The Paleobiolinguistics of the Common Bean (*Phaseolus vulgaris* L.)

Cecil H. Brown[1*], Charles R. Clement[2], Patience Epps[3], Eike Luedeling[4], and Søren Wichmann[5]

Author address: [1]1700 Scenic Highway, #601, Pensacola, FL, 32503-6634, USA (institutional affiliation: Northern Illinois University). [2]Instituto Nacional de Pesquisas da Amazônia, Manaus, AM, Brazil. [3]University of Texas at Austin, Austin, TX, USA. [4]World Agroforestry Centre (ICRAF), Nairobi, Kenya. [5]Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany, and Kazan Federal University, Kazan, Russia.
[*]Corresponding author: brown.cecil@yahoo.com

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Abstract: *Paleobiolinguistics is used to determine when and where the common bean (*Phaseolus vulgaris L.*) developed significance for prehistoric groups of Native America. Dates and locations of proto-languages for which common bean terms reconstruct generally accord with crop-origin and dispersal information from plant genetics and archaeobotany. Paleobiolinguistic and other lines of evidence indicate that human interest in the common bean became significant primarily with the widespread development of a village-farming way of life in the New World rather than earlier when squash and maize and a few other crops became important.*

Keywords: Archaeobotany, crop origins, historical linguistics, Native Americans, paleobiolinguistics, plant domestication, plant genetics

Paleobiolinguistics (PBL) employs the comparative method of historical linguistics to reconstruct the biodiversity known to human groups of the unrecorded past (Brown et al. 2013a).[1] Comparison of words for biological taxa from languages of the same language family facilitates reconstruction of the biological vocabulary of the family's ancient proto-language. This study uses PBL to establish when and where the common bean (*Phaseolus vulgaris* L.) developed significance for different prehistoric groups of Native America. This entails mapping in both time and geographic space proto-languages for which words for the common bean reconstruct. This information is provided to supplement crop-origin studies of the taxon from genetics and archaeology.

As the most important legume domesticated in the New World, and a member of the widespread Native American agricultural triad of maize (*Zea mays* L.), squash (*Cucurbita* spp.), and beans, considerable multidisciplinary attention has been directed to the common bean's origin, domestication, and dispersal. Included within this effort is the first PBL analysis of the species (Brown 2006), which focused primarily on North and Central America, with inclusion of only four language groups south of Panama. Since 2006, automated methods for dating and locating proto-languages have been developed and are employed here, rendering the present study the most up-to-date and definitive PBL treatment currently possible. The present study of bean also advances the earlier investigation by expanding the number of proto-languages treated, especially augmenting the pool of proto-languages from South America.

The genus *Phaseolus* contains about 70 species in the Neotropics, with greatest species diversity to the north (Freytag and Debouck 2002). Five species contain domesticated populations: *P. acutifolius* A. Gray (tepary bean); *P. coccineus* L. (scarlet runner bean); *P. lunatus* L. (lima bean); *P. polyanthus* Greenman (year bean); *P. vulgaris* L. (common bean). Wild populations of *P. vulgaris* L. and *P. lunatus* L. are amply distributed along the edges of the highlands of western North America through to western South America, mostly in the tropics but also somewhat further north and south (Debouck and Smartt 1995). Both were domesticated at least twice, once in the Andes and once in Mexico (Debouck and Smartt 1995, Chacón et al. 2005, 2007, 2012, Mamidi et al. 2011, Schmutz et al. 2014). Domestication of Peruvian *P. vulgaris* occurred in the Andean foothills of southern Peru on the eastern slopes (Chacón et al. 2005). Domestication of Mexican *P. vulgaris* occurred in the Río Lerma–Río Grande de Santiago basin in west-central Mexico (Kwak et al. 2009), north of the Balsas River valley

Table 1. Earliest macro-botanical evidence for common bean in various locations.

Years BP	Location	Reporting Source
4337	Peru: Guitarrero Cave	Kaplan and Lynch 1999
3100	Mexico: Chiapas, Mazatán region	Clark 1994, Blake et al. 1995, Brown 2006
2285	Mexico: Tehuacán, Coxcatlán Cave	Kaplan and Lynch 1999
2200	U.S.: Southwest, Bat Cave, Tularosa Cave	Wills 1988, Kaplan and Lynch 1999
2098	Mexico: Valley of Oaxaca	Kaplan and Lynch 1999
1285	Mexico: Tamaulipas	Kaplan and Lynch 1999
1168	Mexico: Durango, Rio Zape	Kaplan and Lynch 1999
850	U.S.: Eastern North America west of the Mississippi	Adair 2003, Asch and Hart 2004
700	U.S. Eastern North America east of the Mississippi	Hart and Scarry 1999, Hart et al. 2002

where maize was domesticated (Buckler and Stevens 2006).

Table 1 cites the earliest macro-botanical remains of common bean uncovered by archaeology in various parts of the Americas ranging from the eastern U.S. to Peru.[2] The macro-botanical evidence from Peru is considerably earlier than that from Mexico, with a date of 4337 BP at Guitarrero Cave (Kaplan and Lynch 1999), several hundred kilometers northwest of its center of origin and on the western side of the Andes. In fact, domestication may have occurred even earlier in the region. Micro-botanical

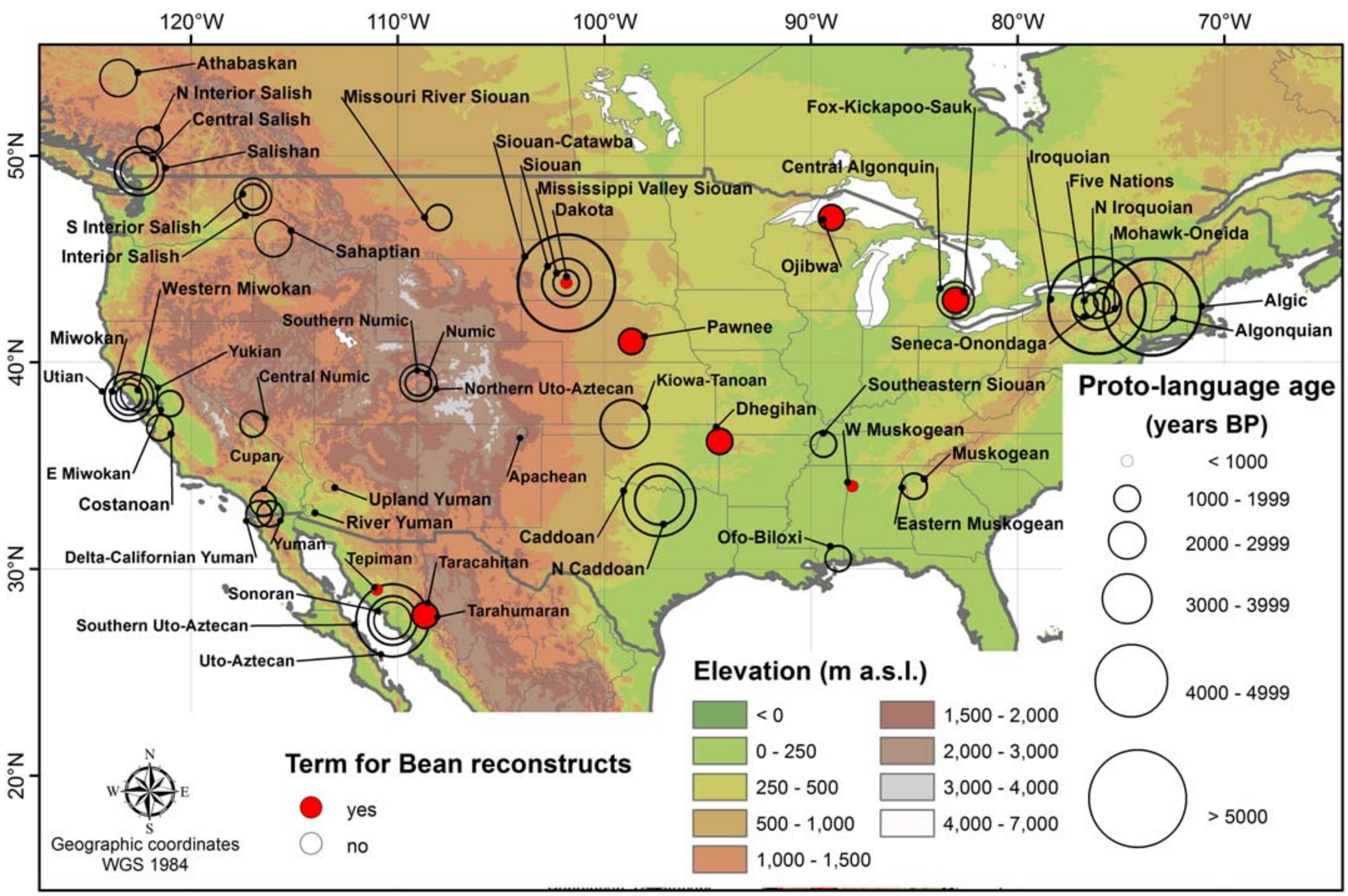

Figure 1. Bean-term reconstruction information from Table 2 plotted on map of North America.

Table 2. Bean-term reconstruction for proto-languages of North America and Northern Mexico.

Years Before Present	Proto-Language	Proto-Word for Bean (NR = Not Reconstructable)	Homeland Center Geographic Coordinates	Family Affiliation	Proto-Word Source
6178	Siouan-Catawba	NR	43.83 -101.83	Siouan-Catawba	
5944	Iroquoian	NR	42.75 -76.17	Iroquoian	
5554	Algic	NR	42.67 -73.5	Algic	
4828	Caddoan	NR	33.33 -97.33	Caddoan	
4018	Uto-Aztecan	NR	27.5 -110.25	Uto-Aztecan	
3827	Salishan	NR	49.25 -122.5	Salishan	
3663	Utian	NR	38.33 -123	Utian	
3472	Southern Uto-Aztecan	NR	27.5 -110.25	Uto-Aztecan	
3434	Kiowa-Tanoan	NR	37 -99	Kiowa-Tanoan	
3343	Algonquian	NR	42.67 -73.5	Algic	
3176	N Iroquoian	NR	42.75 -76.17	Iroquoian	
3169	Siouan	NR	43.83 -101.83	Siouan-Catawba	
3035	N Caddoan	NR	33.33 -97.33	Caddoan	
2980	Interior Salish	NR	48 -117	Salishan	
2725	Sahaptian	NR	46 -116	Sahaptian	
2678	Central Algonquin	NR	43 -83	Algic	
2576	Northern Uto-Aztecan	NR	39 -109	Uto-Aztecan	
2500	Yukian	NR	38.5 -122.5	Yukian	
2459	Central Salish	NR	49.25 -122.5	Salishan	
2400	Sonoran	NR	27.5 -110.25	Uto-Aztecan	
2141	Miwokan	NR	38.33 -123	Utian	
2062	Athabaskan	NR	53.75 -123.5	Athabaskan	
1926	Southeastern Siouan	NR	36.03 -89.39	Siouan-Catawba	
1865	Yuman	NR	32.67 -116.17	Yuman	
1864	N Interior Salish	NR	50.75 -122	Salishan	
1850	Missouri River Siouan	NR	47 -108	Siouan-Catawba	
1839	Ofo-Biloxi	NR	30.5 -88.67	Siouan-Catawba	
1827	Taracahitan	*muni	27.75 -108.67	Uto-Aztecan	Authors
1809	Pawnee	*atit	41 -98.67	Caddoan	Authors
1798	Mississippi Valley Siouan	NR	43.83 -101.83	Siouan-Catawba	
1737	Numic	NR	39 -109	Uto-Aztecan	
1724	S Interior Salish	NR	48 -117	Salishan	
1720	Muskogean	NR	34 -85	Muskogean	
1673	Five Nations	NR	42.75 -76.17	Iroquoian	
1587	Cupan	NR	33.17 -116.5	Uto-Aztecan	
1573	Southern Numic	NR	39 -109	Uto-Aztecan	
1526	Fox-Kickapoo-Sauk	*maskočis	43 -83	Algic	Authors
1378	Mohawk-Onieda	NR	43.5 -74.25	Iroquoian	
1297	Costanoan	NR	36.83 -121.5	Utian	
1295	Ojibwa	*miskodisimin	47 -89	Algic	Authors
1245	Delta-Californian Yuman	NR	32.67 -116.7	Yuman	
1241	E Miwokan	NR	38 -121	Utian	
1234	Western Miwokan	NR	38.33 -123	Utian	
1213	Tarahumaran	*muni	27.75 -108.67	Uto-Aztecan	1
1188	Eastern Muskogean	NR	34 -85	Muskogean	

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Years Before Present	Proto-Language	Proto-Word for Bean (NR = Not Reconstructable)	Homeland Center Geographic Coordinates	Family Affiliation	Proto-Word Source
1173	Seneca-Onondaga	NR	42.75 -76.75	Iroquoian	
1148	Central Numic	NR	37 -117	Uto-Aztecan	
1005	Dhegihan	*hǫbrį́ke	36.17 -94.42	Siouan-Catawba	2
899	Tepiman	*bavi	29 -111	Uto-Aztecan	1, 3
820	Upland Yuman	NR	34 -113.33	Yuman	
737	Dakota	*omnį́ča	43.83 -101.83	Siouan-Catawba	2
718	Apachean	NR	36.58 -104	Athabaskan	
534	River Yuman	NR	32.83 -114.33	Yuman	
345	W Muskogean	*bala’	34 -88	Muskogean	Authors

Proto-Word Source:
1. Stubbs 2011
2. Carter et al. 2006
3. Bascom 1965

evidence from starch grains found in northwestern Peru and attributed to domesticated *Phaseolus* were dated to between 9000 and 7500 BP (Piperno and Dillehay 2008), which is consistent with new genetic modeling of the domestication event in Peru indicating a beginning at 8500 BP, with the bottleneck extending to 7000 BP (Mamidi et al. 2011). Piperno and Dillehay could not conclusively distinguish between *P. vulgaris* and *P. lunatus*, but since the earliest date for *P. lunatus* macro-botanical remains is 3495 BP (Kaplan and Lynch 1999), the NW Peru micro-fossil find may well be the common bean.

The earliest unambiguous macro-botanical evidence for the common bean from Mexico, dated to 2285 BP, was recovered from Coxcatlán Cave in the Tehuacán Valley (Kaplan and Lynch 1999), 600-800 km east southeast of bean's Mexican center of domestication cited above. Macro-botanical remains of approximately the same age (2098 BP) have been uncovered in the Valley of Oaxaca (Kaplan and Lynch 1999), another 100-200 km or so to the east. However, a *Phaseolus* specimen dated to around 3100 BP has been retrieved in the Mazatán region of Chiapas in southern Mexico and may be the oldest macro-remains of *P. vulgaris* in Mexico, although identification to species is not entirely certain (cf. Brown 2006:514). These dates are much later than the genetic model for the Mexican domestication event of common bean, which started at 8200 BP, with the bottleneck extending to 6300 BP (Mamidi et al. 2011). Micro-botanical remains from Mexico have yet to yield dates as old as those reported from Peru (Piperno and Dillehay 2008).[3]

Macro-remains document the presence of bean in northeast Mexico (in Tamaulipas) at 1285 BP and its arrival to the American Southwest no later than 2200 BP (Smith 2001). Earliest macro-botanical dates for the eastern US are 850 BP and 700 BP for respective sites west and east of the Mississippi river (Table 1).

Common bean-term reconstructions are presented for proto-languages of three major regions of the New World: (1) North America and Northern Mexico (Table 2); (2) Southern Mexico and Northern Central America (henceforth Mesoamerica) (Table 3); (3) Southern Central America and South America (Table 4). Tables 2-4 list major proto-languages of the Americas widely regarded by historical linguists as demonstrated. Some major proto-languages are not included, because lexical information from daughter languages is not sufficiently available for drawing either positive or negative conclusions about reconstruction. In addition to identifying proto-languages with common bean terms and the terms themselves, the tables report proto-languages for which these terms are "not reconstructable" (NR). NR is a designation used when terms for the common bean are present in all or most languages of a family, but, nonetheless, are not cognate and, hence, do not attest to a term in their shared ancestral language. NR, then, never indicates non-reconstructibility because of missing data.[4]

Because of the failure of many consulted sources, such as dictionaries, to distinguish species of *Capsicum*

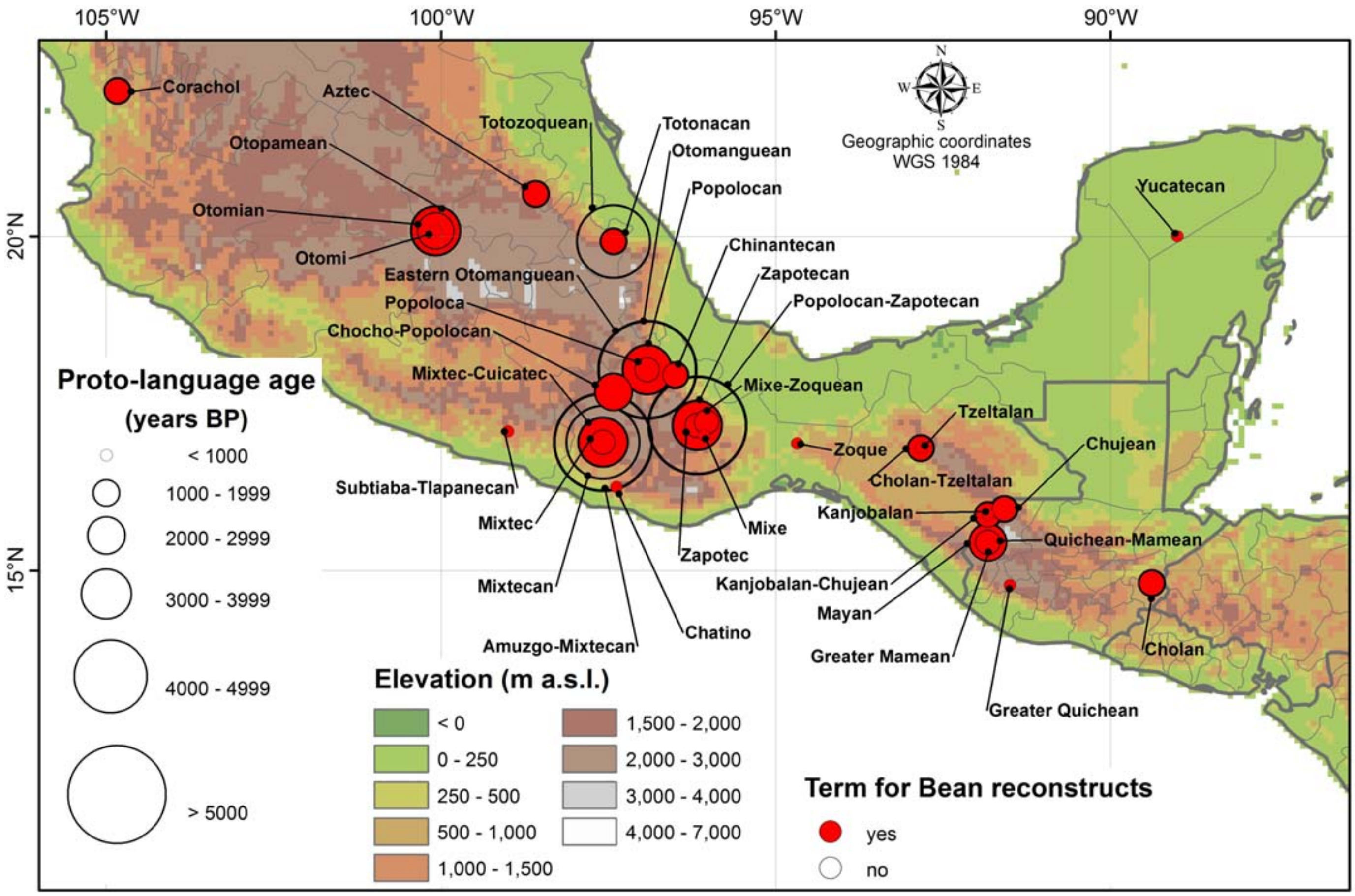

Figure 2. Bean-term reconstruction information from Table 3 plotted on map of Mesoamerica.

designated by words in Native American languages, Brown et al. (2013b) were unable to reconstruct referents of proto-terms for chili pepper to species. In the case of *Phaseolus*, species ambiguity in sources is somewhat problematic as well but not as extensively so. For example, when a native term for a *Phaseolus* species is translated in sources by English *bean* or Spanish *frijol*, that species is typically *P. vulgaris*. When more than one *Phaseolus* species is reported, terms used in translation for species other than *P. vulgaris* are usually linguistically marked, e.g., English *lima bean* or Spanish *frijol blanco* (both *P. lunatus*). In English, of course, *bean* (unmarked) can denote *P. lunatus* as well as *P. vulgaris*, but it would be extraordinary to find in any variety of the language that *bean* refers to *P. lunatus* without also being used to denote *P. vulgaris*. Whatever the details relating to individual languages, we are reasonably confident that all reconstructed words presented here denoted *P. vulgaris*.

Dates for proto-languages presented in the tables are intended to be the latest dates at which these languages were spoken (just before breaking up into daughter languages). These are calculated through use of Automated Similarity Judgment Program (ASJP) chronology, a computational dating approach based on the lexical similarity of languages (Holman et al. 2011).[5] Possible geographic coordinates for proto-language homeland centers given in the tables are produced through automation using an algorithm for identifying the maximum lexical diversity within a language family (Wichmann et al. 2010). The geographic center of lexical diversity of a family is assumed to correlate with where the family's proto-language was spoken. Tables also give a linguistic family affiliation for each proto-language. The information reported in Tables 2, 3 and 4 is plotted respectively on maps of Figures 1, 2 and 3 to give a visual perspective on both the chronological and geographic distributions of reconstructed bean terms.

Archaeological and PBL evidence for the common bean are broadly, but far from perfectly, in accord. Both macro-botanical dates and PBL dates for

Table 3. Bean-term reconstruction for proto-languages of Mesoamerica (Southern Mexico and Northern Central America).

Years Before Present	Proto-Language	Proto-Word for Bean (NR = Not Reconstructable)	Homeland Center Geographic Coordinates	Family Affiliation	Proto-Word Source
6591	Otomanguean	NR	18 -96.92	Otomanguean	
5976	Eastern Otomanguean	NR	18 -96.92	Otomanguean	
5498	Popolocan-Zapotecan	NR	17.17 -96.17	Otomanguean	
5357	Amuzgo-Mixtecan	NR	16.92 -97.58	Otomanguean	
4542	Mixtecan	NR	16.92 -97.58	Otomanguean	
4274	Totozoquean	NR	19.92 -97.42	Totozoquean	
3654	Otopamean	*khiHC-ʔ	20.08 -100.08	Otomanguean	1
3149	Zapotecan	*(kwe-)sa:ʔ	17.17 -96.17	Otomanguean	2
3140	Mixtec-Cuicatec	*^{n}du-^{n}de	16.92 -97.58	Otomanguean	3
3036	Popolocan	*hmaʔ	18 -96.92	Otomanguean	4
2220	Mayan	*keenaq'	15.42 -91.83	Mayan	5
2214	Otomian	*-jü	20.08 -100.08	Otomanguean	Authors
2209	Chocho-Popolocan	*hmaʔ	17.67 -97.42	Otomanguean	Authors
1935	Chinantecan	*hniu:^{L}	17.92 -96.5	Otomanguean	6
1783	Popoloca	*hmaš	18 -96.92	Otomanguean	Authors
1676	Zapotec	*(kwe-)sa:ʔ	17.17 -96.17	Otomanguean	2
1649	Quichean-Mamean	*keenaq'	15.42 -91.83	Mayan	5
1596	Mixe-Zoquean	*sɨk	17.22 -96.03	Totozoquean	7
1492	Greater Mamean	*keenaq'	15.42 -91.83	Mayan	5
1437	Mixtec	*^{n}dutiʔ, nditi	16.92 -97.58	Otomanguean	8
1435	Totonacan	*stápu	19.92 -97.42	Totozoquean	9
1432	Cholan-Tzeltalan	*chenek'	16.83 -92.83	Mayan	5
1225	Kanjobalan-Chujean	*tu't	15.83 -91.83	Mayan	10
1198	Corachol	*muume	22.17 -104.83	Uto-Aztecan	Authors
1186	Aztec	*ee-	20.63 -98.58	Uto-Aztecan	11
1148	Cholan	*chenek', *b'u'ul	14.81 -89.38	Mayan	5,10
1058	Chujean	*tut	15.92 -91.58	Mayan	10
997	Chatino	*n-taa	16.25 -97.38	Otomanguean	2
981	Greater Quichean	*kenaq'	14.78 -91.5	Mayan	5
948	Subtiaba-Tlapanecan	*yaha	17.08 -99	Otomanguean	Authors
900	Mixe	*sɨhk	17.02 -96.07	Totozoquean	7
802	Kanjobalan	*hub'al	15.83 -91.83	Mayan	10
790	Yucatecan	*b'u'ul	20 -89	Mayan	10
787	Zoque	*sɨk	16.9 -94.68	Totozoquean	7
741	Otomi	*jü	20.08 -100.08	Otomanguean	Authors
511	Tzeltalan	*chenek'	16.83 -92.83	Mayan	5

Proto-Word Source:
1. Bartholomew 1965
2. Campbell 2013
3. Rensch 1976
4. Gudschinsky 1958
5. Wichmann and Brown 2011
6. Rensch 1989
7. Wichmann 1995
8. Josserand 1983
9. Brown et al. 2011
10. Brown 2006
11. Merrill 2012

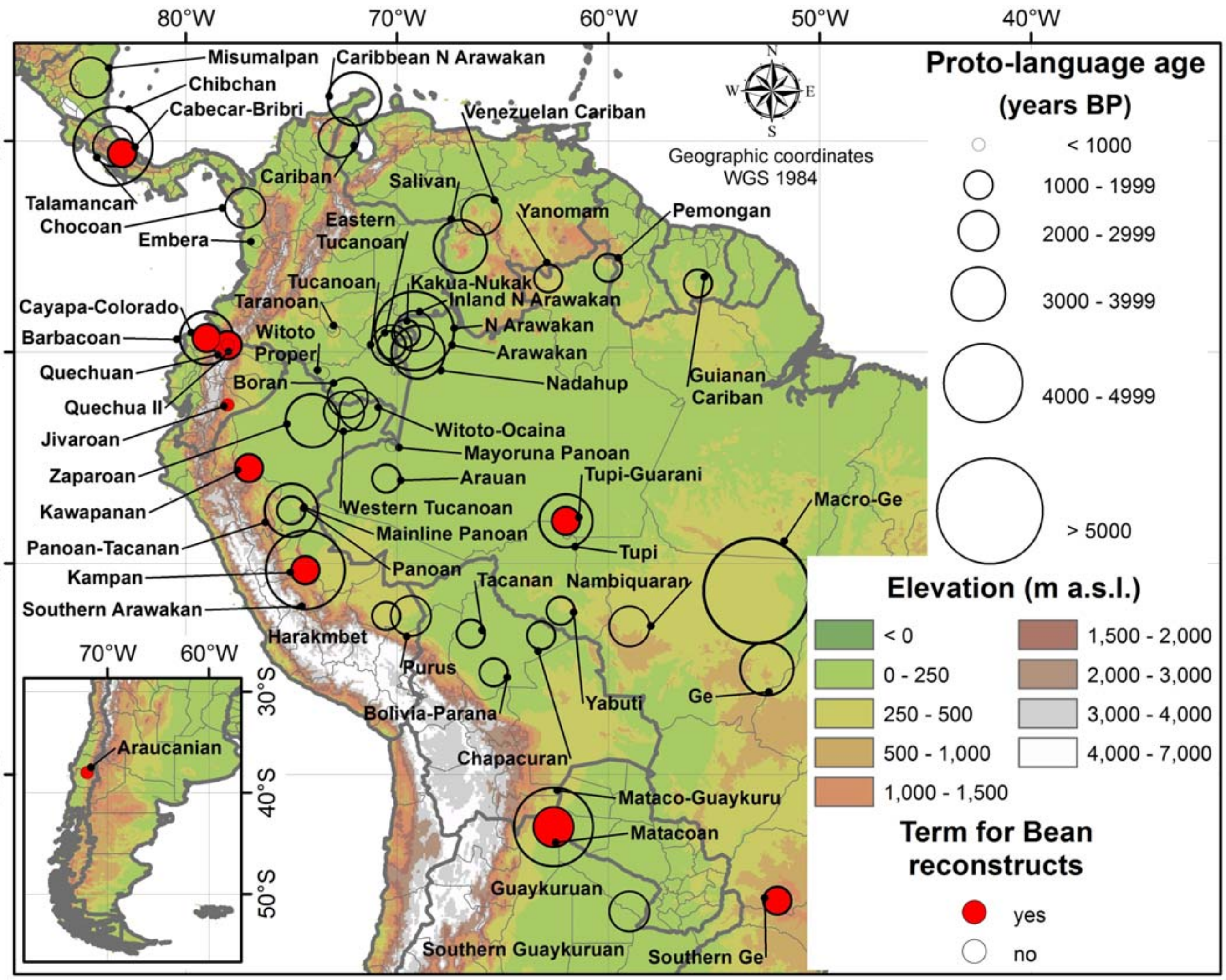

Figure 3. Bean-term reconstruction information from Table 4 plotted on map of Southern Central America and South America.

the eastern US region are the latest in each category for the entire Americas (see respectively Tables 1 and 2). In Mexico, the earliest possible archaeological date for common bean is 3100 BP (Table 1), and the earliest PBL date is 3654 BP (Table 3), dates that are reasonably chronologically close.

PBL chronological determinations for the common bean in southern Mexico are substantially later than those indicated for the four other crops investigated thus far through PBL analysis, i.e., squash, chili pepper, manioc, and maize (respectively Brown et al. 2013a, b, c, and 2014). Words for the latter four reconstruct for Proto-Otomanguean, but a term for the common bean does not. Proto-Otomanguean is the oldest demonstrated ancestral language of the New World (6591 BP). The oldest Mesoamerican proto-language having a term for *P. vulgaris*, Proto-Otopamean (a daughter language of Proto-Otomanguean), dates to 3654 BP (see Table 3 and Figure 2). This and archaeological evidence cited by Smith (2001) suggest that the common bean is the latest addition to the widespread Native American triad of major crops, squash, maize, and common bean. Bean has the distinction of being the only member of the triad not to have developed significance for prehistoric groups, as measured by paleobiolinguistics, before the widespread development of a village-farming way of life in the New World. This may relate to the transition from hunting and gathering (in which protein was commonly obtained from a broad spectrum of plant and animal resources) to an increasingly sedentary lifestyle. As lysine-deficient

Table 4. Bean-term reconstruction for proto-languages of Southern Central America and South America.

Years Before Present	Proto-Language	Proto-Word for Bean (NR = Not Reconstructable)	Homeland Center Geographic Coordinates	Family Affiliation	Proto-Word Source
7266	Macro-Ge	NR	-11.3 -53	Macro-Ge	
4701	Mataco-Guaykuru	NR	-22.5 -62.58	Mataco-Guaykuru	
4461	Southern Arawakan	NR	-10.33 -74.33	Arawakan	
4400	Chibchan	NR	9.75 -83.42	Chibchan	
4134	Arawakan	NR	1 -69.17	Arawakan	
4085	N Arawakan	NR	1 -69.17	Arawakan	
3943	Panoan-Tacanan	NR	-7.5 -75	Panoan-Tacanan	
3585	Tupi	NR	-8 -62	Tupi	
3518	Caribbean N Arawakan	NR	12 -72	Arawakan	
3310	Salivan	NR	5 -67	Salivan	
3241	Barbacoan	NR	0.67 -79	Barbacoan	
3178	Zaparoan	NR	-3.25 -74	Zaparoan	
3124	Nadahup	NR	0 -69	Nadahup	
3023	Ge	NR	-15 -52.5	Macro-Ge	
2909	Guaykuruan	NR	-26.5 -59	Mataco-Guaykuru	
2903	Witoto-Ocaina	NR	-2.75 -71.75	Witoto-Ocaina	
2807	Nambiquaran	NR	-13 -59	Nambiquaran	
2774	Misumalpan	NR	13 -84.5	Misumalpan	
2731	Talamancan	NR	9.75 -83.42	Chibchan	
2699	Tucanoan	NR	0.33 -70.25	Tucanoan	
2593	Inland N Arawakan	NR	1 -69.17	Arawakan	
2503	Venezuelan Cariban	NR	6.5 -66	Cariban	
2433	Southern Guaykuruan	NR	-26.5 -59	Mataco-Guaykuru	
2412	Cariban	NR	10.17 -72.75	Cariban	
2404	Matacoan	*anhetaʃ	-22.5 -62.58	Mataco-Guaykuru	Authors
2271	Boran	NR	-2.17 -72.33	Boran	
2258	Chocoan	NR	6.83 -77.17	Chocoan	
2219	Purus	NR	-12.5 -69.33	Arawakan	
2156	Western Tucanoan	NR	-2.83 -72.5	Tucanoan	
1931	Chapacuran	NR	-13.42 -63.17	Chapacuran	
1875	Southern Ge	*rãgrɔ	-26 -52	Macro-Ge	1
1764	Arauan	NR	-6 -70.5	Arauan	
1717	Quechuan	*purutu	0.33 -78	Quechuan	2
1672	Panoan	NR	-7.5 -75	Panoan-Tacanan	
1647	Bolivia-Parana	NR	-15.17 -65.42	Arawakan	
1634	Mainline Panoan	NR	-7.5 -75	Panoan-Tacanan	
1607	Yabuti	NR	-12.25 -62.25	Macro-Ge	
1590	Tacanan	NR	-13.33 -66.5	Panoan-Tacanan	
1569	Harakmbet	NR	-12.5 -70.5	Harakmbet	
1550	Tupi-Guarani	*kumana	-8 -62	Tupi	3
1519	Kampan	*maroro	-10.33 -74.33	Arawakan	
1418	Cayapa-Colorado	*molo	0.67 -79	Barbacoan	4
1402	Guianan Cariban	NR	3.25 -55.75	Cariban	
1395	Cabecar-Bribri	*atu-	9.42 -83	Chibchan	Authors

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Years Before Present	Proto-Language	Proto-Word for Bean (NR = Not Reconstructable)	Homeland Center Geographic Coordinates	Family Affiliation	Proto-Word Source
1335	Kakua-Nukak	NR	0.88 -69.56	Kakua-Nukak	
1319	Yanomam	NR	3.5 -62.83	Yanomam	
1241	Eastern Tucanoan	NR	0.33 -70.25	Tucanoan	
1185	Kawapanan	*makira	-5.5 -77	Kawapanan	5
1169	Pemongan	NR	4 -60	Cariban	
992	Taranoan	NR	1 -73	Cariban	
974	Quechua II	*purutu	0.33 -78	Quechuan	2
875	Embera	NR	5.25 -76.66	Chocoan	
678	Jivaroan	*miik	-2.5 -78	Jivaroan	Authors
609	Araucanian	*deŋɨlʸ	-38 -72	Araucanian	Authors
414	Witoto Proper	NR	-1 -73.5	Witoto-Ocaina	
389	Mayoruna Panoan	NR	-4.42 -70.25	Panoan-Tacanan	

Proto-Word Source:
1. Marcel Pinho de Valhery Jolkesky 2010
2. Willem Adelaar, personal communication
3. Mello 2000
4. Moore 1962
5. Pilar Valenzuela, personal communication

maize became a staple, the lysine-abundant bean would have become progressively more important.

The picture for South America is somewhat more discordant with an earliest macro-botanical date of 4437 BP (Table 1) and an earliest PBL date of 2404 BP (Table 4). The micro-botanical and genetic-model dates are considerably older, at circa 8500-7000 BP. At present, we offer no explanation for this discordance other than the observation that *P. vulgaris* apparently did not develop widespread, significant salience for groups in South America until thousands of years after it was domesticated in the area.

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Conflicts of interest: None declared.

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Biosketch

Cecil H. Brown is a linguistic anthropologist with interests in ethnobiology, historical linguistics, and Native American languages.

Charles R. Clement is a geneticist studying the origin and domestication of native Amazonian crops, and the ethnobotany associated with anthropogenic soils and other domesticated landscapes.

Patience Epps is a linguist whose work investigates lowland South American languages from historical, typological, and descriptive perspectives.

Eike Luedeling is an agricultural scientist mainly concerned with projection of climate change impacts on agricultural and natural ecosystems and with the development of appropriate adaptation strategies.

Søren Wichmann specializes in quantitative methods in historical linguistics and Mesoamerican languages. He is General Editor of the journal *Language Dynamics and Change*.

Notes

[1]This is the fourth PBL study published in *Ethnobiology Letters*, the first treating chili pepper (Brown et al. 2013b), the second manioc (Brown et al. 2013c), and the third maize (Brown et al. 2014). The method and theory of PBL (and the PBL of squash) is discussed in detail in Brown et al. (2013a) and briefly summarized in Brown et al. (2013b). Given this coverage, a discussion of PBL method and theory will not be repeated here.

[2]Archaeological dates cited in this paper come from various different sources, some firsthand, others second-party reports. Some are direct radiocarbon dates and some indirect, and it is often difficult if not

impossible to determine if calibration is involved. We report all dates as if they were non-calibrated, calendric dates.

[3]PBL and archaeological evidence are in sharp disagreement with dates indicated by the new genetic modeling for the domestication of the common bean in Mexico (Mamidi et al. 2011). Unlike archaeological evidence that can be precisely dated with modern techniques, both PBL and genetic modeling have large variances around the estimated dates, and these variances increase in magnitude as the mean recedes into the past. The new genetic model does not use macro-botanical remains of common bean for calibration (Mamidi et al. 2011), as suggested by van Etten and Hijmans (2010), so these dates may be modified significantly with calibration.

[4]NR should not necessarily be interpreted as indicating that a term for common bean did not pertain to a proto-language and, by implication, that people who spoke the language were not familiar with the taxon. Another possibility is that a bean term did indeed pertain to a proto-language, but that its referent was not especially salient, accounting for the term's failure to survive in offspring languages and, thus, to be reconstructable for the proto-language (cf., Brown et al. 2013a:140).

[5]Occasionally, an ASJP date for a proto-language may be older than a date for its own parent language. For example, Proto-Southern Arawakan (4461 BP) has an ASJP date older than that for Proto-Arawakan (4134 BP). This sometimes occurs in ASJP chronology when a language group's breakup is closely followed in time by the breakup of its immediate subgroup. The attested variability of ASJP dates accounts for this apparent aberrancy (Holman et al. 2011:872).