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The Paleobiolinguistics of Maize (*Zea mays* L.)

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Abstract: *Paleobiolinguistics is used to determine when and where maize (*Zea mays *L.) developed significance for different prehistoric groups of Native America. Dates and locations of proto-languages for which maize 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 maize was extensive millennia before the widespread development of a village-farming way of life in the New World.*

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 maize (*Zea mays* 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 maize reconstruct.

This information is provided to supplement crop-origin studies of maize from genetics and archaeology. Our paper's primary purpose is to supply PBL data for use by scholars directly and intimately focused on maize origin and dispersal. We do not attempt to flesh out nuanced implications of PBL results, but instead offer only the most general interpretation of our findings for understanding developments in the prehistory of maize, leaving consideration of details suggested by PBL to experts dedicated to the taxon. Our limited interpretive approach continues a practice followed in presentation of PBL data relating to chili pepper and manioc published in preceding *Ethnobiology Letters* papers (respectively, Brown et al. 2013b and Brown et al. 2013c).[2]

Being the most important cereal crop domesticated in the New World, substantial multidisciplinary attention has been directed to maize's origin, domestication, and dispersal, much of which is covered in a comprehensive anthology by Staller et al. (2006). Among papers included in Staller et al.'s book is Brown (2006a), an early application of the PBL approach that was neither computer-assisted nor provided proto-language homeland cartography. Since the appearance of the latter, software-based 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 possible. The present study also advances the earlier investigation (Brown 2006a) by expanding the number of proto-languages treated, especially augmenting the pool of proto-languages from South America.

All five species of *Zea* are native to Mexico and Central America (Buckler and Stevens 2006). *Zea mays* contains the domesticated populations of maize (*Zea mays* ssp. *mays*), its wild ancestor (ssp. *parviglumis*), and two other subspecies that hybridize with other populations but do not contribute significantly to the

Table 1. Maize-term reconstruction for proto-languages of North America and Northern Mexico.

Years Before Present	Proto-Language	Proto-Word for Maize (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	*suŋu	27.5 -110.25	Uto-Aztecan	1
3827	Salishan	NR	49.25 -122.5	Salishan	
3663	Utian	NR	38.33 -123	Utian	
3472	Southern Uto-Aztecan	*sunu	27.5 -110.25	Uto-Aztecan	1
3434	Kiowa-Tanoan	*ʔia, *pʼəa	37 -99	Kiowa-Tanoan	2, 3
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	*kuma	39 -109	Uto-Aztecan	3
2500	Yukian	NR	38.5 -122.5	Yukian	
2459	Central Salish	NR	49.25 -122.5	Salishan	
2400	Sonoran	*sunu	27.5 -110.25	Uto-Aztecan	1
2062	Athabaskan	NR	53.75 -123.5	Athabaskan	
1926	Southeastern Siouan	NR	36.03 -89.39	Siouan-Catawba	
1865	Yuman	*tayač	32.67 -116.17	Yuman	Authors
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	*sunu	27.75 -108.67	Uto-Aztecan	1
1809	Pawnee	NR	41 -98.67	Caddoan	
1798	Mississippi Valley Siouan	NR	43.83 -101.83	Siouan-Catawba	
1737	Numic	*kum-	39 -109	Uto-Aztecan	3
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	*kum-	39 -109	Uto-Aztecan	3
1526	Fox-Kickapoo-Sauk	NR	43 -83	Algic	
1378	Mohawk-Oneida	NR	43 -75.67	Iroquoian	
1295	Ojibwa	*mandaamin	47 -89	Algic	Authors
1245	Delta-Californian Yuman	NR	32.67 -116.7	Yuman	
1241	E Miwokan	NR	38 -121	Utian	
1213	Tarahumaran	*sunu	27.75 -108.67	Uto-Aztecan	1
1188	Eastern Muskogean	NR	34 -85	Muskogean	
1173	Seneca-Onondaga	NR	42.75 -76.75	Iroquoian	
1148	Central Numic	*kum-	37 -117	Uto-Aztecan	3
1005	Dhegihan	*wathą́se, *hápa	36.17 -94.42	Siouan-Catawba	4
899	Tepiman	*hunu	29 -111	Uto-Aztecan	1

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Years Before Present	Proto-Language	Proto-Word for Maize (NR = Not Reconstructable)	Homeland Center Geographic Coordinates	Family Affiliation	Proto-Word Source
820	Upland Yuman	*tayač	34 -113.33	Yuman	Authors
737	Dakota	*wahú-apa	43.83 -101.83	Siouan-Catawba	4
718	Apachean	*naadaa	36.58 -104	Athabaskan	Authors
534	River Yuman	*tadič	32.83 -114.33	Yuman	Authors
436	Alabama-Koasati	*čassi	32.33 -87.41	Muskogean	Authors
384	Tewa	*khú-	35.83 -110.42	Kiowa-Tanoan	Authors
345	W Muskogean	*tanči?	34 -88	Muskogean	Authors

Proto-Word Source:
1. Stubbs 2011
2. Davis 1989
3. Hill 2008
4. Carter et al. In Preparation

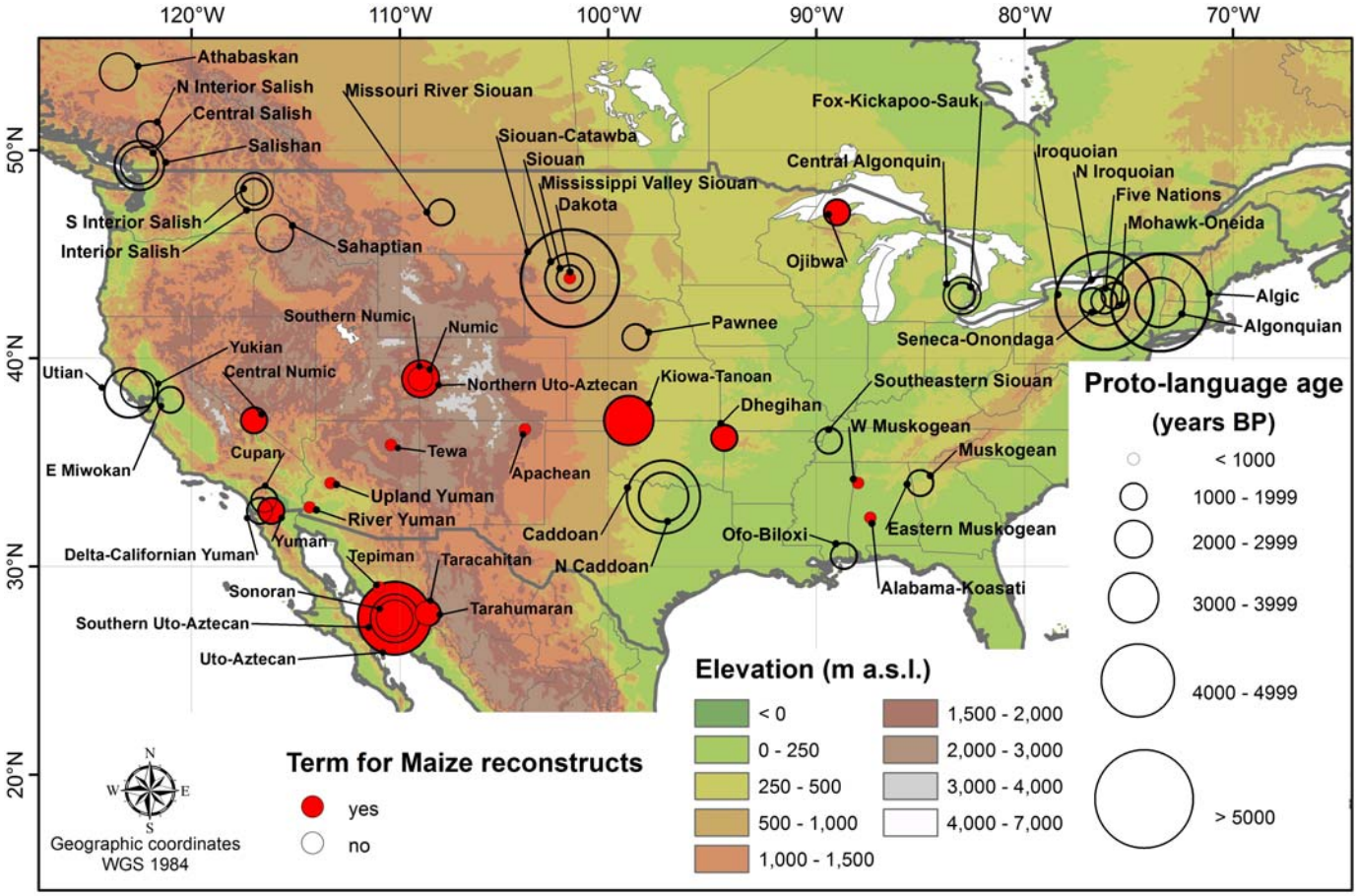

Figure 1. Maize-term reconstruction information from Table 1 plotted on map of North America.

Table 2. Maize-term reconstruction for proto-languages of Mesoamerica (Southern Mexico and Northern Central America).

Years Before Present	Proto-Language	Proto-Word for Maize (NR = Not Reconstructable)	Homeland Center Geographic Coordinates	Family Affiliation	Proto-Word Source
6591	Otomanguean	*k^{w}au, *s(a7)ai(n), *nu	18 -96.92	Otomanguean	1
5498	Popolocan-Zapotecan	*nu-	17.17 -96.17	Otomanguean	Authors
5357	Amuzgo-Mixtecan	*nu-	16.92 -97.58	Otomanguean	Authors
4542	Mixtecan	*ndi-Θe(m)34	16.92 -97.58	Otomanguean	2
4274	Totozoquen	*k^{y}ušI ~ *k^{y}i's	19.92 -97.42	Totozoquean	3
3654	Otopamean	*thǫa, *-sa	20.08 -100.08	Otomanguean	4
3149	Zapotecan	*š-okwaʔ	17.17 -96.17	Otomanguean	5
3140	Mixtec-Cuicatec	*^{n}du	16.92 -97.58	Otomanguean	6
3036	Popolocan	*na-, ñu-hme	18 -96.92	Otomanguean	2
2445	Chiapanec-Mangue	*nuu-	17.07 -92.73	Otomanguean	2
2220	Mayan	*ii'm	15.42 -91.83	Mayan	7
2214	Otomian	*thą	20.08 -100.08	Otomanguean	8
2209	Chocho-Popolocan	*nu-	17.67 -97.42	Otomanguean	Authors
1935	Chinantecan	*k^{w}i:^{L}	17.92 -96.5	Otomanguean	9
1783	Popoloca	*nuwa	18 -96.92	Otomanguean	Authors
1676	Zapotec	*š-okwaʔ	17.17 -96.17	Otomanguean	5
1649	Quichean-Mamean	*-ii'm	15.42 -91.83	Mayan	7
1596	Mixe-Zoquean	*mo:k	17.22 -96.03	Totozoquean	10
1520	General Aztec	*sɨn-	18.35 -99.83	Uto-Aztecan	11
1492	Greater Mamean	*-i'm	15.42 -91.83	Mayan	7
1437	Mixtec	*noniʔ	16.92 -97.58	Otomanguean	12
1435	Totonacan	*kúši'	19.92 -97.42	Totozoquean	7
1432	Cholan-Tzeltalan	*-ii'm	16.83 -92.83	Mayan	7
1225	Kanjobalan-Chujean	*-ii'm	15.83 -91.83	Mayan	7
1198	Corachol	*iku	22.17 -104.83	Uto-Aztecan	13
1148	Cholan	*-ii'm	14.81 -89.38	Mayan	7
1058	Chujean	*-i'im	15.92 -91.58	Mayan	7
997	Chatino	*n-sukwàʔ	16.25 -97.38	Otomanguean	5
981	Greater Quichean	*-iim	14.78 -91.5	Mayan	7
948	Subtiaba-Tlapanecan	*iši	17.08 -99	Otomanguean	Authors
900	Mixe	*mo:hk	17.02 -96.07	Totozoquean	10
802	Kanjobalan	*-i'm	15.83 -91.83	Mayan	7
790	Yucatecan	*-i'm	20 -89	Mayan	7
787	Zoque	*mok	16.9 -94.68	Totozoquean	10
741	Otomi	*thą	20.08 -100.08	Otomanguean	14
511	Tzeltalan	*-im	16.83 -92.83	Mayan	7

Proto-Word Source:
1. Kaufman 1990
2. Rensch 1976
3. Brown et al. 2011
4. Bartholomew 1965
5. Campbell 2013
6. Longacre 1957
7. Brown and Wichmann 2004
8. Newman and Weitlaner 1950b
9. Rensch 1989
10. Wichmann 1995
11. Campbell and Langacker 1978
12. Josserand 1983
13. Stubbs 2011
14. Newman and Weitlaner 1950a

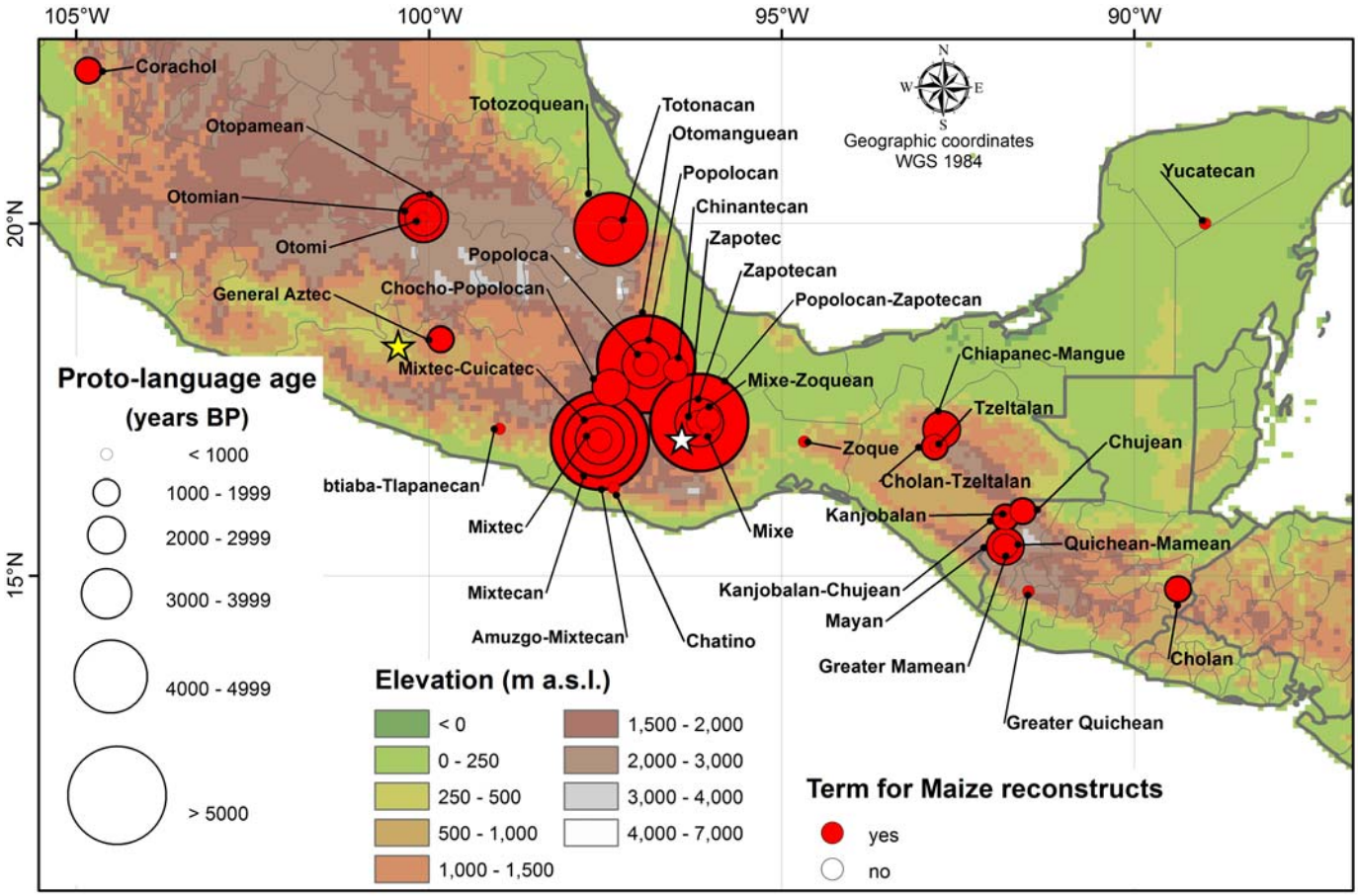

Figure 2. Maize-term reconstruction information from Table 2 plotted on map of Mesoamerica. The yellow star locates the Balsas River valley and the white star locates Guilá Naquitz cave.

domesticated genome (but see Heerwaarden et al. 2011 for the importance of ssp. *mexicana*). Initial domestication of subspecies *mays* occurred in the Balsas River valley of southern Mexico from local populations of ssp. *parviglumis* (Benz 2006; Buckler and Stevens 2006) as early as 9000 BP (Matsuoka et al. 2002; Heerwaarden et al. 2011). The earliest microbotanical evidence dates the crop to 8700 BP in the Balsas River valley (Piperno et al. 2009) and the earliest macrobotanical evidence to 6200 BP at Guilá Naquitz cave, Mexico (Piperno and Flannery 2001). From the Balsas River valley, maize spread both north and south, reaching the U.S. Southwest by 3200 BP, the Eastern U.S. by 2300 BP (Hart et al. 2007), the inter-Andean valleys of Colombia by 7500 BP, northern coastal Peru by 6500 BP (Grobman et al. 2012), and lowland Amazonian Ecuador by 6000 BP (Piperno 2011). Molecular genetic analyses confirm the dispersal from southern Mexico into the southwestern U.S. and then into the northern U.S.[3] The southward dispersal led to a split into two major genetic groups, an Andean and a lowland South American group (Matsuoka et al. 2002; Vigouroux et al. 2008; Heerwaarden et al. 2011).

Much of maize's dispersal occurred well before it developed as a staple crop between 3000 and 2000 BP (Blake 2006; Piperno 2011), suggesting that it was only a minor crop, perhaps having uses other than general consumption. Iltis (2000) hypothesizes that sugar in the plant's stem was initially more important than its kernel, an idea elaborated by Smalley and Blake (2003) with the proposal that maize was first used to produce an alcoholic beverage. Detection of abundant kernel starch grains at the site of early domestication, and lack of stalk phytoliths (Piperno et al. 2009) weaken support for this proposal. Sugar is the basis for fermentation, and can be produced from kernel starch as well as from the stem. Consequently, kernel starch might have been selected for fermentation relating to gifting and feasting events (Bonzani and Oyuela-

Table 3. Maize-term reconstruction for proto-languages of Southern Central America and South America.

Years Before Present	Proto-Language	Proto-Word for Maize (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	*šinki	-10.33 -74.33	Arawakan	Authors
4400	Chibchan	*eba	9.75 -83.42	Chibchan	1
4134	Arawakan	*mariki	1 -69.17	Arawakan	2
4085	N Arawakan	*mariki	1 -69.17	Arawakan	Authors
3943	Panoan-Tacanan	*žiki, *žiki	-7.5 -75	Panoan-Tacanan	3
3585	Tupi	NR	-8 -62	Tupi	
3518	Caribbean N Arawakan	*mariki	12 -72	Arawakan	Authors
3310	Salivan	*n^{y}amo	5 -67	Salivan	Authors
3241	Barbacoan	*pijo	0.67 -79	Barbacoan	4
3196	Wapishanan	*mariki	1 -59	Arawakan	Authors
3178	Zaparoan	*sauku	-3.25 -74	Zaparoan	5
3124	Nadahup	NR	0 -69	Nadahup	
3023	Ge	NR	-15 -52.5	Macro-Ge	
2927	Witoto-Ocaina	NR	-2.75 -71.75	Witoto-Ocaina-Nonuya	
2909	Guaykuruan	NR	-26.5 -59	Mataco-Guaykuru	
2807	Nambiquaran	*ka^{3}ya$\underline{t}$^{3}	-13 -59	Nambiquaran	6
2774	Misumalpan	*aja	13 -84.5	Misumalpan	1
2765	Zamucoan	NR	-20.25 -59.25	Zamucoan	
2731	Talamancan	*ipo ~ *ik^{w}o	9.75 -83.42	Chibchan	Authors
2699	Tucanoan	*we'a	0.33 -70.25	Tucanoan	7
2593	Inland N Arawakan	*(ma)kaanhai	1 -69.17	Arawakan	8
2503	Venezuelan Cariban	*ana-	6.5 -66	Cariban	Authors
2433	Southern Guaykuruan	NR	-26.5 -59	Mataco-Guaykuru	
2414	North Barbacoan	*pija	1.5 -78.25	Barbacoan	Authors
2412	Cariban	*-na-	10.17 -72.75	Cariban	9
2404	Matacoan	*iphAtha	-22.5 -62.58	Mataco-Guaykuru	10
2271	Boran	NR	-2.17 -72.33	Boran	
2258	Chocoan	*pe	6.83 -77.17	Chocoan	Authors
2219	Purus	*šiki	-12.5 -69.33	Arawakan	Authors
2156	Western Tucanoan	*we'a	-2.83 -72.5	Tucanoan	Authors
1931	Chapacuran	*mapak	-13.42 -63.17	Chapacuran	11
1853	Panoan	*šiki, *šiki	-7.5 -75	Panoan-Tacanan	Authors
1853	Pekodian	*-nat	-14 -55	Cariban	Authors
1850	Tupari	*atsitsi	-12.5 -62.5	Tupi	12
1821	Southern Ge	*gãr	-26 -52	Macro-Ge	13
1764	Arauan	*kimi	-6 -70.5	Arauan	14
1717	Quechuan	*sara	0.33 -78	Quechuan	15
1712	Monde	*maek	-10.97 -61.13	Tupi	Authors
1647	Bolivia-Parana	*soporo	-15.17 -65.42	Arawakan	Authors
1634	Mainline Panoan	*šiki	-7.5 -75	Panoan-Tacanan	16
1607	Yabuti	*čiči	-12.25 -62.25	Macro-Ge	Authors
1590	Tacanan	*jike	-13.33 -66.5	Panoan-Tacanan	3
1569	Harakmbet	NR	-12.5 -70.5	Harakmbet	
1550	Tupi-Guarani	*aβati	-8 -62	Tupi	17

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Years Before Present	Proto-Language	Proto-Word for Maize (NR = Not Reconstructable)	Homeland Center Geographic Coordinates	Family Affiliation	Proto-Word Source
1520	Chipaya-Uru	*tura	-19 -68.4	Chipaya-Uru	Authors
1519	Kampan	*šinki	-10.33 -74.33	Arawakan	Authors
1480	Mundurucu	*muira	-7 -55.57	Tupi	Authors
1418	Cayapa-Colorado	*pijo	0.67 -79	Barbacoan	Authors
1402	Guianan Cariban	*-na-	3.25 -55.75	Cariban	Authors
1395	Cabecar-Bribri	*ikwo	9.42 -83	Chibchan	Authors
1335	Kakua-Nukak	NR	0.88 -69.56	Kakua-Nukak	
1319	Yanomam	NR	3.5 -62.83	Yanomam	
1291	Guahiban	*hétsa	6.5 -71.33	Guahiban	18
1241	Eastern Tucanoan	*we'a	0.33 -70.25	Tucanoan	Authors
1185	Kawapanan	*čiʔtiʔ	-5.5 -77	Kawapanan	19
1169	Pemongan	*anaik	4 -60	Cariban	9
992	Taranoan	*a:naci	1 -73	Cariban	20
974	Quechua II	*sara	0.33 -78	Quechuan	15
875	Embera	*pe	5.25 -76.66	Chocoan	Authors
678	Jivaroan	*šaa	-2.5 -78	Jivaroan	Authors
609	Araucanian	*wa-	-38 -72	Araucanian	Authors
419	Coconucan	*pura-	2.5 -76.5	Barbacoan	Authors
414	Witoto Proper	*beǰa	-1 -73.5	Witoto-Ocaina-Nonuya	Authors
389	Mayoruna Panoan	*šik(š)u	-4.42 -70.25	Panoan-Tacanan	Authors

Proto-Word Source:

1. Constenla 1990
2. Payne 1991
3. Girard 1971
4. Curnow and Liddicoat 1998
5. Lev Michael, per. com.
6. Price 1978
7. Thiago Chacon per. com.
8. Ramirez 2001
9. Sergio Meira per. com.
10. Najlis 1984
11. Angenot-de Lima 1997
12. Moore and Galucio 1994
13. Jolkesky 2010
14. Dixon 2004
15. Willem Adelaar per.com.
16. Shell 2008
17. Mello 2010
18. Christian and Matteson 1972
19. Pilar Valenzuela per. com.
20. Meira 2000

Caycedo 2006; Benz and Staller 2006), a possible explanation of maize's use before becoming a food staple.

Maize-term reconstructions are presented for proto-languages of three major regions of the New World: (1) North America and Northern Mexico (Table 1); (2) Southern Mexico and Northern Central America (henceforth Mesoamerica) (Table 2); and (3) Southern Central America and South America (Table 3). The tables 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 maize-term reconstruction. In addition to identifying proto-languages with maize 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 maize are present in all or most languages of a family, but, nonetheless, are not cognate and, hence, do not attest to a maize term in their shared ancestral language. NR, then, never indicates non-reconstructibility because of missing data.[4]

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.

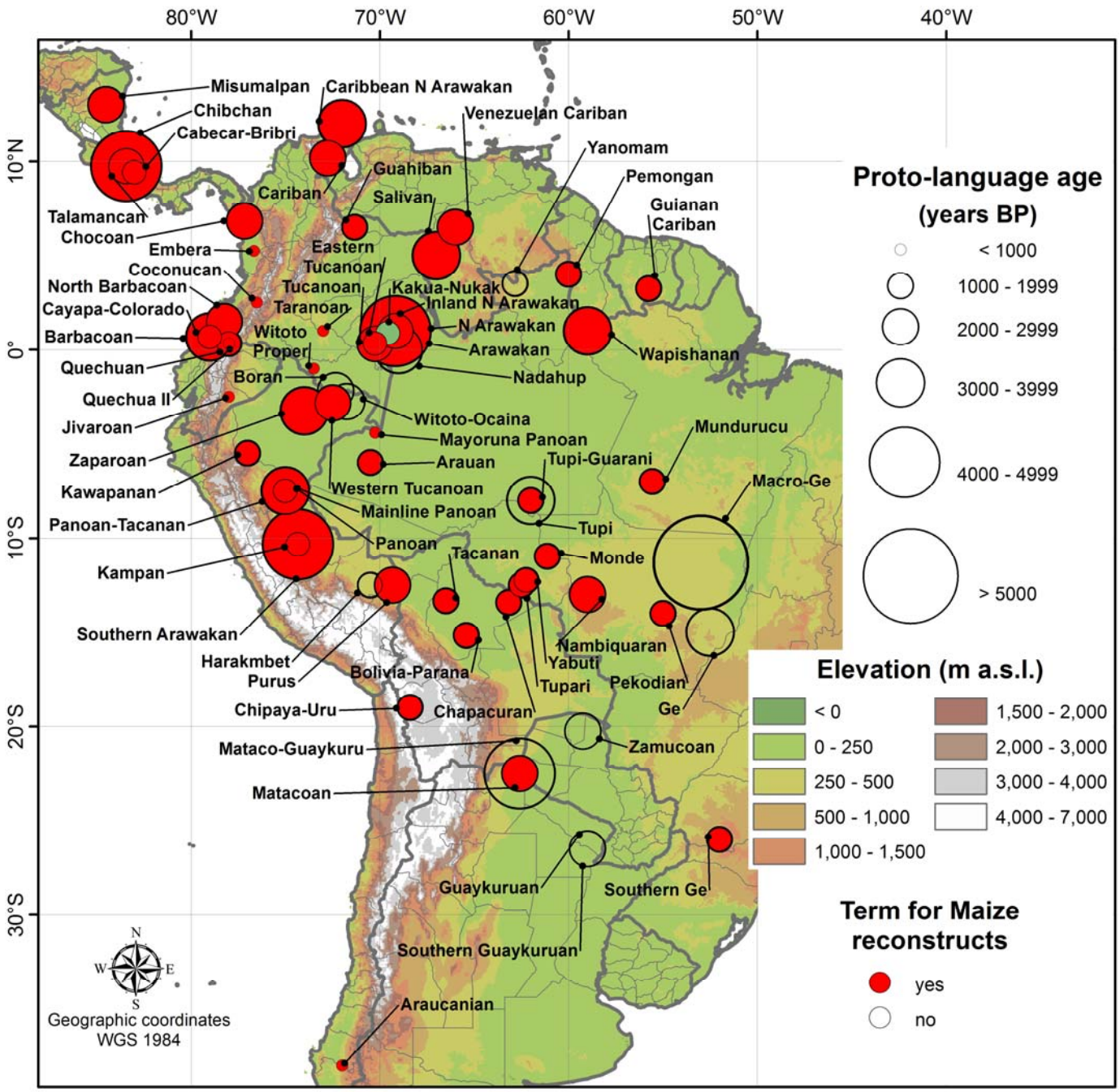

Figure 3. Maize-term reconstruction information from Table 3 plotted on map of Southern Central America and South America.

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 1, 2 and 3 is plotted on maps of Figures 1, 2, 3 and 4 to give a visual perspective on both the chronological and geographic

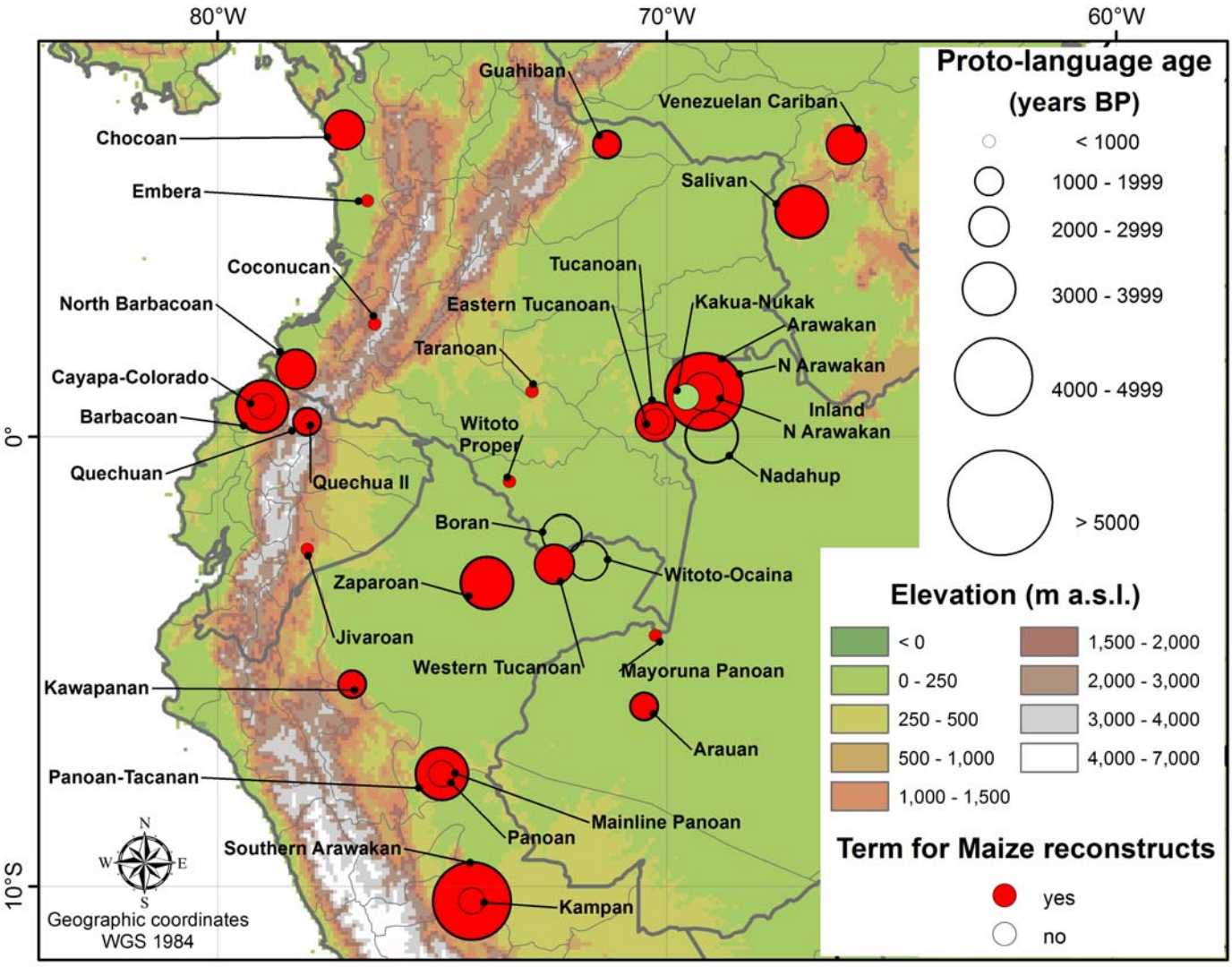

Figure 4. Enlargement of congested region (northwestern South America and adjacent areas) of map of Figure 3.

distributions of reconstructed maize terms. Figure 4 is an enlargement of a highly congested area of the map of Figure 3.

PBL findings reported here are offered as a resource for scholars of maize prehistory interested in pursuing lines of evidence in addition to those provided by genetics and archaeology. While we leave consideration of details suggested by PBL to those with specialized knowledge of the origin and dispersal of maize, we can observe now that PBL chronological and geographic determinations for *Zea mays* L. generally accord with preceding observations relating to the time and place of its domestication, and to subsequent dispersal. For example, the homeland of the oldest ancestral language showing a reconstructed maize term, Proto-Otomanguean (6591 BP), is in southern Mexico, not far from the postulated area of maize's domestication in the Balsas River valley (Benz 2006; Buckler and Stevens 2006; Matsuoka et al. 2002; Heerwaarden et al. 2011) and the Guilá Naquitz cave in Oaxaca from which the earliest macro-botanical examples of maize (6200 BP) have been retrieved (Blake 2006) (see stars on the map of Figure 2 locating these two sites). PBL determinations also mirror the archaeologically attested early appearance of the crop in South America (Piperno et al. 2011), and its relatively late manifestation in the Eastern U.S. (Hart and Lovis 2013). Generally, proto-languages for which maize terms reconstruct are broadly distributed in the Americas, reflecting the crop's substantial dispersal from its origin in southwestern Mexico. ASJP dates for these proto-languages, like archaeobo-

tanical ones, indicate that domestication and dispersal of the crop occurred before the general development of a village-farming way of life in the New World from 4000 to 3000 BP (Piperno and Pearsall 1998) and before maize became a major food crop after 3000 BP (Blake 2006).

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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 working on the development of holistic analysis methods for agricultural development interventions.

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 third PBL study published in *Ethnobiology Letters*, the first treating chili pepper (Brown et al.

2013b) and the second manioc (Brown et al. 2013c). The method and theory of PBL (and also 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]PBL analysis is in its infancy, so that it is difficult to predict what detailed contributions to crop-origin studies may emerge. Our ultimate goal is to produce a PBL atlas of New World crops that presents maps for as many as 31 different taxa. An anticipation of this proposed work is that distribution of reconstructed words for many different crops across New World proto-languages will show hemispheric patterns revealing areas of intensified domestication activities and crop dispersal that may not be so apparent when crops are considered on a one-by-one basis.

[3]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.

[4]NR should not necessarily be interpreted as indicating that a term for maize 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 maize 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).