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The Potential Role of Geophytes, Digging Sticks, and Formed Flake Tools in the Western North American Paleoarchaic Expansion

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Paleoarchaic studies in western North America comprise often competing frameworks of subsistence, technology, work organization, and gender. An alternative approach recognizes the vast energetic and bio-geographic potential of geophytes, particularly cattail (Typha latifolia)*, as well as the most important tool used in their procurement, the digging stick. The manufacture and maintenance of digging sticks requires flaked stone implements, primarily simple edge-modified flake tools that are ubiquitous in most early-dating assemblages. Together, this approach allows us to re-imagine the foundations of Paleoarchaic subsistence-settlement; how flaked stone technologies were organized with regard to the work efforts of both men and women; and how these groups may have expanded into unfamiliar environments.*

PALEOARCHAIC STUDIES in western North America comprise often competing frameworks of subsistence, technology, work organization, and gender. Were these early populations specialized hunters tracking herds of large game? This has been the longer-established view across many regions in North America (Haynes 2002; Kelly and Todd 1988; Martin 1967, 1973; Waguespack 2005, 2014), and has been advocated more recently in certain contexts for the Great Basin (Elston et al. 2014). Driving this argument is the fact that most assemblages dating to this period are comprised almost entirely of flaked stone implements assumed to be hunting-related weaponry. We seem, however, to lose women in such a formulation, or assign them to an often ill-defined supporting role that has left little archaeological residue. Perhaps they were broad spectrum foragers gleaning a variety of plant, small game, fish, waterfowl, and shellfish resources. This certainly comports with the marsh and paleo-wetland settlement contexts of many early sites in western North America (Bedwell 1973; Elston et al. 2014; Grayson 1993; Willig and Aikens 1988), and is in keeping with what is known of the Paleoarchaic faunal record in both California and the Great Basin (Pinson 2007; Rosenthal and Fitzgerald 2012). It also fits more broadly with a more gender-balanced view of Paleoarchaic lifeways that has been in ascendance throughout the Americas in recent times (Adovasio and Page 2002:287; Dillehay 2000; Speth et al. 2013). But again, what about those supposedly masculine-flaked stone tool assemblages, as well as the fact that we are still left with an incomplete picture of how subsistence, technology, gender, and work organization may have actually functioned?

In this paper, we offer a working hypothesis that attempts to reconcile these disparate threads of Paleoarchaic subsistence, technology, work organization, and gender. This approach recognizes the vast energetic and bio-geographic potential of geophytes, particularly cattail (*Typha latifolia*), as well as the most important tool used in their procurement, the digging stick. We argue that the manufacture and maintenance of digging sticks requires flaked stone implements, primarily simple edge-modified flake tools, and offer indirect evidence that their ubiquity in many Paleoarchaic assemblages may have resulted, in part, from this activity. We would argue that this framework allows us to re-consider the foundations of Paleoarchaic subsistence-settlement; how flaked stone technologies were organized with regard to the work efforts of both men and women; and how these early groups might have expanded throughout an unfamiliar western North American continent. As this argument rests more on its appeal to theoretical parsimony, logical argument, and a reliance on mostly indirect archaeological evidence, it is considered a working hypothesis and avenue for future research.

We focus first on the botany, biogeography, and energetics of marsh geophytes, specifically cattail, whose caloric return rates compare favorably to those of other available plant staples. Our argument, however, may be applicable to other classes of geophytes, and later in this paper we discuss the role that blue dicks (*Dichelostemma capitatum*) may have played in the initial colonization of the Channel Islands. We review the experimental, ethnographic, and archaeological manifestations of geophyte procurement, identifying its behavioral and assemblage correlates, particularly those related to digging stick manufacture and maintenance. We then assess these correlates in relationship to known Paleoarchaic toolkits, revealing the technological organization behind a geophyte-based subsistence regime. We conclude the paper by briefly considering the implications of this approach for the initial colonization of the Americas, as well as suggesting several avenues for future research. As to terminology, we rely on an expansive definition of the Paleoarchaic developed for the Great Basin that focuses on a timeframe between about 13,100 to 8,000 cal B.P. (Madsen 2007:14). Our primary interest, however, is the early end of this timeframe and those assemblages that reflect initial conditions of expansion, relying primarily on the archaeological records of the Great Basin and California.

GEOPHYTES WITH UNDERGROUND STORAGE ORGANS

Geophytes are perennial herbs that store their energy reserves in below-ground structures such as bulbs, tubers, corms, and enlarged roots—collectively referred to as underground storage organs (USOs). These energy reserves are mostly in the form of starchy carbohydrates and digestible carbohydrates (glucose) that are the most expedient way for humans to obtain energy (Hardy 2010). Western North American geophytes that figure prominently in archaeological and/or ethnographic contexts include, among many others, cattail (*Typha latifolia*), epos (*Perideridia* sp.), camas (*Camassia quamash*), biscuitroot (*Lomatium cous*), wild onion (*Allium anceps*), sego lily (*Calochortus nuttallii*), blue dicks (*Dichelostemma capitatum*), and balsamroot (*Balsamorhiza sagittata*).

Our particular focus is directed at cattail, not only with regard to its superlative energetic returns, but also because of its unique ecological and bio-geographical characteristics (Fig. 1). The cattail is a familiar perennial plant with long, slender green stalks (up to three meters tall) topped with brown, fluffy, sausage-shaped heads. It is found in or near shallow water (less than 15 cm. deep), including marshes, ponds, lakes, and depressions, and it is capable of aggressively colonizing newly exposed wet mud with its abundant, wind-dispersed seeds. It is also rhizomatous, and spreads by forming large inter-connected stands that can tolerate perennial flooding, reduced soil conditions, and even moderate salinity (USDA NRCS 2014). Perhaps because of these characteristics, it is ubiquitous in many wetland settings and is found throughout the world, from the Arctic to 30 degrees south latitude (Fig. 1; Hardy 2010:673).

Although the shoots, stalks, seeds, and pollen of cattail have all been described as important food sources, it is the starch-bearing USOs that are the focus of our analysis (Fig. 2). In comparison to other food crops of the Great Basin and Plateau, Fowler and Rhode (2006:Table 3, 349–350) rank cattail rhizomes, along with biscuitroot, epos, and bitterroot (*Lewisia rediviva*), as having the highest carbohydrate content. The easily extracted, starchy flour of cattail USOs yields up to 266 kcal/100 g., which is comparable with emmer wheat (Revedin et al. 2010:Table 2, 18818). With respect to actual return rates, Madsen (2002:390–391; see also Madsen 1979 and Madsen et al. 1997) ranks cattail USOs that have been processed to separate out starch as the highest of any Great Basin plant food, posting an average return of 3,299 kcal/hour (Fig. 3). Madsen also stresses the seasonal importance of cattail USOs during the fall and winter, increasing the value of this resource.

In combining the energetic potential of cattail with its habitat expression, often in vast stands in shallow water, it would be difficult to underestimate the caloric bonanza represented by such a resource. One acre of

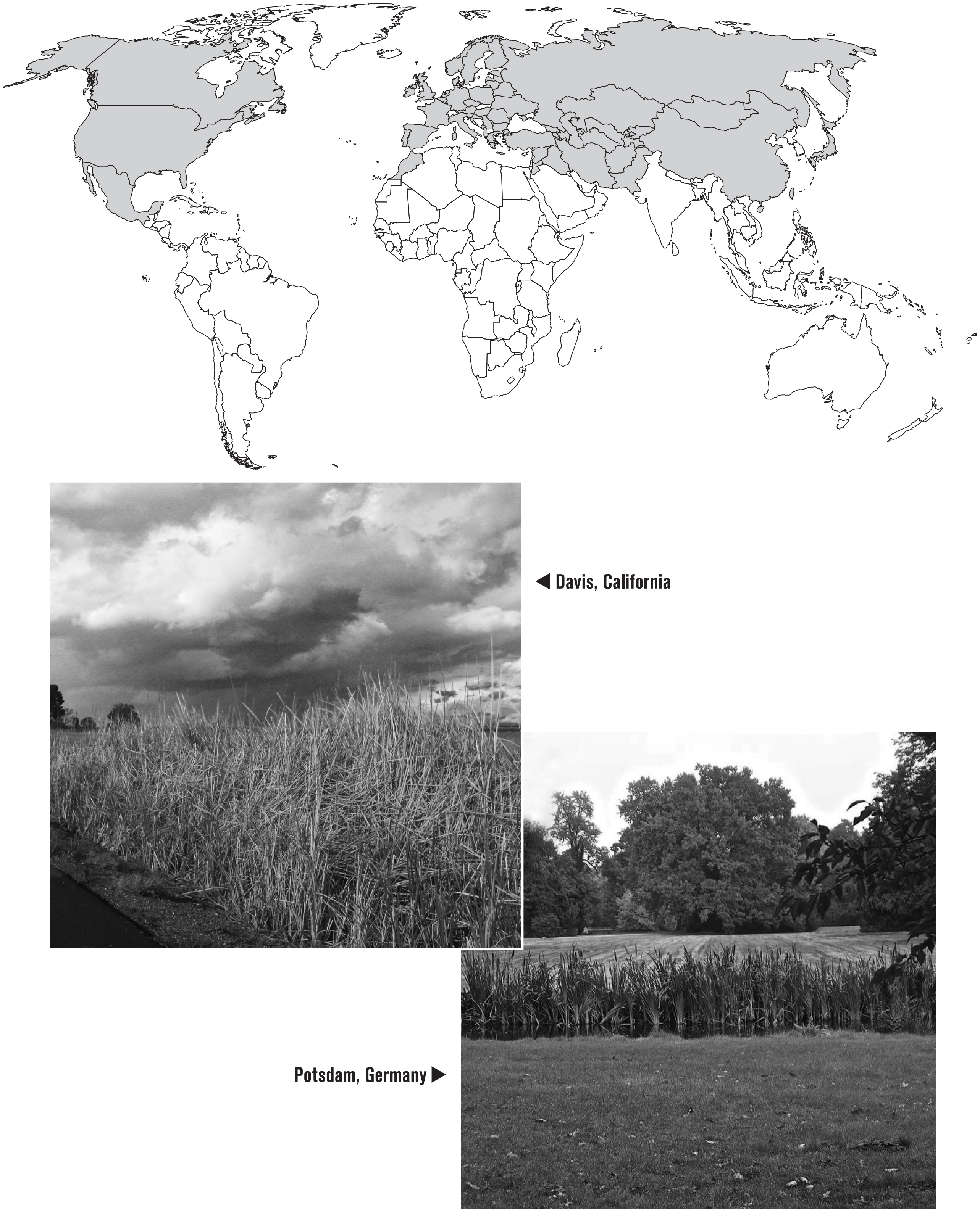

Figure 1. Top: Native range of Cattail (*Typha latfolia*). Adapted from the Global Invasive Species Database (www.issg.org/database/welcome). Center left: Cattail stand in mid-winter, Davis, California (courtesy of Tammara Norton). Lower right: Cattail stand in Postdam, Germany (courtesy of Carmen S. Kuffner).

Figure 2. Cattail (*Typha latfolia*) stalks and rhizomes.

cattail can produce upwards of 2,500 kg. of starch flour (Morton 1975; USDA NRCS 2014), or nearly 6,650,000 calories. Madsen (1979) performs a similar analysis of cattail productivity in the Sevier River Valley of Utah, arguing that precontact wetlands in this area could have yielded an astounding 25 million kilograms of starch flour a year. Of course, in a prehistoric context, the energetic yields associated with cattail are based on a number of factors, including the technology at hand, which we address below.

THE TECHNOLOGICAL REQUISITES OF CATTAIL PROCUREMENT AND PROCESSING

The cattail is both visible and prevalent in most marsh and wetland settings in the Northern Hemisphere. It is no surprise that its starch grains have been observed on stone tools dating to 30,000 years ago in Europe (Revedin et al. 2010), and that *Typha* USOs and other geophytes have been identified as a potential major source of carbohydrates and energy for Neanderthal populations (Hardy 2010). In North America, charred

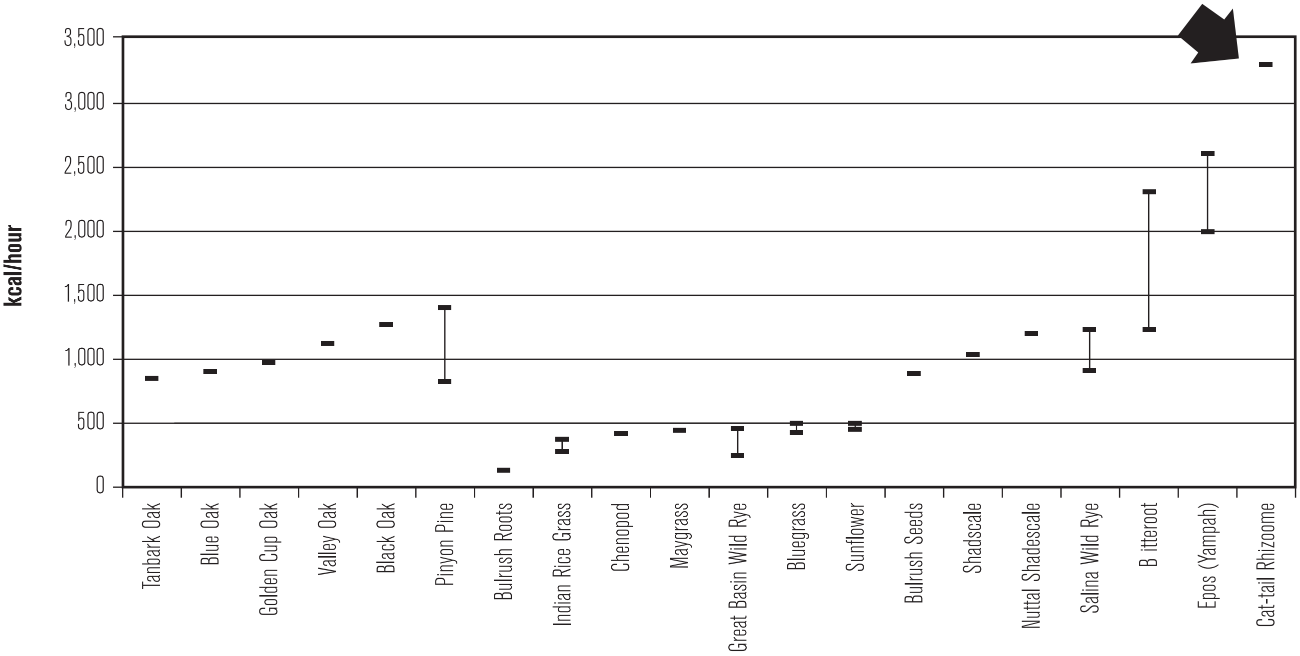

Figure 3. Comparison of energetic return rates for key Great Basin and California plants (modified from Rosenthal and Fitzgerald 2012; data derived from Barlow and Heck 2002, Gremillion 2004, Madsen 2002, O'Connell et al. 2008, and Simms 1987).

Figure 4. Digging stick, Yokuts Indians, San Joaquin Valley, California (courtesy of the Smithsonian Institution, Washington D.C.).

cattail seeds (but no USOs) have been found in deposits dated to between 13,100 and 10,600 cal B.P. near the Great Salt Lake (Rhode and Louderback 2007:231–247).

Given both the ubiquity and antiquity of this resource with regard to hunter-gatherer adaptations, it is unlikely to have ever been displaced or ignored as a valuable plant resource even as diet breadth expanded; indeed, its importance is cited in any number of western North American ethnographic accounts (Fowler 1992; Harrington 1933; Mayfield 1993:77; Rhode 2002:167–169). The Northern Paiute people of the Carson Desert and Stillwater Marsh area of central Nevada—who refer to themselves as the *Toidikadi*, or the Cattail Eaters—illustrate this point, in keeping with a general pattern of tribal identification with key food staples associated with particular districts in the Great Basin (Fowler 1992:64–66). Along with a description of the harvesting and processing of USOs (see below), Fowler also describes the subsistence roles of cattail pollen, seeds, and spring-emergent shoots, as well as the importance of cat-tail stalks as material for housing and fibers for various manufacturing tasks.

The primary tool for harvesting geophytes across the world is the digging stick (Fig. 4); it is referenced for 139 of the 281 cultures listed in the Human Relations Area Files (Human Relations Area Files, Inc., 2014; see also Thoms 1989:84–93) and is of very ancient origin, appearing in the toolkits of modern humans as early as 44,000 years ago in South Africa (Villa et al. 2012), and at Monte Verde in southern Chile, one of the oldest documented occupation sites in the Americas (Dillehay 1997:158–162). At the Paisley Caves in southern Oregon, an abundance of Apiaceae pollen, most likely representing a meal of biscuitroot (*Lomatium* sp.), was found in a coprolite dated to over 14,000 cal B.P. (Jenkins et al. 2014:502–503). Jenkins makes the point that the harvesting of biscuitroot requires a digging stick (see Hodges 2015:137; see also Middleton et al. 2014). The digging stick is used to probe, loosen, lever, and excavate geophytes, and there are specific ethnographic accounts of the use of these implements for harvesting the USOs of both cattail and tule (Mayfield 1993:77).

While cattail USOs can be mucked out of shallow water and mud by hand, Madsen (et al. 1997:10) argues that in winter they are much more easily obtained using a digging stick on firmer, drier ground where water has receded. He notes that dry and/or frozen earth can be easily separated from the USOs in these conditions, in contrast to harvests in wet or boggy conditions where heavy mud clings to the USOs and is difficult to remove. Madsen also notes that in sub-freezing winter conditions, it is virtually impossible to spend more than a few moments working in water.

Although there are any number of characteristics and morphologies associated with digging sticks, they are invariably made of the hardest woods available—mountain mahogany being one such favorite in the Great Basin and Plateau (Voegelin 1942:175). They are described in these particular geographic contexts as generally being about a meter in length and fashioned from limb wood that has been stripped of bark and sharpened at one or both ends, either by whittling with stone tools or by abrasion (Gleason 2001:237; Thoms 1989). We will return to the topic of the role that stone tools played in making and maintaining digging sticks in relationship to Paleoarchaic assemblages in western North America.

With regard to post-harvest processing costs, cattail USOs present somewhat of a moving target, as they can be eaten raw, dried and stored, cooked, and/or processed in various ways to separate energy-laden starch grains from the fibrous structure. In a series of experiments, Madsen (et al. 1997) describes a process of crushing the rhizomes and then boiling them to release the starch, creating a soup. However, he adds that it is not necessary to boil the tubers, as they can either be soaked or simply hand-manipulated in water to release the starch. Similarly, the contemporary plant-gathering literature identifies a technique of crushing or shredding cattail USOs in water; the starch grains settle to the bottom and the fibrous material is raked off (Morton 1975:21–23; see also Brill and Dean 1994; Duffy 1997). The water is then poured or boiled off, leaving a starchy slurry or flour that can be prepared as a flatbread or cake, or added to other foods.

Cattail USOs can also be dried and stored (Fowler 1992) before they either undergo the same water-separation process or are simply crushed to release the starch grains from the fibrous chaff (Madsen et al. 1997). As described by Fowler (1992:64–66), the Cattail Eaters peeled and consumed freshly harvested USOs or split them into strips for roasting and drying. The dried strips were ground into a flour and mixed with water and made into a mush or into cakes.

The preparation of cattail flour from dried rhizomes may date to as early as 30,000 years ago in Europe, as starch residues have been identified on burins, anvils, and pestle-like grinders from a number of sites dating to this period (Aranguren et al. 2007; Revedin et al. 2010). In a North American example, the Yokuts of the San Joaquin Valley in California pounded the rhizomes into a soft mass, which was then transferred into a cooking basket and covered with hot water (Mayfield 1993:77). The crushed roots were removed, and the starch was allowed to settle at the bottom of the basket. The water was then poured off, and the starch was made into a cake. Note that the various methods of concentrating cattail starch are relatively simple in comparison to the elaborate leaching technologies associated with acorns or the roasting processes required to de-toxify camas root—all of which may help explain cattail's antiquity with regard to human food production.

THE ARCHAEOLOGICAL CORRELATES OF GEOPHYTE PROCUREMENT

Our emerging understanding of the role of digging stick manufacture and use in the harvesting of geophytes potentially provides a bridge to the unique character of the Paleoarchaic flaked stone tool assemblages observed in North America. The laboratory for this work has centered along the interface between California, the Columbia Plateau, and the northwestern Great Basin in an area characterized as the "root complex" with respect to ethnographic lifeways (Fig. 5; see also Fowler and Liljeblad 1986:435–465), and involves recent studies by Gleason (2001), the University of Utah (O'Connell et al. 2008; Trammell et al. 2008; see also Thoms 1989), as well as the authors (McGuire and Stevens 2016; see also Hildebrandt et al. 2016).

The focus of these studies has been directed mainly at epos (*Perideridia* sp.), a late spring/early summer ripening geophyte that occurs in abundance in the volcanic lithosols common to this region. Gleason (2001:555–558) makes the point that because digging sticks are wooden and generally do not preserve in the archaeological record, the key to tracking their prehistoric use—and geophyte procurement in general—is through the flaked stone tools used in their manufacture and maintenance. This is also corroborated in any number of ethnographic accounts. For example, Goddard (1903:30) noted that Hupa women were often accompanied by men on geophyte foraging rounds "to keep their digging sticks sharp with stone knives." Similarly, Kelly (1932:101) observed for the Surprise Valley Paiute that "the old digging stick (*bodo*) was a straight piece of mountain mahogany (*tu pi*) sharpened to a point with a stone knife." In this sense, the early substitution of newly-available metal for wood in many ethnohistoric accounts and photographs of digging sticks (see Fig. 5) proves the point regarding the heavy use this class of wooden implement was subjected to.

Gleason singles out the critical role of utilized flakes, scrapers, choppers, and other implements used in the digging stick manufacture and maintenance process that are characterized by their long, durable working edges. She also suggests that such tools might not occur in association with the usual reduction debris at site locations, but may often be distributed in more scattered contexts across productive prehistoric geophyte tracts. Thoms (1989:312) identifies a similar flaked-stone tool kit that includes "cobble choppers and large flake tools with notched edges or spokeshave-like indentations, as well as the thick scraper edges frequently interpreted as woodworking tools."

Figure 5. Marion Louie, Northern Paiute, harvesting biscuit-root with a metal digging stick (courtesy of Marilyn Couture).

A Late Holocene Case Study at Barrel Springs and Long Valley

A comparative study of flaked stone assemblages from two study transects, one located in a prime volcanic upland epos habitat and the other in an adjacent alluvial valley context less suitable for geophyte production, was conducted in the Barrel Springs/Long Valley area of northwest Nevada as part of the Ruby Pipeline project (Fig. 6; Hildebrandt et al. 2016; McGuire and Stevens 2016). Each transect was completely surveyed and all identified sites were excavated using the same sampling methodology. A total of 91 sites were included in the sample, and more than 4,000 flaked stone tools were recovered.

Of particular interest are the frequencies and distributions of simple and formed flake tools in each of these two environmental regions. Simple flake tools (i.e., utilized flakes) occur at a density of 212 tools/acre in the epos transect, whereas the density in the adjacent non-epos transect falls to 4.3 tools/acre—essentially a 50-fold drop (Table 1). Formed flake tools (i.e., retouched flakes) are less frequent on the landscape, occurring at a density of 7.2 tools/acre in the epos transect, but are *completely absent* in the adjoining non-epos transect. The demand for high-quality flakes for digging stick maintenance must be met by a supply, and this may explain the super-abundance of cores at Barrel Springs, some 27 times higher than at Long Valley.

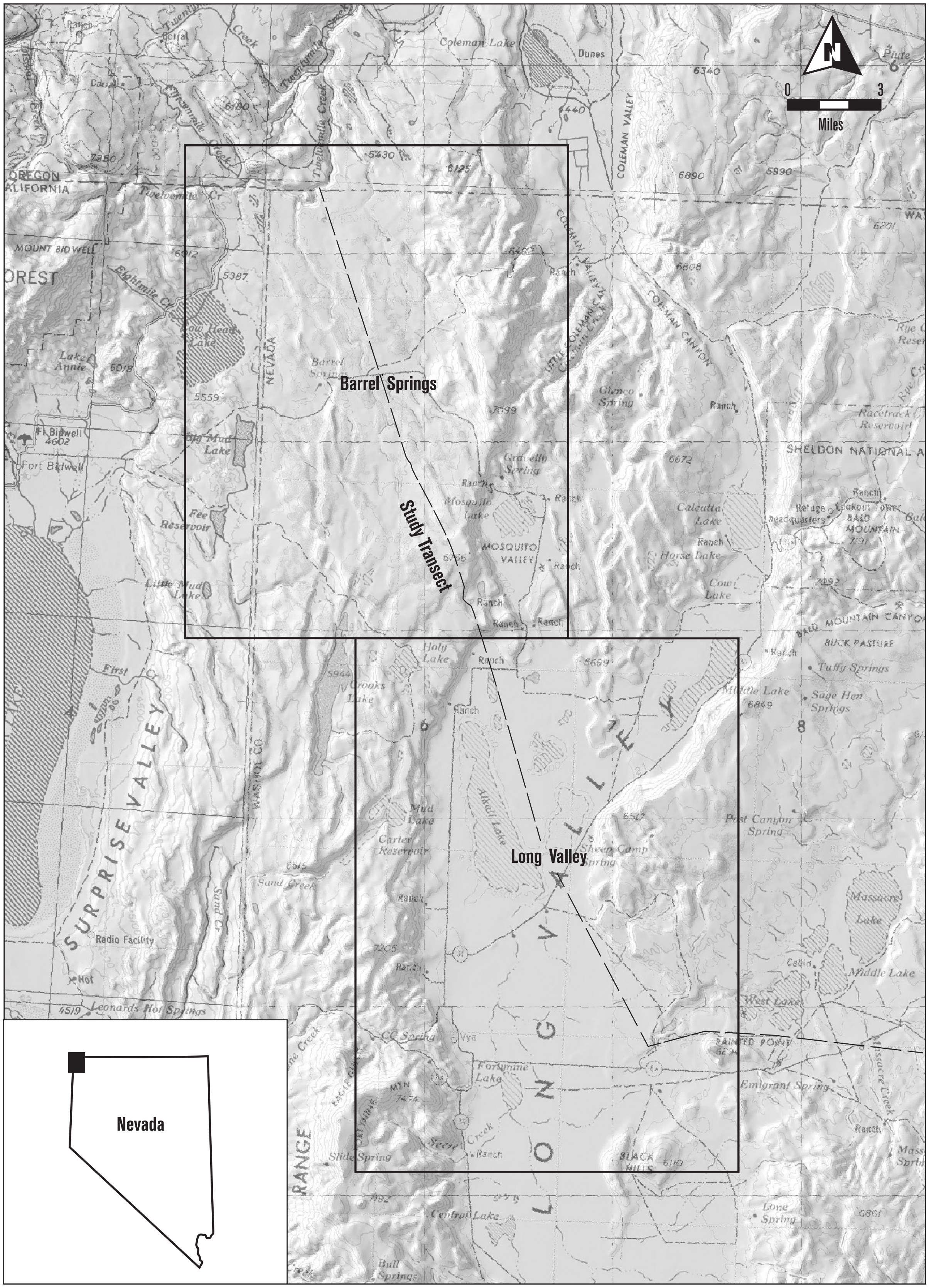

Figure 6. Archaeological study transect: the Barrel Springs and Long Valley areas of northwestern Nevada.

While McGuire and Stevens (2016) acknowledge that these tools can be used for a variety of tasks, they argue that their overwhelming representation in prime epos tracts is strong evidence for the manufacture and maintenance of digging sticks. Furthermore, use-wear and morphological analyses performed on both of these tool classes showed that most of these tools were used for processing hard substances, most likely wood. In their analysis, formed flake tools that functioned as scrapers have a ventral-to-dorsal orientation (i.e., with the ventral face contacting the worked material). Accordingly, edge damage (step fracture, flake removals) is most prevalent on dorsal sides of tools. In most cases, this damage is consistent with interaction with hard materials, most likely wood. Furthermore, this use-wear signature is most prevalent in those tools recovered from prime epos habitat at Barrel Springs, as opposed to other geographic contexts along the pipeline corridor. Simple flake tools have more variable edge angles and were probably used for a wider variety of tasks. The pipeline study, however, identifies considerable overlap in the weight and edge angle of formed and simple flake tools, with the larger tools with steeper edge angles exhibiting very similar damage (interaction with hard materials) as the formed flake tools. Furthermore, simple flake tools from the Barrel Springs, as opposed to other project zones, tend to have more concave-shaped working edges, typical of digging stick maintenance (Thoms 1989).

McGuire and Stevens conclude that simple and formed flake tools in this particular geophyte harvesting area constitute a tool kit for the manufacture and maintenance of digging sticks; the former were probably used in the more-or-less constant maintenance of the tool's business end, whereas the latter were used less frequently for the stripping and shaping associated with the actual manufacture of digging sticks. Of course, the broader point is that the use of digging sticks for the harvesting of geophytes is associated with an *identifiable* flaked stone tool kit, one consisting of a series of often informal but variable-angled flaked stone tools.[1]

Table 1

ASSEMBLAGE COMPARISONS:
BARREL SPRINGS VERSUS LONG VALLEY

Description	Barrel Springs	Density	Long Valley	Density
Projectile point	351	44.5	118	10.5
Drill	14	1.8	4	0.4
Biface	1,364	172.9	296	26.3
Formed flake tool	57	7.2	0	0.0
Flake tool	1,679	212.9	48	4.3
Core tool	15	1.9	1	0.1
Core	255	32.3	14	1.2
Millingstone	20	2.5	83	7.4
Handstone	30	3.8	43	3.8
Bowl mortar	5	0.6	0	0
Pestle	12	1.5	1	0.1
Total Milling Tool Density	**67**	**8.4**	**127**	**11.3**

Note: Density is configured on total study transect area of Barrel Springs (788.5 acres) and Long Valley (1,127 acres) project segments.

PALEOARCHAIC TOOLKITS

Having proposed a flaked stone technology for the manufacture and maintenance of digging sticks used for geophyte procurement—essentially a continuum of sharply-angled simple flake tools and more oblique-edged formed flake tools—it remains for us to identify potential analogs in Paleoarchaic tool kits. However, given the wide divide between Paleoarchaic land-use practices and those observed during the Late Holocene in northwestern Nevada, it is unlikely the analogs of formed flake tools will be exactly equivalent, although a side-by-side comparison of these tools for each of these time periods demonstrates broad morphological similarities (Fig. 7). We also run into issues of typology and nomenclature, as the most likely candidates for this class of woodworking tools are variously identified as scrapers, end-scrapers, unifaces, formed flake tools, burins, and flake tools, to name a few. We prefer the term *formed flake tool*, which in our estimation is the most neutral with regard to either form or function; they are characterized as "flaked based tools with margins that have been intentionally shaped by intrusive retouch to produce continuous, uniform edges" (Jurich 2005:58). As a class, such tools have long been recognized as an essential part of the Paleoarchaic tool kit in western North America (Bedwell 1973; Campbell et al. 1937; Warren et al. 1961; Willig and Aikens 1988).

In Paleoarchaic contexts in the Mojave Desert, Basgall (1993) views formed flake tools as highly formalized, multi-functional implements, that in contrast to more expedient flake-based tools, tended to be curated for longer periods of time by mobile foragers. As Jurich (2005:147–149) further points out, part of the multi-functional

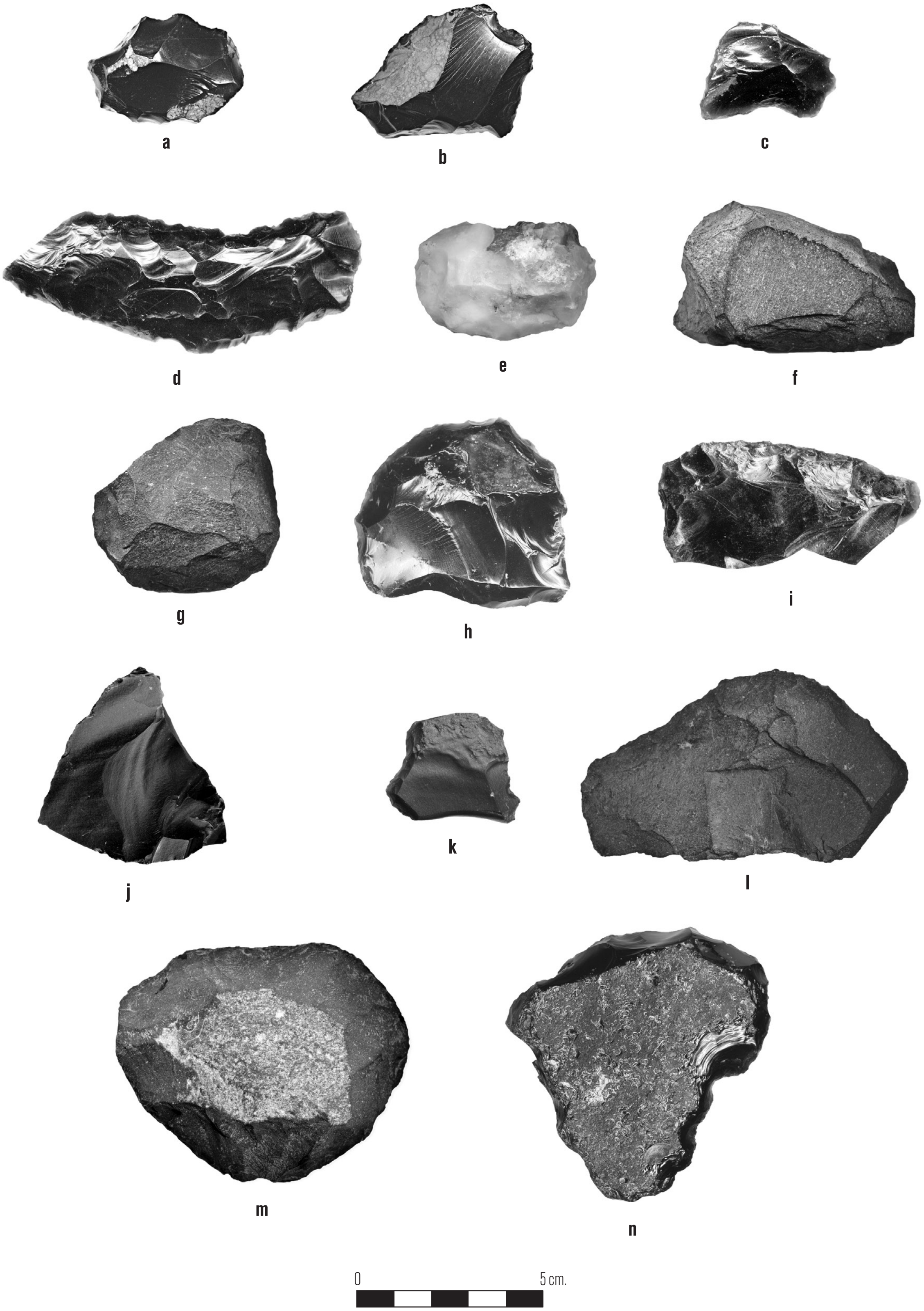

Figure 7. Formed flake tools from northwestern Nevada obtained from Late Holocene contexts (a–g) and Paleoarchaic contexts (h–n).

aspect of formed flake tools included heavier-duty tasks associated with woodworking. In contrast to formed flake tools dated to the Late Holocene in the Mojave Desert, Jurich (2005:147–148) observes a much higher incidence of damage diversity on formed flake tools associated with older Lake Mohave and Pinto components which—through replicative studies—she correlates with more intense chopping, sawing, whittling, and scraping of medium to hard materials, most likely wood.

While the results of this regional assessment of formed flake tools are relatively straightforward and the literature on this subject is comprehensive—starting with the work of Wilmsen (1968, 1970; see also Crabtree and Davis 1968; Tringham et al. 1974) and various subsequent studies, critiques, and commentary (Kamminga 1982; Keeley 1974, 1980; Lewenstein 1987; Morrow 1997; Seeman et al. 2013; Shott 1995)—it is often problematic to derive exact linkages between specific tool functions and formed flake tool types and sub-types, edge angles and shapes, and use-damage. Though formed flake tools were almost certainly used for a variety of purposes, their robust size and edge configuration, coupled with often high levels of edge damage, suggests that they were used in large measure for woodworking in many Paleoarchaic contexts. An obvious note of caution should be made here, in that Paleoarchaic woodworking was not limited to digging stick manufacture and maintenance; one can envision their use for shaping any number of wooden implements.

But moving beyond the use-wear argument, if formed flake tools were simply part of a hunting tool kit (e.g., hide scrapers), their abundance should track the trans-Holocene record of large mammal abundance in archaeological assemblages (see Broughton et al. 2011 for a similar indexing approach to large game abundance using projectile points and other artifact classes). In California and the Great Basin, most such indices show *increasing* amounts of large game through time (McGuire and Hildebrandt 2005; Pinson 2007:187–2003; Rosenthal and Fitzgerald 2012:67–103) while the use of formed flake tools *declines*; therefore, we conclude that this relationship is not substantiated. This is illustrated in Figure 8, which plots the trans-Holocene frequency of formed flake tools as a ratio of the total number of flaked stone tools from 20 component assemblages documented at Fort Irwin in the Mojave Desert. This is plotted against the artiodactyl index from 39 site components also located in the Mojave Desert.[2] As can be seen, the relationship between formed flake tools and the artiodactyl index is actually inverse until the latest prehistoric occupation; i.e., across the Paleoarchaic/Archaic transition, evidence for taking large game increases while the use of formed flake tools decreases dramatically. If formed flake tools were implements used primarily to manufacture and maintain digging sticks for the procurement of cattail USOs and other geophytes, this decrease may simply reflect the ever-diminishing extent of wetland habitats progressing into the Holocene, population and settlement expansion moving into less productive habitats, and the development of millingstone technologies to exploit lower-ranked resources found in these habitats.

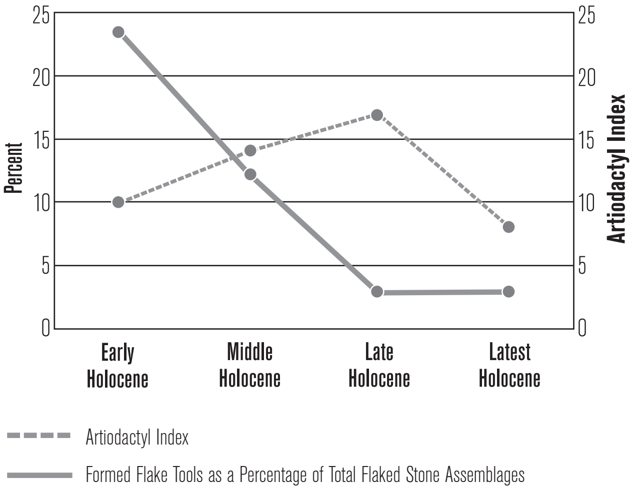

Figure 8. The percentage of formed flake tools to all other flaked stone tools from select components in the Mojave Desert plotted against the Artiodactyl Index for each major time period in the Mojave Desert.

What is undisputed is the ubiquity of formed flake tools in Paleoarchaic assemblages. Table 2 presents summary assemblage results for several large-landscape studies in the Great Basin, including the Old River Bed in the Great Salt Lake Desert (Duke 2011) and Nelson Basin in the Mojave Desert (Basgall 1993). The former includes 95 sites, all dated to between 12,100 and 9,900 cal B.P.; the latter includes 11 sites, all ascribed to the Lake Mohave period and dated from 12,800 to 7,800 cal B.P. Both of these assemblages are devoid of ground stone; thus these six flaked stone tool classes comprise almost all of the assemblage variation for this time period. In both cases, formed flake tools clearly stand out, comprising between

Table 2

PALEOARCHAIC ASSEMBLAGE PROFILES: OLD RIVER BED AND NELSON BASIN

	Sites	Projectile Points	Projectile Bifaces	Drill	Formed Flake Tools	Simple Flake Tools	Core Tool	Core	Total
Old River Bed	95	644	1,064	0	860	35	0	32	**2,635**
		24.4%	40.4%	0.0%	32.6%	1.3%	0.0%	1.2%	
Nelson Basin	11	98	1,572	7	506	222	41	150	**2,596**
		3.8%	60.6%	0.3%	19.5%	8.6%	1.6%	5.8%	

Note: Old River Bed data adapted from Duke 2011:208, Table 21; Nelson Basin data from Basgall 1993:Table 5.1.

19.5 and 32.6 percent of all tools. In each case, they actually out-number projectile points.

Unlike the Barrel Springs/Long Valley example previously described, simple flake tools are not well represented in these early-dating contexts. Several explanations may account for this. First, these tools are not purposefully shaped and generally lack typologically distinct attributes, other than subtle macro- and microscopic use-wear characteristics that are often degraded or erased by the effects of weathering over many millennia. It follows that such tools receive, at best, uneven analytical treatment, even at the catalogue level, and are therefore under-represented in most studies. It is more likely, however, that their low representation has a behavioral basis. As a number of researchers have pointed out, toolstone conservation was important to Paleoarchaic populations, as they are generally understood to have practiced a wide-ranging and residentially mobile land-use pattern. This would have placed a premium on more formalized, highly curated implements, as opposed to more wasteful, expedient technologies that relied on the production of a large number of expendable flake tools (Basgall 1993).

Of course, the broader questions here are why there are so many formed flake tools in Paleoarchaic assemblages, and why do they often appear to have been used to modify hard materials such as wood? Even accounting for changes in climate and habitat, the Mojave Desert and Great Salt Lake Desert were never replete with trees, so what were these tools being used for? We believe that one explanation is that they were being used, in part, in the manufacture and maintenance of wooden digging implements to procure cattail and other geophtyes. Furthermore, this activity was of such intensity as to leave a consistent archaeological signature, notwithstanding the fact that (in the case of cattail) much of this harvest was seasonally restricted to fall and winter.

DISCUSSION

The thesis presented here is, of course, an indirect one. The argument relies primarily on its agreement with contemporary foraging theory, compatibility with Paleoarchaic flaked stone assemblages and technologies, and parsimony with regard to gender-specified work organization. Each of these topics is discussed below.

Given that cattail USOs seasonally represent the most concentrated store of carbohydrates of any widely available economic plant in many areas of western North America, and that their harvest requires virtually no search time and only modest levels of processing, they should have *always been taken* where seasonally available. Moreover, this resource essentially stores itself in easily observed wetland tracts, reaching its highest energy content in its dormant phase during the fall and winter—i.e., precisely during the mortality bottleneck of hunter-gatherers in temperate latitudes (Baumhoff 1963:161; Schulz 1981:94–97). As we've detailed, these tracts represent huge energy reserves with nearly 6,650,000 calories/acre potentially available for harvest, not to mention any number of other plant and animal resources seasonably available in wetlands. Thriving in the Terminal Pleistocene/Early Holocene riverine deltas and outwash plains as glaciers retreated, cattail habitat may have been the ultimate resource patch with respect to Paleoarchaic foraging behavior.

This perspective also potentially accommodates both a large-game *and* a broad-spectrum view of Paleoarchaic subsistence. As to the former, it conforms to predictions based on foraging theory that plant-gathering activities in societies that otherwise emphasize the taking of large animals should focus on crops with high post-encounter returns, such as roots and fruits, as opposed to seeds and nuts that require higher processing costs (Keeley 1988, 1995; O'Connell and Hawkes 1981; Waguespack 2005). But geophyte procurement on this scale seems hardly ancillary or subordinate to the exigencies of hunting; indeed, it may have conditioned or perhaps even facilitated hunting by providing a measure of energetic stability to the boom-or-bust variance generally associated with the hunting of mobile, large-bodied prey (Pinson 2007; see also Bird et al. 2009). We can also envision a scenario where the harvesting of cattail USOs and other geophytes may have served to anchor settlement activity within or near wetland resource patches in the absence or depletion of large mammal populations (see Elston et al. 2014; Madsen et al. 2015), thus complementing the taking of fish, small game, waterfowl, and shellfish, as well as the harvesting of any number of other plant resources. Indeed, the flexibility afforded by this particular form of keystone geophyte procurement may explain much of the variation we see in Paleoarchaic adaptations across time and space.

One of the more consequential aspects of this hypothesis is that it begins to restore some semblance of gender symmetry to Paleoarchaic toolkits and work organization. Paleoarchaic assemblages are often limited to flaked stone tools, and are usually bereft of the milling implements that are the standard signature of women's work. As such, these assemblages are most often assumed to be hunting-oriented and therefore the province of men. Waguespack (2005:667–668) notes that until the presence and extent of plant gathering in Paleoarchaic assemblages is understood, the role of women will remain ambiguous and mostly inferred. She describes this as the *Incredible Shrinking Women* problem, its origins potentially based in (1) egregious gender stereotyping revolving around large game hunting conducted by males (see also Gifford-Gonzalez 1993); (2) under-representation of evidence of gathering activities, perhaps because such activities were less important at this time or because the tools used in these tasks were subject to differential preservation (i.e., perishable implements); or (3) the fact that a plant processing tool kit has yet to be analytically identified as such.

While all of these factors may be in play to varying degree, the results presented here point to Item 3 above—i.e., that we have failed to clearly identify a plant processing tool kit. Cattail and other keystone geophytes were probably procured by women using digging sticks. Formed flake tools were crucial to the manufacture and continuous maintenance requirements associated with these implements and may have also been used to process (cut, shred, pulp) the starch-bearing USOs of these plants. Conversely, they appear to be less associated with hunting-related activities, as they are not correlated with regional increases in the taking of large game. The role of women in the actual manufacture of these tools is more uncertain, although there is some ethnographic data to support such an inference (Gleason 2001). Formed flake tools constitute a major element of most Paleoarchaic tool kits in North America, comprising upwards of 20 to 30 percent of all tools in many Paleoarchaic assemblages.

As we have indicated, the ubiquity of formed flake tools in assemblages diminishes after the Paleoarchaic Period in conjunction with the increasing use of milling equipment (Basgall 1993). While the timing of this transition is geographically variable, such changes in technological investment are potentially more coherent within a framework of early geophyte use. Ever-diminishing wetlands at the onset of the Holocene, coupled with continued population growth, promoted subsequent use of less productive resource zones and an increasing investment in milling technologies that facilitated the processing of lower ranked plant resources (e.g., hard seeds) found in these tracts. These changing circumstances—typical of the Paleoarchaic-Archaic transition—radically altered settlement systems and women's work organization in such a way as to diminish the primacy of wetland geophytes and the tools used in their procurement.

The Channel Islands

If our thesis is correct—that geophytes, and the technologies used to procure them, provided a critical source of carbohydrates for Paleoarchaic populations—we should perhaps see evidence of this with other geophyte taxa and in different geographies. As previously noted, there is some recent research to suggest that geophytes played a significant role in upland settlement contexts for Paleoarchaic populations in southern Oregon (see Jenkins et al. 2014; Middleton et al. 2014). Target species may have included members of the Apiaceae family (wild carrots, desert parsley, and biscuitroot).

A noteworthy test of this concept also comes from the Channel Islands off the coast of southern California, and specifically from stratified archaeological deposits and plant remains documented at Daisy Cave on San Miguel Island (Erlandson 2007; Erlandson et al. 1996; Reddy and Erlandson 2011; see also Gill and Hoppa 2016). Deposits dated between 11,500 and 8,500 cal B.P. are mostly bereft of small seeds but contain an abundance of carbonized *Brodiaea* corms, a class of similar geophytes that includes blue dicks, which occur naturally on the island. Blue dicks are a high-energy source of carbohydrates that were harvested in the summer and could be cooked, eaten raw, or stored for winter consumption (Reddy and Erlandson 2011). The Channel Islands figure prominently in the coastal colonization argument, as some of the earliest dated human remains in North America have been documented there (Johnson et al. 2002). Additionally, a substantial Paleoarchaic presence is documented at a number of open-air sites, with assemblages containing an assortment of stemmed points, crescents, bifaces, and (not surprisingly) formed flake tools similar to those identified in interior parts of North America (Erlandson et al. 2011).

Reddy and Erlandson make the point that an abundant, high-carbohydrate geophyte, that was both easily processed and stored, solves an ongoing mystery as to how occupation of these supposedly marginal islands may have been sustained in Paleoarchaic times. While local circumstances certainly varied across western North America, the example here indicates that geophytes, and the simple technologies used in their procurement, may have been instrumental in providing a stable subsistence platform for colonizing populations.

FINAL THOUGHTS

Until a cache of digging sticks or dried tubers is recovered from some western lakeshore cave or rockshelter, the argument presented here remains a hypothesis at best, but one that should stimulate future research. For example, it seems clear that cattail has been neglected to some extent in the foraging literature, given its biogeography and energetic potential. It may be possible to model its ancient habitat distributions and then cross-reference these locations with the distribution of key artifact classes, such as formed flake tools. It may also be time to more broadly consider other Paleoarchaic tool categories with the idea that their function and gender affiliation may have been more heterogeneous than previously thought. This might apply to more formal elements of the Paleoarchaic toolkit, such as stemmed points and crescents. Indeed, Meltzer (2009:279) compares Clovis points to Swiss Army knives, in that among other tasks, they may have been used for "digging out stubborn edible roots." The point here is that even many formal flaked stone tools may have been used for a variety of functions, and that future analytical approaches should incorporate this emerging understanding.

The hypothesis presented here may also have implications for the initial colonization of the Americas. Meltzer (2009:209–238) makes the point that new landscapes must be learned by their initial occupiers, requiring the detailed and often slow accumulation of knowledge regarding local plants, small animals, fish, birds, larger herding animals, lithic sources, and water, as well as social networks and nearest potential mates. All of these are constraints to rapid migration. But what if one of the most important subsistence resources was the same species from Siberia to Mexico? What if it grew in large tracts in common and predictable wetland settings, was flagged by three-meter-high stalks and florets easily observed in all seasons, and contained a trove of carbohydrates waiting to be excavated with the simplest of technologies? At least with cattail, there was not much learning to be done. These early and no doubt quickly expanding populations (see Richerson et al. 2001) could move between valley systems across a range of latitudes, biomes, and local habitats with a predictable outcome with respect to this key plant staple.

As cattail and other geophytes are common across latitudes in interior continental habitats, as well as in estuarine coastal zones, a geophyte-based procurement system would also appear to accommodate either the interior "ice-free corridor" point of entry hypothesis, or more recent considerations of a coastal migration from Beringia down the Pacific Coast. In either case, Paleoarchaic population movements are thought to have been funneled along major drainages and rivers that form, for example, the Mississippi River basin (Anderson

1990:195–196), or the Columbia River drainage (Beck and Jones 2010; Erlandson et al. 2007). In certain non-wetland settings, such as that described above for the Channel Islands, other geophyte species may have played this same role of providing a stable caloric platform for colonizing populations.

When we consider the energetic potential of cattail and other geophytes with the flaked stone technologies used to harvest and process them, we can begin to rethink the foundations of Paleoarchaic subsistence-settlement, how flaked stone technologies were organized with regard to the work efforts of both men and women, and how these groups might have gained a toe-hold in western North America and expanded so quickly into an unfamiliar environment.

NOTES

[1] The use of simple retouched flake tools for a range of woodworking tasks, including the manufacture and maintenance of digging sticks, has been documented in archaeological contexts in other arid lands. See, for example, Veth (et al. 2011) for a discussion of the woodworking attributes of the Tula, a hafted retouched flake tool common across much of the Australian arid zone.

[2] The formed flake tool sample used here includes those same archaeological contexts identified by Jurich (2005:59–64) in her use-wear study. She describes them as well-dated and high-quality contexts, identified by compiling information on radiocarbon dates, obsidian hydration readings, and chronological markers such as projectile points, beads, and ceramics. Artiodactyl Indices ($\sum$Artiodactyl + Large Mammal/$\sum$ All Fauna) were compiled from 39 dated site components in the Mojave Desert, as reported in Basgall (1993), Basgall and Hall (1993, 1994), Byrd (1996), Byrd et al. (1994), Douglas et al. (1998), and Foster et al. (2003).

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