub, contributing to the invasion of mesquite and thornscrub (Archer, 1989, 1994; Bahre, 1991; Búrquez et al., 1998; Johnston, 1963; Turner et al., 2003). Thus, the cattle industry has spent much of the twentieth century transforming large tracts of arid and semi-arid lands in Sonora, with every sign that such trends will continue into the twenty-first century (Búrquez et al., 2002; Turner et al., 2003).

Over the last twenty years, Mexico has restructured its economy, as part of a global trend favoring open markets and neoliberal reforms. This restructuring is aimed at a complete transformation of the relationship between the state and society, in which the state no longer protects the national economy from international markets (Cuijpers and Fernández, 1995; Grispun and Kreklewich, 1995). The restructuring led to austerity measures, privatization, a reduction in public sector spending, and the liberalization of trade and investment (Cuijpers and Fernández, 1995; Grispun and Kreklewich, 1995; Randall, 1996). As part of these shifts in policy, the Mexican government restructured Article 27 of the Mexican Constitution, allowing formerly communal land to be parceled and sold (Yetman and Búrquez, 1998). Among other repercussions, this allowed large agro-businesses to convert what were previously small land parcels into large agro-industrial plots. As such, the amendments to Article 27 of the Mexican Constitution during the early 1990s initiated a process of appropriation by dispossession and land use conversion (Cuijpers and Fernández, 1995; Grispun and Kreklewich 1995; Harvey, 2003; Randall, 1996).

The significance of these changes in the context of our arguments here lies in the fact that in the case of livestock, the privatization of agricultural property opened the door to a transformation process that created dramatic ecological and social consequences in Sonora (Baroni, 1991; Randall, 1996; Wong-Gonzalez et al., 1994). These consequences included the clearing and replacement of indigenous Sonoran vegetation for cattle grazing, as well as the loss of land tenure for many local communities (Yetman and Búrquez, 1998). Increasing livestock activities

have also led to the proliferation of expensive (monetarily and in terms of water use) wells, tanks, troughs, and irrigation projects (Moreno, 1992). Of all animal husbandry practices, beef production has the greatest water demand on dry rangeland: The production of 1 kilogram of meat from a cow living in the desert requires 50,000–200,000 kilograms of water (Eshel et al., 2014; Pimentel et al., 1997, 2004). By contrast, birds—a source of high-quality protein—require much less water, where a serving size of chicken-based protein requires roughly 4% of the water needed to produce the same amount of beef protein (Eshel et al., 2014; Pimentel et al., 1997, 2004). Research (Moreno, 2012) indicates that a significant portion of the surface water and groundwater in the Sonora River basin no longer reaches the river, and instead is retained for livestock uses. Every year, cattle growers ask for federal and state aid to provide water to their cattle, even though the average rainfall over the year has not changed appreciably during the last century, and is not expected to change in the near future (Overpeck and Udall, 2010).

The government has also provided subsidies to maintain a high livestock presence in Sonora and establish African prairie grasses, which have resulted in replacing important sections of the Sonoran Desert with a less diverse ecosystem (Bravo-Peña et al., 2010). The introduction of the African buffelgrass (*Pennisetum ciliare*) has led to the alteration of large areas of the arid Sonoran region (Cox et al.1988; De la Cueva, 2015; Moreno, 1992; Ibarra et al., 1995; Turner et al., 1995). Since its large-scale introduction, buffelgrass has multiplied the stocking rates, i.e., the number of cattle that can be accommodated in a particular acreage, by a factor of three (Hanselka and Johnson, 1991; Pérez, 1992, 1993; Búrquez et al., 2002; Franklin et al., 2006). However, this gain has been achieved at the expense of the removal of the desert plants that provide forage when buffelgrass stops growing during the winter. The replacement of perennials, coupled with overgrazing, has in turn led to increases in the risk of drought-like conditions in Sonora.

Ranchers know that after a few years of management, buffelgrass productivity decreases. They then sometimes resort to setting controlled fires to restore the land to its prior fertility level and to stop the return of woody desert and thornscrub species; since plants of the Sonoran Desert do not have adaptations to fire, significant local biodiversity is lost every time a fire occurs (Búrquez et al., 1998, 2002; Búrquez and Martínez-Yrízar, 2000; Turner et al., 1995). Central Sonora, particularly the Sonoran Desert subdivision known as the "Plains of Sonora," is the

area that has been most severely affected by the transformation of the desert into buffel grasslands (Moreno, 1992). Even now that studies have established the long-term environmental consequences of buffelgrass, new permits for clearing the desert are still granted by the Mexican Secretariat of Environment and Natural Resources (SEMARNAT). For example, between 1996 and 2006, 117,000 hectares of Sonoran Desert and thornscrub were granted permits for transformation. Furthermore, despite the proven environmental consequences of buffelgrass, almost 100,000 hectares of already established buffel grasslands that the desert had started reclaiming were artificially "restored" to their exotic grass condition with permission of SEMARNAT (Bravo-Peña et al., 2010). Considering the numerous legal and illegal clearings (see Yetman [2002] for a detailed exploration of the activities of the drug cartels in using buffelgrass to launder drug money), the fully transformed area of the desert easily exceeds 1 million hectares in Sonora alone (Búrquez et al., 2002).

Given the clearly established evidence that the desert of Sonora is in a precarious condition, and that a significant reason for this ecological transformation has to do with the proliferation of government-supported cattle ranches and feedlots, we were curious as to how much of an impact urban demand for carne asada has had on cattle production in recent years. Our first major finding was that no data have been collected regarding the production and consumption of carne asada in Sonora, nor have there been any attempts to clearly link data from the cattle industry with carne asada practices. We therefore decided to attempt to explore the links between cattle, carne asada production, and taco consumption. The numbers and analyses we employ here are meant to give the reader a rough picture of the ecological context of carne asada, and also—we hope—will serve as a preliminary analysis for future detailed explorations of this important topic.

For the purposes of our rough analysis presented here, we estimated that the city of Hermosillo has about 245 street stands selling carne asada.[9] Based on information gathered in the interviews with the owners of the street stands, we calculated that more than 3,057,600 kilograms of carne-asada-style meat are consumed each year in Hermosillo. That amount does not even consider the domestic and more formal restaurant consumption of grilled beef. One kilogram of beef can be spread across an average of 10 to 20 tacos, a very imprecise number but one that reflects the extreme variability in taco size and quality reported by taqueros. For this exercise, we estimated 20 tacos per kilogram of beef

(the estimate is based on the opinion of butchers and residents of Hermosillo). Even with this conservative number, we estimated that the 784,342 inhabitants of Hermosillo (INEGI, 2010) alone ingest a minimum of 61,152,000 tacos purchased from taquerías annually.

Carne asada in these informal establishments comes mainly from the chuck (diezmillo), the ribs (costillas), and the true "fajita" (arrachera: from the diaphragm). Other parts of the cow, usually of higher quality, are also offered in some taquerías. The 3,057,600 kilograms of beef that we estimated are being consumed as carne asada represent about 30,576 steers, since—according to our informants in the ranching and butchering business—a steer at slaughter time typically weighs about 545 kilograms, of which only about 100 kilograms of meat per steer come from the aforementioned cow parts. To calculate the ecological footprint of these cows in terms of foraging native grasslands, we used the cattle stocking rates in Sonora (INEGI, n.d.). According to these rates, each cow needs 24.45 hectares of land to forage. This means that each Hermosillo inhabitant requires about 1 hectare of Sonoran Desert for his or her yearly approximate 78-taco consumption (see figure 2). However, given that only about one-

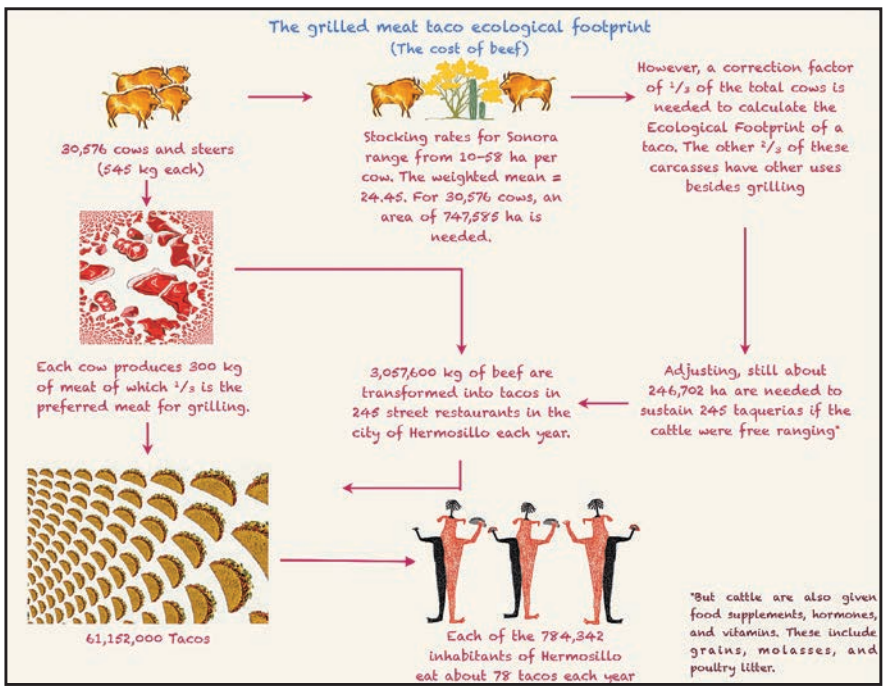

Figure 2: The grilled meat taco ecological footprint (the cost of beef). (Designed by Nemer Narchi)

third of each cow is transformed into tacos de carne asada, the total acreage should be corrected to about 0.31 hectare per person, per year.

To reiterate, this is a very preliminary set of calculations; we are admittedly missing many important variables, including the effects of gender and age on taco consumption. The importance of this analysis lies in the fact that no one else has attempted to collect these kinds of data and to establish these sorts of relationships.

Firewood, Charcoal, and the Mesquite Bouquet of Carne Asada

The impact of carne asada goes beyond the effects of the cattle who graze in the Sonoran Desert that eventually become the beef used in a taco de carne asada. Indirect impacts include an increasing demand for charcoal (usually lump charcoal, also called charwood or natural charcoal, made from woody trees) and firewood for the grilling, demands which seriously deplete local stocks of desert hardwoods, mainly ironwood, mesquite, and other legume trees (Taylor, 2008).

The charcoal used for grilling mainly comes from the desert velvet mesquite (*Prosopis velutina*), which locals say imparts a unique smoke flavor to the meat. Sonora is the number-one producer of non-timber wood in Mexico (excluding conifers and oaks), and its production of mesquite and other closely related desert species accounts for 66% of the total Mexican production (SEMARNAT, 2011). Historically, the most arid counties in Sonora (Hermosillo, Guaymas, Puerto Peñasco, Sonoyta, and San Luis Río Colorado) have contributed to more than half of the overall extraction of mesquite in Sonora (INEGI, 1993; Taylor, 2008). The ancient forests of mesquite have therefore largely disappeared, due to an ever-increasing coal demand in the markets of North America and Sonora. The wood from land clearings to establish buffelgrass is also intimately related to the production of firewood and charcoal, as 90% of the non-timber wood collected in Sonora is transformed into charcoal (SEMARNAT, 2011; Taylor, 2008).

We sampled the charcoal usage in the Hermosillo taquerías we visited, finding that on average they use 50 kilograms of charcoal to produce carne asada every day. Considering that the estimated 245 taquerías in Hermosillo work six days a week, they must consume something on the order of 12,250 kilograms of charcoal daily. From our interviews and the existing literature, we know that most charcoal used daily in Hermosillo is locally produced.

Typically, only 1 kilogram of charcoal is produced from 4–8 kilograms of wood (Antal et al., 1996; Stassen, 2002; Wolf and Vogel, 1986). We therefore assumed a 20% yield of about 200 kilograms of charcoal for every ton (Mg) of dry mesquite wood. Working back to the amount of wood needed to produce the charcoal, we found a figure of 19,110 Mg of wood used by the local taquerias. We know (Burquez et al., 2010) that the Sonoran Desert has a sizable aboveground biomass (AGB): 6.4 Mg ha^{-1} in the plains (71% of AGB from trees), 25.7 Mg ha^{-1} in the arroyos (59% of AGB from trees), and 11.5 Mg ha^{-1} in the hillsides (71% of AGB from trees). Only a small fraction of the aboveground biomass (e.g., trunks and large branches of hardwood species) is suitable for transformation into charcoal. Optimistically, only 5% of the desert's aboveground biomass are harvestable trees, and only half of those trees are suitable for charcoal production. That gives a charcoal yield of about 0.1136 Mg ha^{-1} in the plains, 0.3791 Mg ha^{-1} in the arroyos, and 0.1236 Mg ha^{-1} in the hillsides.[10] The annual ecological footprint of charcoal production for carne asada used in street stands would thus be equivalent to harvesting 168,222 hectares of all the useful aboveground biomass found in the plains, 50,412 hectares of the arroyos, and 154,580 hectares of the hillsides. Using the weighted mean of 16 Mg ha^{-1} for these plant communities, the total annual acreage harvested (pooled across community types) would be 80,375 hectares (see figure 3).

This analysis, in its current form, is more of an intellectual exercise than one that has produced hard data. Nevertheless, it is an important first step in attempting to delineate some of the intricacies that characterize the cow-to-taco trajectory in the Sonoran context. Even more importantly, it clearly demonstrates that the Sonoran love of tacos de carne asada should matter to ecologists. This intensive use of the desert to produce charcoal is consistent with the reported disturbance of all habitats throughout the Sonoran Desert (Búrquez and Martínez-Yrízar, 1997, 2000; Burquez et al., 2010; Taylor, 2008). Wood-harvesting techniques used in the Sonoran Desert imply the complete depletion of the resource. In economic terms, wood harvesting in the Sonoran Desert is profitable because of the vast extensions of land readily available. However, as cities grow bigger and resources become scarcer, the profitability of wood harvesting and charcoal production decreases. Parcels that have been completely devastated in the past need decades to recover and become productive again in profitable terms.

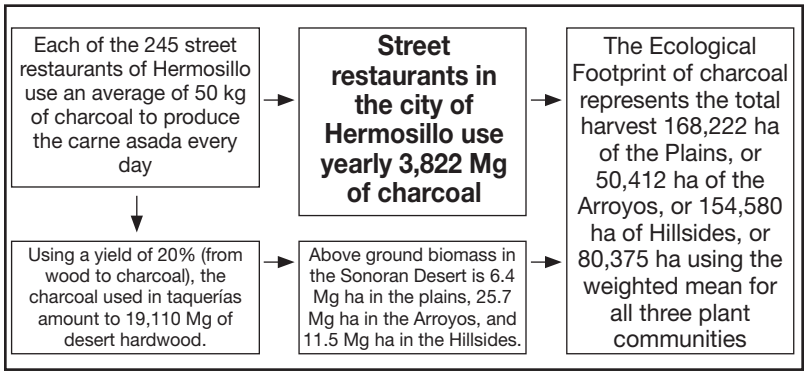

Figure 3: The grilled meat taco ecological footprint (the cost of charcoal).

Conclusion

The introduction of exogenous crops and fauna into the Mexican northwest after European contact was intended to impose a mode of production that was familiar to the Europeans, rendering the environment and its people intelligible and accessible to newcomers. Fortunately for the Spanish in Sonora, the biophysical characteristics of the area were so favorable to these new organisms that cattle grazing and wheat farming were extraordinarily successful, replacing previous patterns of agriculture and mobility. This model was so effectively disseminated by missionaries and settlers (many of whom saw this as an opportunity for immediate promotion up the social ladder) that beef and wheat eventually became iconic cultural symbols of the Mexican northwest, enshrined above all else in the now ubiquitous taco de carne asada found everywhere in Sonora. These food products now symbolically trump what were once abundant and easily accessible resources (such as maize), but have not entirely displaced the latter in local gastronomies.

Over the years, with the aid of structural reforms and a shift in economic development, the private, familial event of carne asada has become a public practice, materialized in the form of tacos de carne asada sold in restaurants, stands, and carts in every town in northern Mexico. A taco encompasses the history of cultural clashes, social relationships, economic transitions, and landscape transformation that has been written across the Sonoran Desert region since the Spanish conquest. Currently, in Sonora, taco production has grown into large-scale commercial operations that depend on many energy subsidies from the government

but that also impose heavy loads on the environment, contributing to land degradation and groundwater desiccation. The overall environmental impact and sustainability of beef production has been discussed elsewhere (e.g., Eshel et al., 2014; Pimentel et al., 1997, 2004). However, and to the best of our knowledge, the links between meat production/consumption and particular culinary practices have been little explored.

Throughout this paper we have tried to balance our analysis of a deeply rooted and beloved culinary practice and food product within Sonora with an analysis of its past historical and current ecological implications. Most importantly, we note that eating a taco de carne asada means nothing less than tasting not only the whole sociohistory of the Mexican northwest, but also the surrounding ecology and resources of Sonora. ✣

Notes

1. Our archival research was immeasurably enriched by access to records, scholarship, and other area-based scholars in Sonora, as well as by working with archival materials at the Arizona State Museum's Office of Ethnohistorical Research and other area-based scholars working at the University of Arizona's Southwest Center.

2. Our ethnographic research of current practices relating to carne asada relied on extensive participant observation throughout the city of Hermosillo, supplemented with in-depth interviews of customers, employees, and owners of shops selling carne asada. During casual conversations at a variety of restaurants and taco stands across the city, we built rapport that allowed us to eventually conduct unstructured interviews with 20 individuals. We then returned for in-depth, semi-structured interviews with six restaurant owners, four restaurant employees, two taco stand owners and one employee, the manager of a meat boutique, and a butcher. By identifying common trends in different interactions, we formulated questions about the number of taco selling points in the city, the amount of charcoal used by each taco selling point in a week, the amount of beef bought weekly, the sources of the supplies, and the importance of carne asada in the diet of the peoples of Hermosillo. We also asked each individual to describe in their own words what constituted the essence of a taco de carne asada. Although we realize that our sample is biased, in favor of people already intimately connected to the production and consumption of carne asada, Búrquez's and Rentería-Valencia's long familiarity with the city and its province, as well as our reliance on other existing scholarly work, allowed us to contextualize the data. Interviews were recorded, according to interviewee preferences, and extensive notes were taken throughout and then cross-checked with each other for accuracy. Prior informed consent was orally obtained from all participants, in line with the requirements of Universidad Autónoma Metropolitana–Unidad

Xochimilco's ethical prescriptions for publication of this report and any accompanying images.

3. The ethnographic component of this thrust of the research focused on semi-structured interviews with the manager of a cattle ranch, along with officers at SAGARPA and COFEPRIS, as well as participant observation in Hermosillo and its surroundings. Data were gathered from the interviews with Hermosillo-based taco stand and restaurant owners and employees, including information on the number of taco selling points in the city, the amount of charcoal used by each taco selling point in a week, and the amount of beef bought weekly by each vendor.

4. The health consequences to the people living in Hermosillo of increasing urbanization, development, and changing foodways (e.g., an increased emphasis on fried food, red meat, and pre-made food put together and sold outside the home—all of which are encapsulated in street tacos) are a fascinating topic in their own right but not the focus of this paper. See Brewis (2011) and Leatherman and Goodman (2013) for discussions of these issues, including some data drawn from Mexico. Other interesting scholarship on this topic does exist, although we would emphasize that widespread public discussion of the deleterious nutritional nature of most tacos de carne asada remains largely absent in Sonora, with few people acknowledging the negative repercussions of a meal dominated by white-flour tortillas, beef, and lard.

5. The systematic, large-scale displacement of local food items and "heirloom" animal and plant cultivars worldwide, first by European colonization and later accelerated as a result of industrialized enterprise—which prioritizes large-scale grain cultivation, especially of a few rice, corn, and wheat varieties—is likewise an interesting subject deserving in-depth exploration in its own right. However, due to space and thematic constraints, we do not explore it here.

6. The American periglacial horse subspecies, *Equus caballus mexicanus*, disappeared from the Americas during the Late Pleisocene (Sandom et al., 2014).

7. Although there is clear evidence that corn domestication and processing first occurred millennia ago in what is now the Mexico-Guatemala region (Davidson, 2014), and that corn tortilla use was widespread throughout what is now Mexico long before the Spanish arrived, the origins of the taco specifically have been surprisingly difficult to trace and scholars are divided in their views. Dakin (2009), for example, argues that based on linguistic evidence, the taco most likely comes from itacate, the snack farmers would take to the milpa while they were working.

8. To reiterate an earlier point, this paper is not focused on the health implications of the epidemiological transition occurring in Mexico, and its associated changes in terms of globalization, retail restructuring, rising obesity rates, etc., although we acknowledge how pivotally important such issues are.

9. Our estimate is based on the interviews we held with taqueros and governmental officers. We approached the Comisión Federal para la Protección contra Riesgos Sanitarios (COFEPRIS) for the current census of street vendors of carne asada. After receiving no official response, we obtained an unofficial estimate of "about 300."

10. We were forced to simplify once again, and to assume only local production of charcoal, without taking imports into consideration, as we did not have the resources to explore that angle in this preliminary set of analyses.

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