

Reply to Hill and Brown: Maize and Uto-Aztec cultural history

The hypothesis that Proto-Uto-Aztec (PUA) speakers cultivated maize in or near Mesoamerica rests primarily on Jane H. Hill's argument (1) that a maize-related vocabulary can be reconstructed for PUA, based on cognates in Northern Uto-Aztec (NUA) and Southern Uto-Aztec (SUA) languages. In our essay (2), we noted that Hill fails to demonstrate the existence of this PUA vocabulary, because the NUA words she identifies as cognates of maize-related words in SUA languages lack the expected phonological forms or the expected meanings. The same characterization applies to the additional evidence from three California NUA languages that she cites in her reply.

Despite Hill's claim, it is by no means certain that a PUA word for "maize" existed. Hill's proposed PUA ***sunu* can be reconstructed with a gloss of "maize" only for the SUA languages. The most likely NUA cognate, the Hopi word *sojowī*, labels not maize but a wild grass, the giant sandreed. Whether the initial morpheme *soj-* in the Gabrielino word *soj-áxe-y* "tortilla" is cognate with SUA **sunu* or Hopi *sojowī* is uncertain, because the Gabrielino vowel *o* can reflect three different PUA vowels: ***o*, ***u*, and, most frequently, PUA ***i* (3, 4).

The Luiseño term *ša:xi-š* "grain, wheat" deviates both phonologically and semantically from the expected. If ***saki* existed as a PUA word, the Luiseño reflex should be *saki*, not *ša:xi*, because Luiseño *-x-* is a reflex of PUA ***k-* when ***k-* occurs before ***a* or ***o*, not before ***i* (5). Unequivocal cognates for **saki* exist only in the SUA languages, and the meanings attached to these cognates all relate to " parching" or " parched maize" (4, 6), which are absent in the gloss of Luiseño *ša:xi-š* as "grain, wheat." Similarly, the Tübatulabal term *paca:hil* "shelled pine nuts" lacks a maize association and is clearly related to the Tübatulabal verb *paca:h ~ ʔapaca:h* "to shell it" (7). It may not be cognate with the PUA term ***pa7ca*, which usually is reconstructed as ***paci* and analyzed as originally meaning "seed," not "maize kernel" (4). Here, as elsewhere, Hill derives the maize-related meanings she assigns to purported PUA terms exclusively from cognates in SUA languages such as Opatá and Classical Nahuatl.

The absence of more convincing sets of maize-related cognates in both NUA and SUA languages strongly suggests that the members of the PUA speech community did not cultivate maize. The proposal that the PUA homeland was located in Mesoamerica also is doubtful. Loanwords from Mesoamerican languages into PUA would provide compelling evidence for this location, but Hill's perspectives on the relationship between PUA and Otomanguean languages, based on very limited phonological and semantic resemblances (8), are highly speculative.

We concur with Hill that historical linguistic data alone cannot reveal the mechanisms for the dispersal of maize from Mesoamerica to the US Southwest. That is why we considered such data in conjunction with archaeological, paleoecological, and

human genetic data, all of which support the conclusion that maize agriculture was introduced to the US Southwest through group-to-group diffusion rather than the long-distance migration of Mesoamerican farmers.

To respond to Cecil H. Brown's comments (9) first requires clarifying three aspects of our perspectives on Uto-Aztec cultural history: (i) the kind of evidence upon which we base our proposal of a Great Basin homeland for the PUA speech community; (ii) the timing of the division of this community into NUA and SUA branches; and (iii) the location of SUA bands during the period when maize agriculture diffused from Mesoamerica to the southwestern United States.

We identify the Great Basin as the most likely location for the PUA speech community based upon both positive and negative evidence. The positive evidence is the mix of plants and animals for which PUA terms can be reconstructed, which is consistent with a homeland in the Great Basin as well as many other areas extending southward to Mesoamerica. To determine more specific possibilities for the PUA homeland within this vast area, we consider the distribution of the biological taxa for which PUA terms cannot be reconstructed, which include not only hot desert and tropical species but also "pinyon" and "oak." Given the nutritional potential of pine nuts and acorns, we regard the absence of PUA terms for "pinyon" and "oak" as strong, albeit negative, evidence that these taxa were absent in the PUA homeland. Of the areas between the western United States and Mesoamerica that included the biological taxa for which PUA terms exist, only the west central Great Basin also lacked both oaks and pinyons and only until ≈ 5500 cal. B.C., when pinyons began spreading northward from refugia along the southern edges of the basin (10).

We propose that the foraging bands that constituted the PUA speech community began migrating out of the Great Basin during a period of declining effective moisture that began there ≈ 6900 cal. B.C. The actual division of PUA into NUA and SUA branches could have occurred later, although we assume that it took place before NUA speakers encountered pinyons and developed a label for them. If the NUA speech community was located, as we suspect, near the southern Sierra Nevada, this encounter could have dated to as early as ≈ 5500 cal. B.C. We speculate that, following the NUA-SUA split, speakers of SUA dialects or languages migrated into the southwestern United States and northern Mexico and that they were the first Uto-Aztec (UA) speakers to acquire maize as it traveled northward via group-to-group diffusion from Mesoamerica. We do not assume, as Brown implies, that any SUA-speaking bands had reached Mesoamerica by the time that this diffusion got under way.

Brown's main concern is that our proposed time period for the breakup of the PUA speech community is so much earlier than the date of 2118 B.C. calculated within a recently modified approach to glottochronology [Automated Similarity Judgment

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Program (ASJP)]. Whether the dates for linguistic divergence generated within this new approach will be judged more reliable than those produced by earlier, discredited versions of glottochronology remains to be seen (11). We suspect that the diversification of the UA language family was more gradual than abrupt and that extensive, long-term linguistic interaction across UA dialect and language boundaries has maintained relatively high levels of similarity, lexical and otherwise, within the UA language family, which would produce an ASJP date for initial divergence more recent than when this divergence actually occurred.

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1. Hill JH (2010) New evidence for a Mesoamerican homeland for Proto-Uto-Aztecan. *Proc Natl Acad Sci USA* 107:E33.
2. Merrill WL, et al. (2009) The diffusion of maize to the southwestern United States and its impact. *Proc Natl Acad Sci USA* 106:21019–21026.
3. Munro P (1983) Selected studies in Uto-Aztecan phonology. *Int J Am Linguist* 49: 277–298.
4. Stubbs B (2008) *Uto-Aztecan: A Comparative Vocabulary* (Shumway, Yorba Linda, CA).
5. Manaster Ramer A (1993) On lenition in some northern Uto-Aztecan languages. *Int J Am Linguist* 59:334–341.
6. Hill JH (2004) *Memoirs of the Seventh International Conference on Linguistics in the Northwest* (Translated from Spanish), eds Morúa Leyva MdC, Ortiz Ciscomani RM (Universidad de Sonora, Hermosillo, Mexico), vol 2, pp 59–81.
7. Voegelin CF (1958) Working dictionary of Tübatulabal. *Int J Am Linguist* 24:221–228.
8. Hill JH (2008) *In Hot Pursuit of Language in Prehistory: Essays in the Four Fields of Anthropology in Honor of Harold Crane Fleming*, ed Bengtson JD (John Benjamins, Philadelphia), pp 309–320.
9. Brown CH (2010) Lack of linguistic support for Proto-Uto-Aztecan at 8900 BP. *Proc Natl Acad Sci USA* 107:E34.
10. Madsen DB (1986) *Anthropology of the Desert West*, eds Condie CJ, Fowler DD, University of Utah Anthropological Papers 110:21–41.
11. Campbell L (1998) *Historical Linguistics: An Introduction* (MIT Press, Cambridge, MA).