Institut für Ur- und Frühgeschichte
Diffusionäre Prozesse im Neolithikum Mitteleuropas
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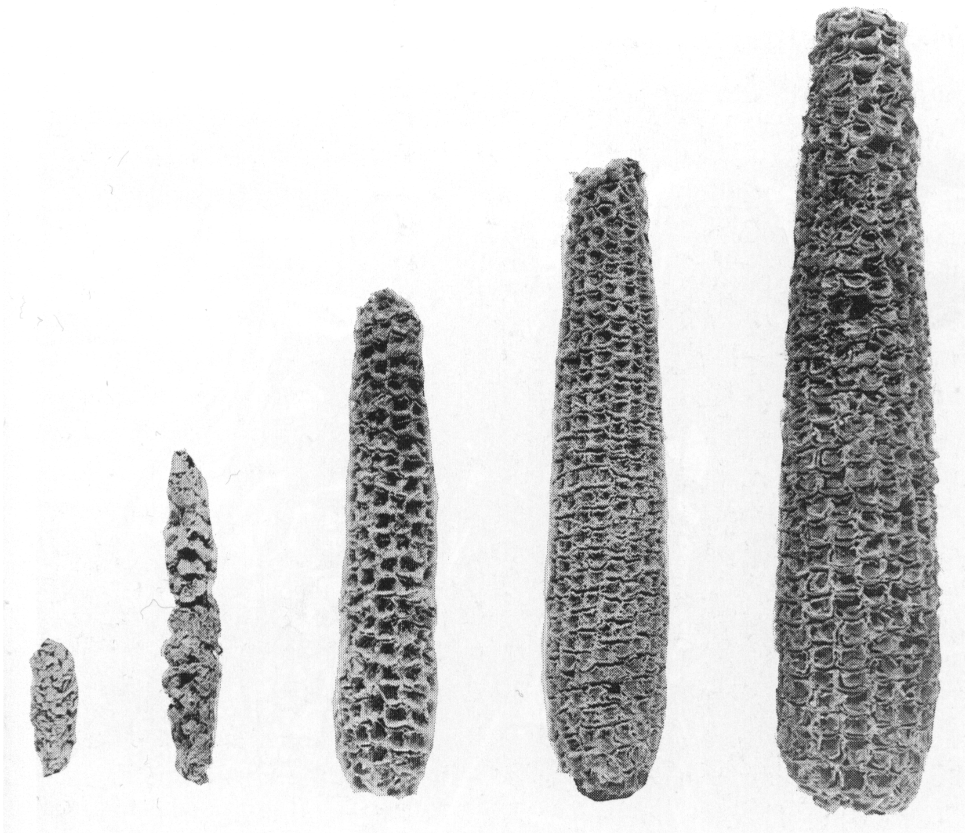
Ausbreitung der Maiskultivierung in Nord- und Mittelamerika



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Titelbild: Entwicklung der Maiskolben über 5 000 Jahre (Fagan 1993, 273).

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1 Vorbemerkungen

Korrektur
In der abgegebenen Version steckte ein grober Fehler. Bei den Korrelationen waren alle Geschwindigkeiten als Kehrwerte angegeben. Dieser Fehler ist hier behoben und aus den neuen Werten werden von den ursprünglichen abweichende Schlüsse gezogen.

Im Überblicken der relevanten Literatur gewinnt man den Eindruck, daß nahezu alle frühen Maisdatierungen noch hoch umstritten sind und über den zeitlichen Verlauf kaum Einigkeit besteht (Tagg 1996, Fritz 1994, MacNeish 2001). Ein grundsätzliches Problem besteht zudem in einer Verzögerung von sechshundert bis tausend Jahren zwischen dem ersten Maisanbau und seinem Aufstieg zu einem bedeutenden Nahrungsbestandteil, die die Anfänge für mehrere Jahrhunderte archäologisch nahezu unsichtbar macht (Smith 1992, Kohler 2008, Rose 2008).

Einige Zitate sollen die methodischen Probleme verdeutlichen:

Tagg 1996, 319
: The new dates are evidence that radiocarbon assays on wood charcoal may not be valid for establishing the precise age of associated cultigens at the site. Radiocarbon determinations on corn were 600 years younger than dates on charcoal from the same pit feature, and wood charcoal samples dated in 1990 did not correlate with ages obtained by Carmichael on samples from the same stratigraphic levels of the same units. [. . .] Wood charcoal from three levels of C29 were all 675 to 1,225 years older than associated cultigens.

Riley 1990, 529
: We argue that a single early introduction of maize through the Southwest remains to be demonstrated and that an early trans-Caribbean entry into eastern North America and a later infusion from the Gulf Coast or the Southwest is the most likely alternative.

Fritz 1994, 305, 308
: My concern is with the dating of early domesticated plants in the New World, especially maize (Zea mays ssp. mays). Direct AMS dates on maize

from Mexico, the Greater Southwest, and eastern North America show that previous estimates for the antiquity of maize agriculture at key sites are unsubstantiated and true dates may be significantly more recent. Chronologies for the adoption of maize agriculture north of Mexico have been revised accordingly. For some reason, however, the old Mesoamerican sequence persists unchanged in new editions of textbooks (e.g., Fagan 1994, Fiedel 1991) and in recent volumes and articles devoted to aspects of domestication (e.g. papers in Cowan and Watson 1992, papers in Gebauer and Price 1992, Goloubinoff, Pääbo, and Wilson 1993). I argue that reliance on the earlier figures should be discontinued until or unless direct dates on clearly domesticated plant specimens become available.

... The consequences of a seemingly sedentary preagricultural occupation include a higher rate of population growth, increased manipulation of useful plants including teosinte (which was represented in the macrobotanical assemblage at Zohapilco), and "a more integrated sociopolitical organization" (Niederberger). Heightening the complexity of the hunter-gatherers who evidently engaged in domestication in Mexico brings the Mesoamerican transition into the sphere of general explanations for agricultural origins espoused by researchers including Hayden, Price, and Price and Gebauer. In these explanations, sedentariness, packing of people in highly productive environmental zones, emergence of leaders with higher status, and demand for plant products used in social exchange precede the shift to food production.

MacNeish 2001, 99, 100

In that letter I listed my reasons why I thought those dates were "absurd" or to put it less bluntly, "unacceptable," and thought that settled the matter. Apparently it did not.

... Finally, Arizona dated two "wild cobs" from square ON3 in zone XI at 4040 ± 100 B.P. (AA-3312) and 1860 ± 45 B.P. (AA-3309). In contrast, carbon from unit W4 of that zone was dated by Johnson at 7050 ± 1400 B.P. (I-567), which clearly falls after the date for zone XII and before that of zone X. Not only are the Arizona dates internally inconsistent, but the dates of 1900 B.P. (AA-3307), 1860 B.P. (AA-3304), and 450 B.P. (AA-3314), purportedly on wild corn, represent a time when such corn no longer grew in the Tehuacan area (see Mangelsdorf 1967a) or elsewhere.

2 Auswertung

Auf der Suche nach relevanten Meßwerten wurden die Zeitschriften

- nature
- science
- PNAS
- Journal of Archaeological Science
- American Antiquity
- Latin American Antiquity

nach dem Stichwort „maize“ durchsucht sowie natürlich weiterführenden Verweisen nachgegangen. Aus den in den Vorbemerkungen genannten Gründen wurden dabei ausschließlich direkte AMS-Datierungen an Maisresten selbst berücksichtigt und ältere Messungen an assoziierten Holzkohlen ignoriert. Tabelle 4 im Anhang listet alle gefundenen Einzelwerte. Für die Auswertung wurde an Fundplätzen mit zahlreichen Proben nicht nur das älteste Datum übernommen sondern zugunsten der Vergleichbarkeit stets mehrere, weil die Wahrscheinlichkeit, tatsächlich den Beginn zu fassen, natürlich mit der Zahl der Proben steigt. Bei erkennbarer Gruppenbildung stammen alle berücksichtigten Proben aus der ältesten Gruppe.

Die ausgewählten Daten wurden gruppenkalibriert (Tafel 1–4) und in Abbildung 1 mit dem resultierenden Alter kartiert. Wie nicht anders zu erwarten streuen die Punkte deutlich in Zeit und Raum und erlauben es nicht, den Weg der Ausbreitung genau nachzuvollziehen. Es sind jedoch drei mögliche Achsen erkennbar:

- Vom Ursprungsort im südlichen Mexiko nach Nordwesten (und Südosten),
- in nordostlicher Richtung quer über den Kontinent,
- vom Ontariosee südwestlich zur Küste.

Für jede dieser drei Achsen wurde ein passender Nullpunkt gewählt[1] und von diesem aus die Entfernungen bestimmt.

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[1] Die Lage des Nullpunktes geht in die Regression nicht ein. Es spielt keine Rolle, ob die Punkte auf der Abszisse zwischen $4 \div 8$ oder zwischen $54 \div 58$ liegen. Die Krümmung der Entfernungskreise vom Ursprung nimmt mit der Entfernung aber ab und sie nähern sich, wenn dieser weit genug weg liegt, Geraden senkrecht zur angenommenen Ausbreitungsachse an.

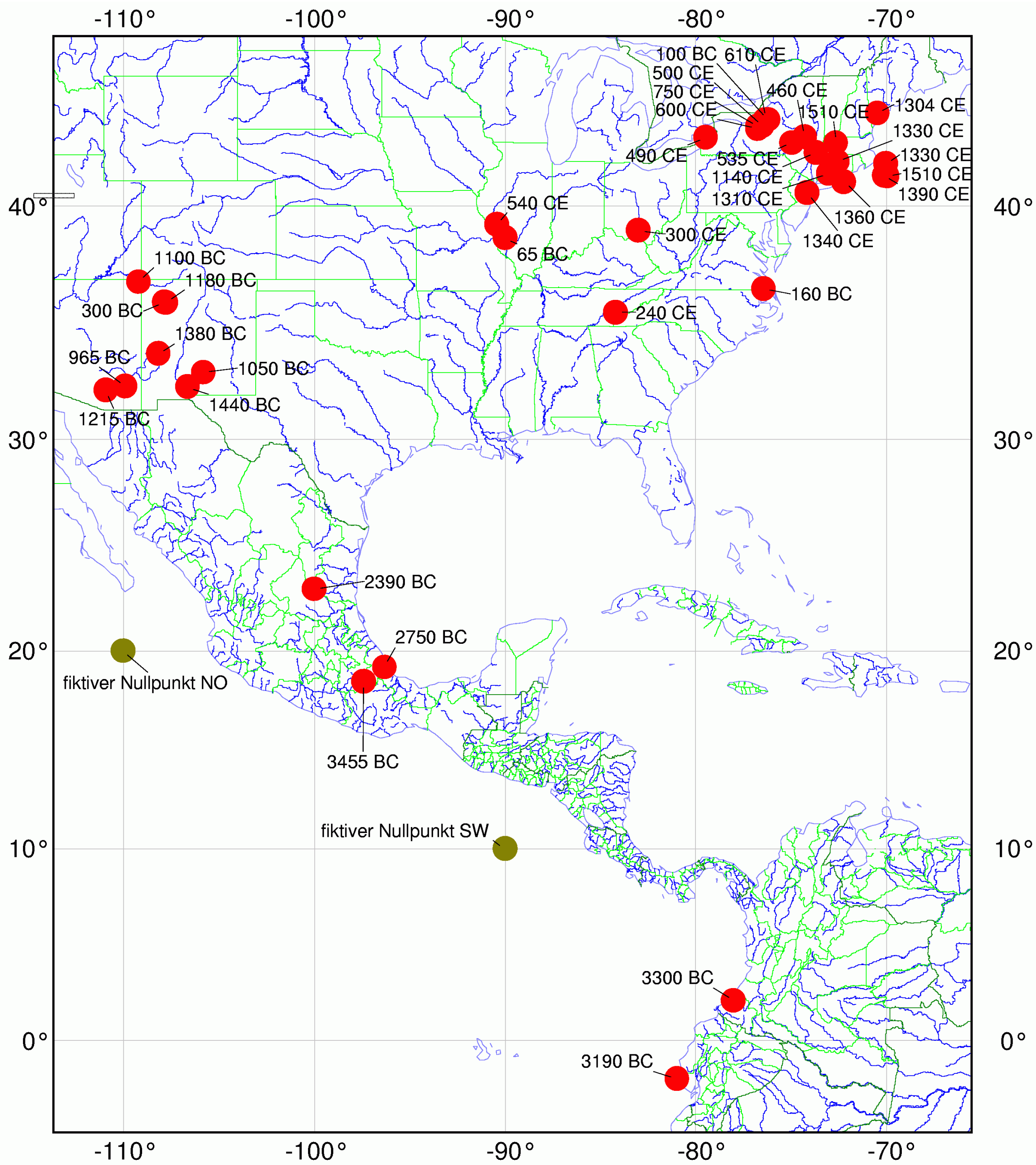

Abbildung 1: Übersichtskarte aller ausgewerteten Fundplätze mit kalibrierten Daten für den Beginn des Maisanbaus.

2.1 Von Mexiko nach Ecuador und in den Südwesten

Die Punkte dieser Ausbreitung zerfallen in zwei Gruppen, einmal die Daten aus Meso- und Südamerika und dann der Cluster von Fundplätzen im Südwesten der USA. Der eigentliche Ursprung der Maisdomestikation wird im Tal von Tehuacán in Mexiko vermutet. Von dort stammen auch die ältesten Maisfunde mit einem gruppenkalibrierten Datum von 3455 ± 110 Jahren BC. Die auf den ersten Blick sehr hohe Korrelation mit einem Koeffizienten von 94 % und der Geschwindigkeit

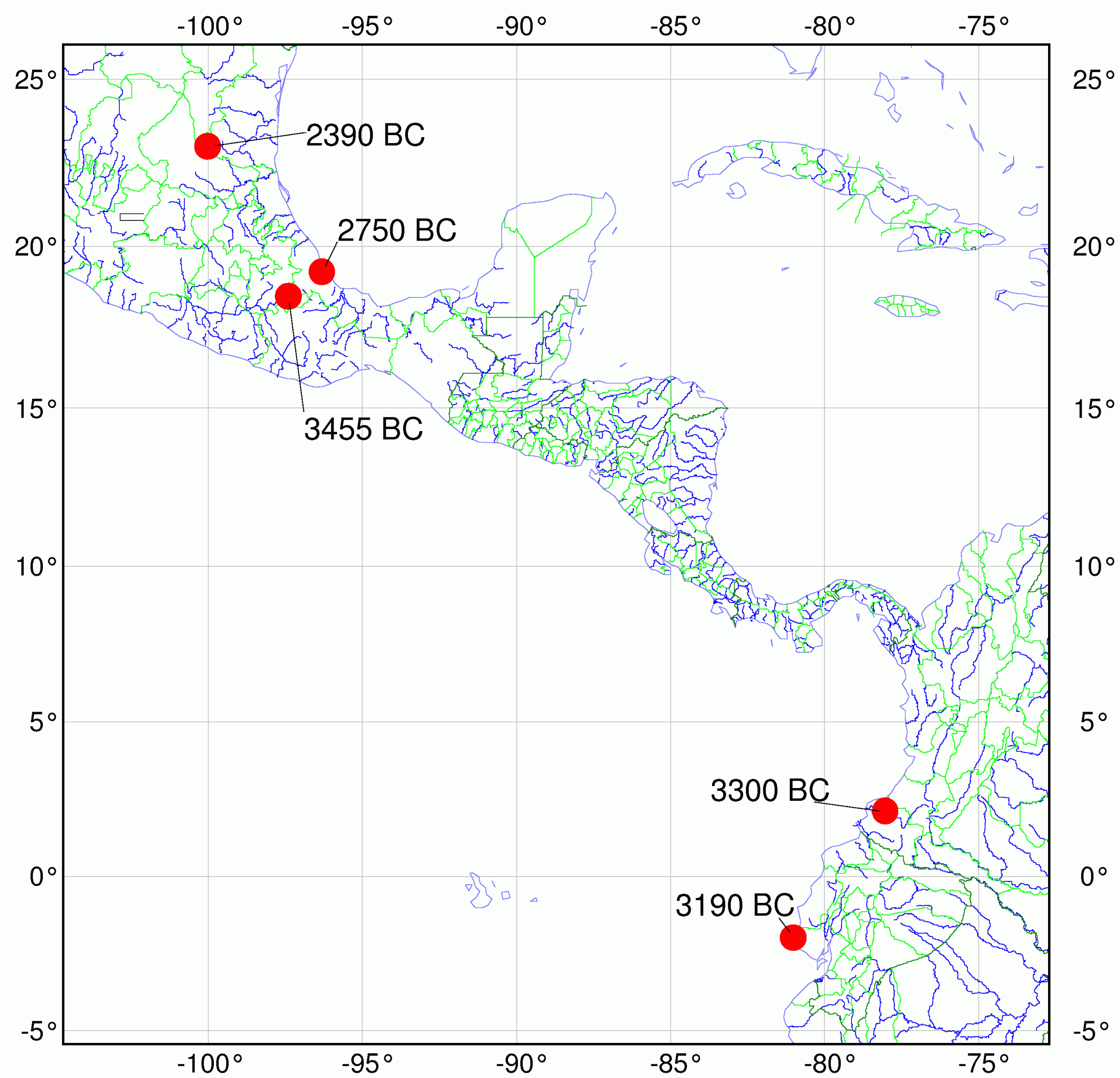

Abbildung 2: Fundplätze in Mittelamerika mit kalibrierten Daten für den Beginn des Maisanbaus.

0.98 km/a kommt fast ausschließlich durch die Bildung der beiden Cluster zustande. Die acht Daten aus den südwestlichen USA zeigen zwar ebenfalls einen deutlichen Trend mit 1.46 km/a aber dem deutlich geringeren Korrelationskoeffzienten von nur 39 %.

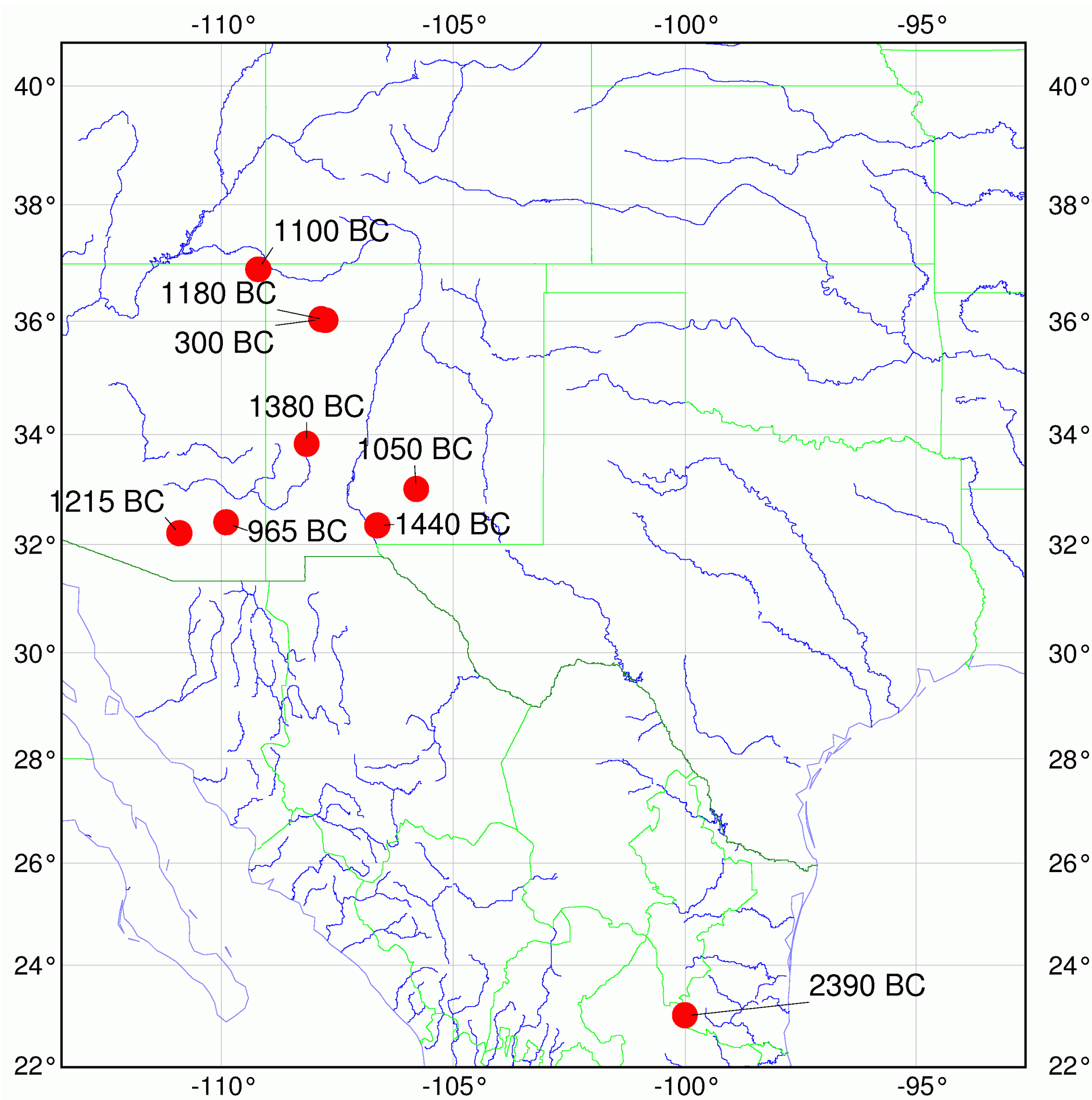

Abbildung 3: Fundplätze im Südwesten der USA mit kalibrierten Daten für den Beginn des Maisanbaus.

Fundplatz	Breite	Länge	Entfernung	kal. Alter
Cueva San Marcos	18.46	−97.39	1301	3455 ± 110 BC
Lake Ayauch	2.08	−78.02	1679	3300 ± 150 BC
Loma Alta	−2.00	−81.00	1759	3190 ± 115 BC
Veracruz core	19.20	−96.30	1296	2750 ± 90 BC
Romero's cave	23.00	−100.00	1896	2390 ± 85 BC
Tornillo Rockshelter	32.35	−106.63	3185	1440 ± 30 BC
Bat Cave	33.82	−108.16	3414	1380 ± 80 BC
Las Capas	32.20	−110.90	3456	1215 ± 75 BC
LA 18091	36.02	−107.75	3595	1180 ± 320 BC
Three Fir Shelter	36.90	−109.20	3759	1100 ± 170 BC
Fresnal Shelter	33.00	−105.80	3197	1050 ± 255 BC
Milagro	32.40	−109.90	3403	965 ± 100 BC
Sheep Camp Shelter	36.03	−107.85	3601	300 ± 275 BC

Tabelle 1: Fundplätze der nordwestlichen Ausbreitungsrichtung mit Entfernungen vom fiktiven Startpunkt bei 10° N, 90° W.

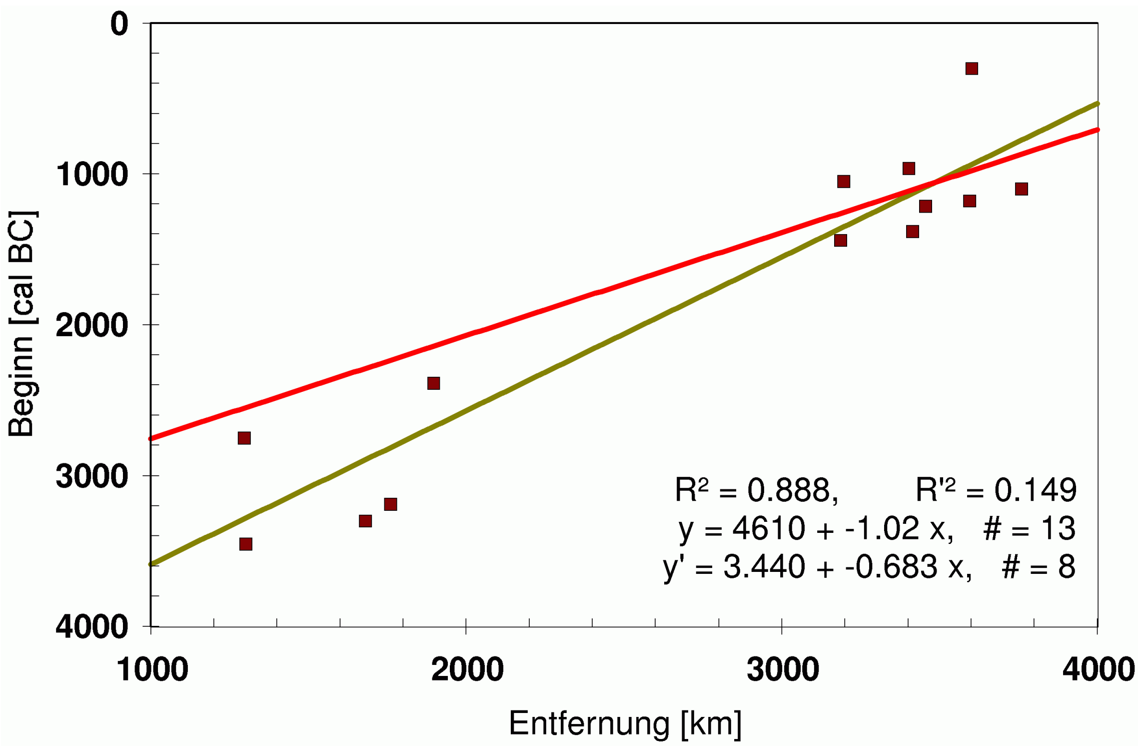

Abbildung 4: Regressionsrechnung für die nordwestliche Ausbreitungsrichtung mit Entfernungen vom fiktiven Startpunkt bei 10° N, 90° W. Die rote Regressionsgerade ist allein mit den acht Daten im Südwesten der USA gerechnet.

2.2 Von Arizona nordöstlich nach Neuengland

Dieser Teil der Ausbreitung ist am schwersten nachvollziehbar. Thomas Riley hält sogar einen eigenen Weg über die Karibik und Florida für möglich (Riley 1990). Die in der Regression deutlich erkennbaren Gruppen um 600 CE und 1400 CE passen nicht zum angenommenen Ausbreitungsweg und der rechnerischen Geschwindigkeit von 1.39 km/a dürfte keine nachvollziehbare Realität zugrundeliegen. Dafür spricht auch das erheblich jüngere Alter der meisten Datierungen aus den Great Plains. (Adair 2003, Tabelle 4)

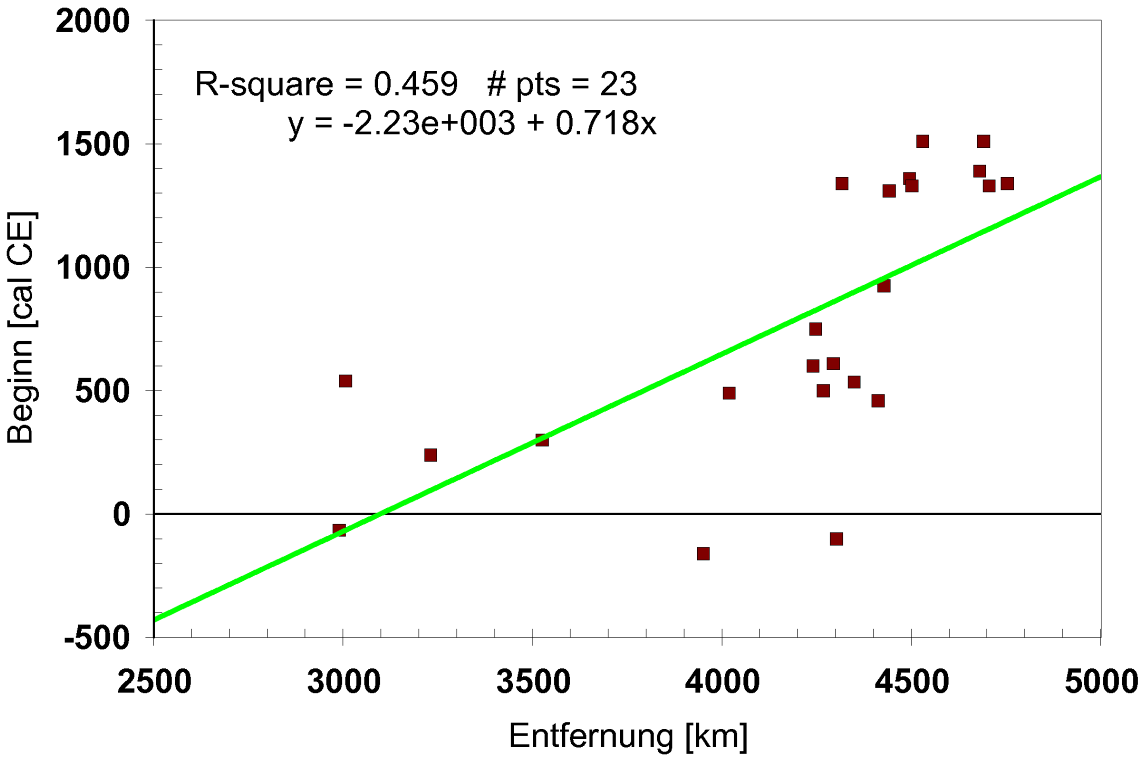

Abbildung 5: Regressionsrechnung für die nordöstliche Ausbreitungsrichtung mit Entfernungen vom fiktiven Startpunkt bei 20° N, 110° W. Offenbar stimmt diese angenommene Richtung mit der tatsächlichen Ausbreitung wenig überein.

Fundplatz	Breite	Länge	Entfernung	kal. Alter
Holding	38.70	−90.00	2989	65 ± 80 BC
Lake Drummond	36.60	−76.45	3950	160 ± 140 BC
Vinette	43.38	−76.22	4302	100 ± 175 BC
Icehouse Bottom	35.59	−84.19	3230	240 ± 120 CE
Edwin Harness	39.00	−83.00	3525	300 ± 105 CE
Westheimer	42.71	−74.30	4412	460 ± 50 CE
Grand Banks	42.70	−79.50	4018	490 ± 110 CE
Felix	43.15	−76.51	4267	500 ± 55 CE
Fortin 2	42.49	−74.97	4348	535 ± 55 CE
Crane	39.25	−90.40	3006	540 ± 370 CE
Kipp Island	43.02	−76.77	4240	600 ± 35 CE
Wickham	43.38	−76.33	4293	610 ± 30 CE
Hunter's Home	43.13	−76.76	4247	750 ± 60 CE
Hudson R., NY	42.11	−73.72	4427	925 ± 75 CE
Housatonic R., CT	41.28	−73.06	4441	1310 ± 60 CE
Bernhm-Shep., CT	41.76	−72.59	4501	1330 ± 50 CE
Cape Cod, MA	41.67	−70.04	4705	1330 ± 50 CE
Staten I., Bowmans Br.	40.52	−74.16	4316	1340 ± 50 CE
Saco R., ME	43.63	−70.50	4753	1340 ± 40 CE
Sebonac, Long I., NY	40.96	−72.23	4495	1360 ± 60 CE
Ram Pasture, MA	41.22	−70.13	4679	1390 ± 60 CE
Deerfield R., MA	42.49	−72.66	4530	1510 ± 80 CE
Nantucket, MA	41.18	−69.98	4690	1510 ± 70 CE

Tabelle 2: Fundplätze der nordöstlichen Ausbreitungsrichtung mit Entfernungen vom fiktiven Startpunkt bei 20° N, 110° W.

2.3 Vom Ontariosee südwestlich nach Massachusetts

Von allen drei Ausbreitungen ist diese die deutlichste. Der Mais wurde hier als späte Feldfrucht von bereits ackerbauenden Gesellschaften aufgenommen. Die besonders niedrige Geschwindigkeit von 0.58 km/a über diese rund 800 km weist auf eine kulturelle Adaption ohne Wanderung hin. Trotz des Korrelationskoeffizienten von 85 % verläuft aber auch diese Verbreitung nicht gleichmäßig linear sondern zeigt zwei größere Gebiete, in denen der Anbau um 600 CE und um 1400 CE jeweils sprunghaft fast gleichzeitig auftritt.

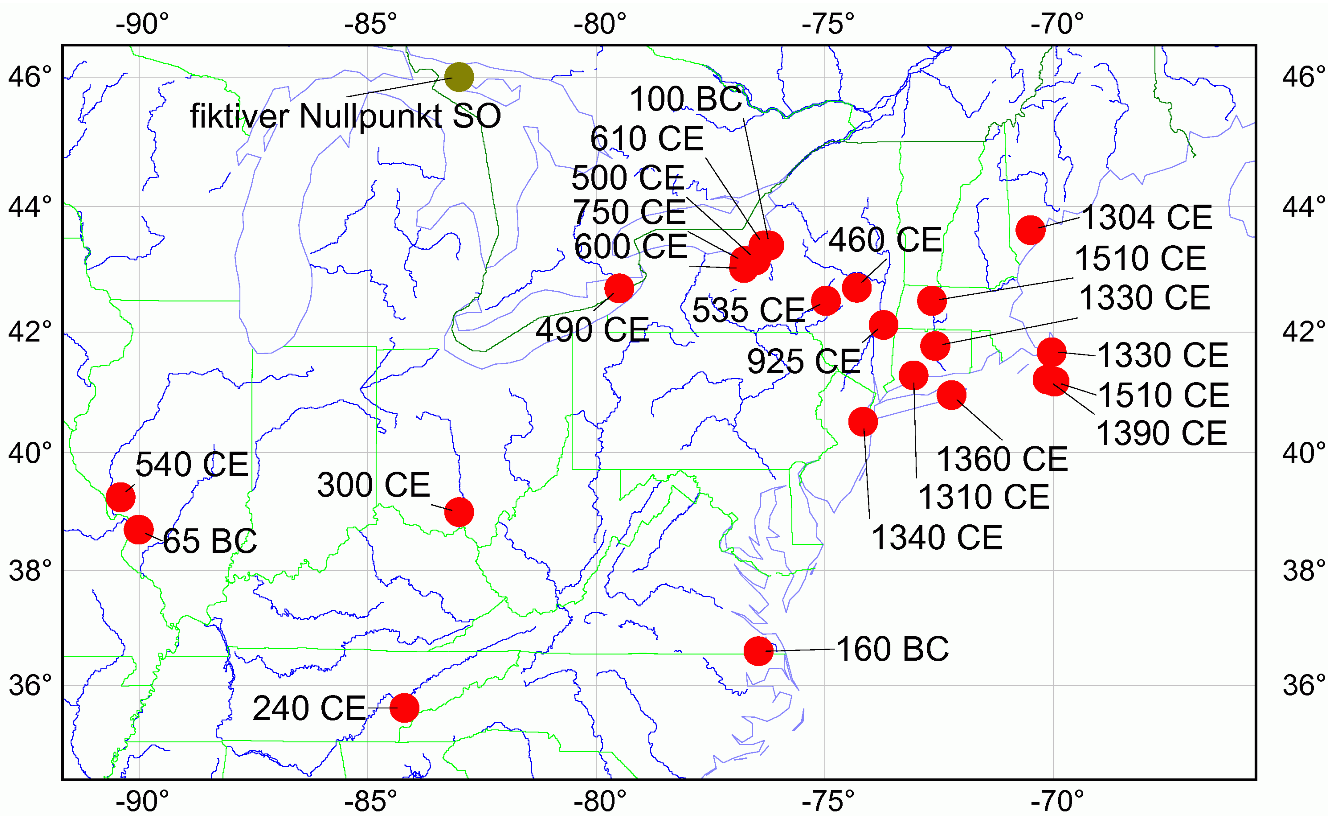

Abbildung 6: Fundplätze im Nordosten der USA mit kalibrierten Daten für den Beginn des Maisanbaus.

Fundplatz	Breite	Länge	Entfernung	kal. Alter
Vinette	43.38	−76.22	644	100 ± 175 BC
Westheimer	42.71	−74.30	826	460 ± 50 CE
Grand Banks	42.70	−79.50	486	490 ± 110 CE
Felix	43.15	−76.51	638	500 ± 55 CE
Fortin 2	42.49	−74.97	791	535 ± 55 CE
Kipp Island	43.02	−76.77	628	600 ± 35 CE
Wickham	43.38	−76.33	636	610 ± 30 CE
Hunter's Home	43.13	−76.76	621	750 ± 60 CE
Hudson R., NY	42.11	−73.72	906	925 ± 75 CE
Housatonic R., CT	41.28	−73.06	1009	1310 ± 60 CE
Bernhm-Shep., CT	41.76	−72.59	1011	1330 ± 50 CE
Cape Cod, MA	41.67	−70.04	1208	1330 ± 50 CE
Staten I., Bowmans Br.	40.52	−74.16	992	1340 ± 50 CE
Saco R., ME	43.63	−70.50	1077	1340 ± 40 CE
Sebonac, Long I., NY	40.96	−72.23	1091	1360 ± 60 CE
Ram Pasture, MA	41.22	−70.13	1228	1390 ± 60 CE
Deerfield R., MA	42.49	−72.66	962	1510 ± 80 CE
Nantucket, MA	41.18	−69.98	1242	1510 ± 70 CE

Tabelle 3: Fundplätze der südöstlichen Ausbreitungsrichtung mit Entfernungen vom fiktiven Startpunkt bei 46° N, 83° W.

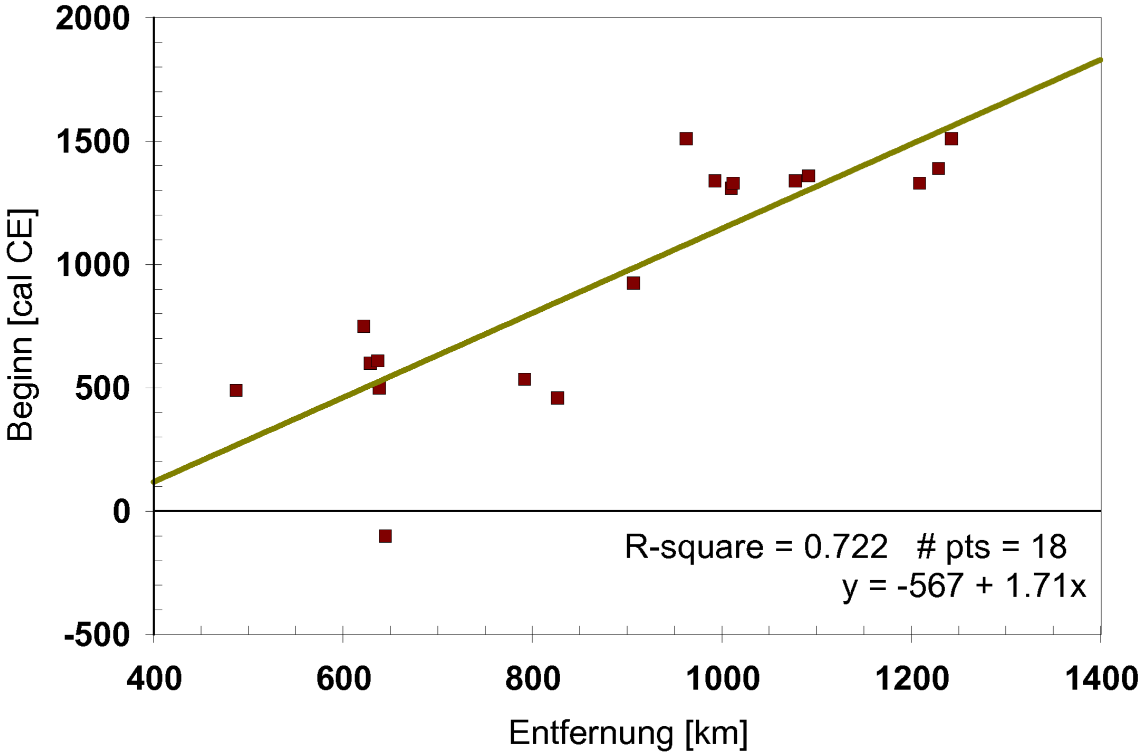

Abbildung 7: Regressionsrechnung für die südöstliche Ausbreitungsrichtung in New York und Massachusetts mit Entfernungen vom fiktiven Startpunkt bei 46° N, 83° W.

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A Liste aller Datierungen und Gruppenkalibration der Auswahl

Lab. Nr.	Material	A[2]	C14-Alter	Breite	Länge	Fundort
WILLS 1995						
AA-3305	Zea mays		4700 ± 60	18.46	−97.39	Cueva San Marcos
AA-3304	Zea mays		4680 ± 50	18.46	−97.39	Cueva San Marcos
AA-3310	Zea mays		4600 ± 60	18.46	−97.39	Cueva San Marcos
AA-3308	Zea mays		4090 ± 50	18.46	−97.39	Cueva Coxcatlan
AA-3312	Zea mays		4040 ± 100	18.46	−97.39	Cueva Coxcatlan
A4187	Zea mays		3740 ± 70	33.82	−108.16	Bat Cave
Beta ?	Zea mays		3610 ± 170	36.9	−109.2	Three Fir Shelter
A4188	Zea mays	x	3120 ± 70	33.82	−108.16	Bat Cave
A4186	Cucurbita pepo		2980 ± 120	33.82	−108.16	Bat Cave
A3388	Cucurbita pepo		2900 ± 230	35.92	−107.72	Sheep Camp Shelter
Beta 26271	Zea mays	x	2880 ± 140	36.9	−109.2	Three Fir Shelter
A4179	Phaseolus vulgaris		2400 ± 250	34.15	−108.43	Tularosa Cave
A4184	Phaseolus vulgaris		2140 ± 110	33.82	−108.16	Bat Cave
GX-12720	Zea mays	x	3175 ± 240	32.35	−106.63	Tornillo Rockshelter
AA-4457	Zea mays	x	2815 ± 80	32.4	−109.9	Fairbank
AA-2782	Zea mays	x	2790 ± 60	32.4	−109.9	Cortaro Fan
AA-1074	Zea mays	x	2780 ± 90	32.4	−109.9	Milagro
DIEHL 2005						
Beta-90225	maize		2580 ± 60	32.2	−110.9	Clearwater
Beta-85405	maize		2520 ± 40	32.2	−110.9	Clearwater
Beta-90226	maize		2500 ± 60	32.2	−110.9	Clearwater
Beta-148408	maize		3670 ± 402	32.2	−110.9	Las Capas
Beta-148409	maize		3060 ± 402	32.2	−110.9	Las Capas
Beta-145108	maize		3060 ± 402	32.2	−110.9	Las Capas
Beta-140055	maize	x	3020 ± 30	32.2	−110.9	Las Capas
Beta-140054	maize	x	3000 ± 30	32.2	−110.9	Las Capas
Beta-140064	maize	x	2970 ± 30	32.2	−110.9	Las Capas
Beta-145107	maize	x	2960 ± 40	32.2	−110.9	Las Capas
Beta-140063	maize	x	2960 ± 40	32.2	−110.9	Las Capas
Beta-148407	maize		2940 ± 40	32.2	−110.9	Las Capas

Fortsetzung auf der nächsten Seite

[2] Für die Auswertung ausgewählte Daten.

Lab. Nr.	Material	A	C14-Alter	Breite	Länge	Fundort
Beta-148405	maize		2940 ± 40	32.2	−110.9	Las Capas
Beta-145105	maize		2940 ± 40	32.2	−110.9	Las Capas
Beta-119633	maize		2930 ± 40	32.2	−110.9	Las Capas
Beta-118416	maize		2930 ± 50	32.2	−110.9	Las Capas
Beta-140062	maize		2920 ± 30	32.2	−110.9	Las Capas
Beta-129426	maize		2880 ± 40	32.2	−110.9	Las Capas
Beta-129427	maize		2849 ± 50	32.2	−110.9	Las Capas
Beta-119631	maize		2820 ± 50	32.2	−110.9	Las Capas
Beta-123450	maize		2810 ± 70	32.2	−110.9	Las Capas
Beta-140059	maize		2780 ± 40	32.2	−110.9	Las Capas
Beta-133891	maize		2770 ± 40	32.2	−110.9	Las Capas
Beta-133898	maize		2770 ± 40	32.2	−110.9	Las Capas
Beta-133894	maize		2760 ± 60	32.2	−110.9	Las Capas
Beta-119630	maize		2750 ± 50	32.2	−110.9	Las Capas
Beta-140051	maize		2750 ± 40	32.2	−110.9	Las Capas
Beta-140058	maize		2740 ± 40	32.2	−110.9	Las Capas
Beta-140057	maize		2740 ± 30	32.2	−110.9	Las Capas
Beta-118150	maize		2730 ± 50	32.2	−110.9	Las Capas
Beta-140056	maize		2730 ± 60	32.2	−110.9	Las Capas
Beta-133890	maize		2710 ± 40	32.2	−110.9	Las Capas
Beta-140060	maize		2710 ± 50	32.2	−110.9	Las Capas
Beta-140050	maize		2690 ± 40	32.2	−110.9	Las Capas
Beta-140053	maize		2690 ± 40	32.2	−110.9	Las Capas
Beta-133892	maize		2670 ± 40	32.2	−110.9	Las Capas
Beta-119634	maize		2660 ± 40	32.2	−110.9	Las Capas
Beta-133893	maize		2650 ± 40	32.2	−110.9	Las Capas
Beta-140061	maize		2630 ± 40	32.2	−110.9	Las Capas
Beta-119632	maize		2550 ± 40	32.2	−110.9	Las Capas
Beta-140052	maize		2530 ± 40	32.2	−110.9	Las Capas
Beta-133897	maize		2500 ± 40	32.2	−110.9	Las Capas
Beta-123600	maize		2380 ± 40	32.2	−110.9	Los Pozos
Beta-91147	maize		2240 ± 60	32.2	−110.9	Los Pozos
Beta-123603	maize		2240 ± 40	32.2	−110.9	Los Pozos
Beta-125224	maize		2230 ± 40	32.2	−110.9	Los Pozos
Beta-95628	maize		2190 ± 80	32.2	−110.9	Los Pozos
Beta-125223	maize		2190 ± 50	32.2	−110.9	Los Pozos
Beta-124700	maize		2190 ± 50	32.2	−110.9	Los Pozos
Beta-123599	maize		2190 ± 50	32.2	−110.9	Los Pozos
Beta-125222	maize		2180 ± 50	32.2	−110.9	Los Pozos
Beta-91144	maize		2170 ± 60	32.2	−110.9	Los Pozos
Beta-91149	maize		2160 ± 60	32.2	−110.9	Los Pozos
Beta-125225	maize		2160 ± 30	32.2	−110.9	Los Pozos
Beta-95629	maize		2150 ± 80	32.2	−110.9	Los Pozos
Beta-124698	maize		2150 ± 60	32.2	−110.9	Los Pozos
Beta-91142	maize		2150 ± 50	32.2	−110.9	Los Pozos

Fortsetzung auf der nächsten Seite

Lab. Nr.	Material	A	C14-Alter	Breite	Länge	Fundort
Beta-91140	maize		2140 ± 60	32.2	−110.9	Los Pozos
Beta-123602	maize		2140 ± 50	32.2	−110.9	Los Pozos
Beta-126328	maize		2140 ± 50	32.2	−110.9	Los Pozos
Beta-91148	maize		2140 ± 50	32.2	−110.9	Los Pozos
Beta-125226	maize		2140 ± 40	32.2	−110.9	Los Pozos
Beta-124697	maize		2130 ± 50	32.2	−110.9	Los Pozos
Beta-123601	maize		2130 ± 40	32.2	−110.9	Los Pozos
Beta-91141	maize		2120 ± 60	32.2	−110.9	Los Pozos
Beta-95630	maize		2110 ± 80	32.2	−110.9	Los Pozos
Beta-91145	maize		2110 ± 50	32.2	−110.9	Los Pozos
Beta-124699	maize		2100 ± 60	32.2	−110.9	Los Pozos
Beta-95632	maize		2090 ± 80	32.2	−110.9	Los Pozos
Beta-91146 ′	maize		2090 ± 60	32.2	−110.9	Los Pozos
Beta-126332	maize		2070 ± 50	32.2	−110.9	Los Pozos
Beta-95631	maize		2060 ± 80	32.2	−110.9	Los Pozos
Beta-91143	maize		2050 ± 50	32.2	−110.9	Los Pozos
Cook 2007						
I-7087	charred corn		395 ± 80	39.8	−83.2	Sun Watch
Hart 2007						
A0541	cooking residue		2905 ± 35	42.91	−78.01	Scaccia
A0456	cooking residue		2510 ± 35	43.38	−76.22	Vinette
A0500	cooking residue	x	2270 ± 35	43.38	−76.22	Vinette
A0505	cooking residue		2205 ± 30	43.15	−76.51	Felix
A0410	cooking residue		1995 ± 35	42.49	−74.97	Fortin 2
A0455	cooking residue	x	1990 ± 40	43.38	−76.22	Vinette
A0452	cooking residue	x	1940 ± 35	43.38	−76.22	Vinette
A0454	cooking residue		1695 ± 35	43.38	−76.33	Wickham
A0194	cooking residue		1648 ± 47	43.38	−76.33	Wickham
A0453	cooking residue		1635 ± 35	43.38	−76.33	Wickham
A0542	cooking residue		1620 ± 35	43.38	−76.33	Simmons
A0498	cooking residue	x	1600 ± 35	42.71	−74.30	Westheimer
A0406	cooking residue	x	1525 ± 35	42.49	−74.97	Fortin 2
A0407	cooking residue	x	1505 ± 35	42.49	−74.97	Fortin 2
A0497	cooking residue	x	1575 ± 35	43.15	−76.51	Felix
A0503	cooking residue	x	1525 ± 40	43.15	−76.51	Felix
A0504	cooking residue	x	1520 ± 35	43.15	−76.51	Felix
A0499	cooking residue		1430 ± 40	43.15	−76.51	Felix
A0502	cooking residue		1405 ± 40	43.15	−76.51	Felix
A0506	cooking residue		1315 ± 50	43.15	−76.51	Felix
A0190	cooking residue		1425 ± 45	43.38	−76.33	Wickham
A0195	cooking residue		1450 ± 43	43.38	−76.33	Wickham
A0501	cooking residue	x	1390 ± 35	43.38	−76.33	Simmons
A0225	cooking residue		1470 ± 43	43.02	−76.77	Kipp Island
A0226	cooking residue		1461 ± 43	43.02	−76.77	Kipp Island

Fortsetzung auf der nächsten Seite

Lab. Nr.	**Material**	**A**	**C14-Alter**	**Breite**	**Länge**	**Fundort**
A0227	cooking residue		1428 ± 41	43.02	−76.77	Kipp Island
A0228	cooking residue		1260 ± 39	43.02	−76.77	Kipp Island
A0191	cooking residue		1228 ± 42	43.38	−76.33	Wickham
A0192	cooking residue		1231 ± 44	43.13	−76.76	Hunter's Home
A0193	cooking residue		1286 ± 40	43.13	−76.76	Hunter's Home
A0197	cooking residue		1247 ± 48	43.13	−76.76	Hunter's Home
A0198	cooking residue		1211 ± 46	43.13	−76.76	Hunter's Home
A0196	cooking residue		1138 ± 40	43.13	−76.76	Hunter's Home
A0229	cooking residue		1043 ± 40	42.49	−74.97	Street
A0235	cooking residue		781 ± 42	42.06	−76.37	Haner
A0528	cooking residue		445 ± 40	43.08	−74.54	Smith-Pagerie
A0523	cooking residue		480 ± 40	43.08	−74.54	Klock
A0522	cooking residue		425 ± 40	43.08	−74.54	Garoga
HART 2007						
	residue		1043 ± 40	42.49	−74.97	Street, NY
	maize		1050 ± 50	42.11	−73.79	211-1-1, NY
	maize		1060 ± 60	42.7	−79.5	Grand Banks, ON
	maize		1150 ± 100			Forster, ON
	residues		1221 ± 16	43.13	−76.76	Hunters Home, NY
	residue		1228 ± 42	43.38	−76.33	Wickham, NY
	maize		1250 ± 80	42.7	−79.5	Grand Banks, ON
	maize		1270 ± 100	42.7	−79.5	Meyer, ON
	residue		1390 ± 35	43.38	−76.33	Simmons, NY
	residues		1392 ± 26	43.15	−76.51	Felix, NY
	residues		1423 ± 20	43.02	−76.77	Kipp Island, NY
	residues		1438 ± 31	43.38	−76.33	Wickham, NY
	maize		1450 ± 350	39.25	−90.4	Crane, EL
	residues		1515 ± 27	42.49	−74.97	Fortin 2, NY
	residues		1541 ± 23	43.15	−76.51	Felix, NY
	maize		1551 ± 78	42.7	−79.5	Grand Banks, ON
	residue		1600 ± 35	42.71	−74.30	Westheimer 2, NY
	maize		1730 ± 60	39.0	−83.0	Edwin Harness, OH
	maize		1775 ± 100	35.5883	−84.1917	Icehouse Bottom, TN
	residues		1960 ± 28	43.38	−76.22	Vinette, NY
	maize		2037 ± 41	38.7	−90.0	Holding, IL
	residue		2270 ± 35	43.38	−76.22	Vinette, NY
SIMMONS 1986						
UGa 3621	charcoal		3680 ± 85	36.03	−107.85	LA 17337
UGa 3623	charcoal		3560 ± 95	36.03	−107.85	LA 17337
UGa 3622	charcoal		225 ± 90	36.03	−107.85	LA 17337
UGa 3627	charcoal		3985 ± 155	36.02	−107.75	LA 18103
UGa 3628	charcoal		3650 ± 70	36.02	−107.75	LA 18103
UGa 4179	carbonized maize	x	2950 ± 275	36.02	−107.75	LA 18091
UGa 4181	charcoal		3090 ± 215	36.02	−107.75	LA 18091

Fortsetzung auf der nächsten Seite

Lab. Nr.	Material	A	C14-Alter	Breite	Länge	Fundort
UGa 4183	charcoal		2940 ± 145	36.02	−107.75	LA 18091
UGa 4184	charcoal		2675 ± 105	36.02	−107.75	LA 18091
UGa 4658	charcoal		2850 ± 75	36.03	−107.85	Sheep Camp Shelter
A3388	C. pepo seed		2900 ± 230	36.03	−107.85	Sheep Camp Shelter
A3395	Z. mays kernel	x	2170 ± 180	36.03	−107.85	Sheep Camp Shelter
A3396	Z. mays kernel	x	2290 ± 210	36.03	−107.85	Sheep Camp Shelter
A3159	C. pepo seed		2220 ± 290	36.03	−107.85	Sheep Camp Shelter
UGa 4605	charcoal		1400 ± 80	36.06	−107.99	Ashislepah Shelter
UGa 4606	charcoal		2205 ± 65	36.06	−107.99	Ashislepah Shelter
CHAPMAN 1987						
Beta-16576	maize kernel	x	1775 ± 100	35.5883	−84.1917	Icehouse Bottom
RILEY 1994						
AA-8718	kernel	x	2017 ± 50	38.7	−90.0	Holding
AA-8717	cob fragment	x	2077 ± 70	38.7	−90.0	Holding
TAGG 1996						
GX-1488	wood charcoal		3615 ± 120	33.0	−105.8	Fresnal Shelter
ISGS 812	wood charcoal		7310 ± 75	33.0	−105.8	Fresnal Shelter
ISGS 845	wood charcoal		7110 ± 75	33.0	−105.8	Fresnal Shelter
ISGS 888	wood charcoal	x	3150 ± 70	33.0	−105.8	Fresnal Shelter
ISGS 897	wood charcoal	x	2690 ± 80	33.0	−105.8	Fresnal Shelter
ISGS 955	wood charcoal		3030 ± 70	33.0	−105.8	Fresnal Shelter
ISGS 969	wood charcoal		2770 ± 70	33.0	−105.8	Fresnal Shelter
A3070	maize cob	x	2540 ± 200	33.0	−105.8	Fresnal Shelter
A3071	maize kernel		1990 ± 320	33.0	−105.8	Fresnal Shelter
Beta 36738	wood charcoal		1890 ± 60	33.0	−105.8	Fresnal Shelter
Beta 36739	bison dung		5090 ± 60	33.0	−105.8	Fresnal Shelter
Beta 36740	wood charcoal		4800 ± 70	33.0	−105.8	Fresnal Shelter
Beta 36741	wood charcoal		2890 ± 70	33.0	−105.8	Fresnal Shelter
Beta 36742	wood charcoal		2740 ± 60	33.0	−105.8	Fresnal Shelter
Beta 36743	wood charcoal		3590 ± 70	33.0	−105.8	Fresnal Shelter
Beta 36744	wood charcoal		3510 ± 90	33.0	−105.8	Fresnal Shelter
Beta 36745	wood charcoal		3040 ± 70	33.0	−105.8	Fresnal Shelter
AA-6402	maize cob	x	2945 ± 55	33.0	−105.8	Fresnal Shelter
AA-6403	maize kernel		1665 ± 55	33.0	−105.8	Fresnal Shelter
AA-6404	bean		1955 ± 55	33.0	−105.8	Fresnal Shelter
AA-6405	bean		2015 ± 65	33.0	−105.8	Fresnal Shelter
AA-6406	maize kernel		1935 ± 65	33.0	−105.8	Fresnal Shelter
AA-6407	bean		2085 ± 60	33.0	−105.8	Fresnal Shelter
AA-6408	maize stalk		2015 ± 60	33.0	−105.8	Fresnal Shelter
AA-6409	maize cob	x	2880 ± 60	33.0	−105.8	Fresnal Shelter
AA-6410	maize kernel		1720 ± 65	33.0	−105.8	Fresnal Shelter
AA-6411	maize kernel		1690 ± 55	33.0	−105.8	Fresnal Shelter

Fortsetzung auf der nächsten Seite

Lab. Nr.	Material	A	C14-Alter	Breite	Länge	Fundort
Crawford 1997						
TO-5875	cupules		970 ± 50	42.7	−79.5	Grand Banks
TO-4584	kernel		1060 ± 60	42.7	−79.5	Grand Banks
TO-4585	cupules		1250 ± 80	42.7	−79.5	Grand Banks
NSRL-302	kernel and cupule		1450 ± 350	38.9	−89.6	Crane
TO-5308	cupules	x	1500 ± 150	42.7	−79.5	Grand Banks
TO-5307	cupules	x	1570 ± 90	42.7	−79.5	Grand Banks
N/A	kernel	x	1720 ± 105	39.0	−83.0	Edwin Harness
N/A	kernel	x	1730 ± 85	39.0	−83.0	Edwin Harness
Beta-16576	kernel		1775 ± 100	35.5883	−84.1917	Icehouse Bottom
AA-8718	kernel		2017 ± 50	38.7	−90.2	Holding
AA-8717	cob fragment		2077 ± 70	38.7	−90.2	Holding
PITT-1073	charcoal		1190 ± 40	41.1	−77.25	Memorial Park
UGa-2683	plant material		1245 ± 70	40.85	−77.65	Fisher Farm
M-1519	charcoal		1250 ± 120	41.6	−83.15	Sissung
GX-1743	charcoal		1345 ± 180	41.0	−81.7	Leimbach
DC-416	human bone		1340 ± 80	41.3	−83.2	Gard Island 2
DC-415	charcoal		1360 ± 95	41.3	−83.2	Indian Island
DC-414	charcoal		1410 ± 95	41.3	−83.2	Indian Island
S-2207	charcoal		1405 ± 60	43.9	−78.4	Dawson Creek
N/A	charcoal		1650 ± 70	41.7	−85.7	Eidson
Beta-19990	charcoal		1680 ± 80	34.55	−86.9	Walling Mound
SI-2051	charcoal		2325 ± 75	40.0	−80.4	Meadowcroft
SI-1674	charcoal		2290 ± 90	40.0	−80.4	Meadowcroft
Little 2002						
GX-19319	kernel	x	620 ± 59	41.67	−70.04	Cape Cod, MA
Beta-27676	kernel	x	620 ± 70	41.76	−72.59	Bernhm-Shep., CT
GX-21994	kernel	x	400 ± 60	42.49	−72.66	Deerfield R.,MA
Beta-84972	maize		310 ± 60	41.28	−73.06	Housatonic R., CT
Beta-84973	maize	x	690 ± 60	41.28	−73.06	Housatonic R., CT
Beta-84969	kernel	x	1050 ± 50	42.11	−73.72	Hudson R., NY
Beta-84970	kernel		850 ± 60	42.11	−73.72	Hudson R., NY
Beta-84971	kernel		390 ± 50	42.11	−73.72	Hudson R., NY
GX-22651	kernel		380 ± 50	42.56	−73.69	Hudson River., NY
Beta-15769	maize	x	610 ± 60	40.52	−74.16	Bowmans Brook, NY
Beta-123997	kernel		290 ± 40	41.27	−67.97	Nantucket, MA
Beta-123998	kernel	x	400 ± 30	41.18	−69.98	Nantucket, MA
GX-22044	kernel	x	500 ± 60	41.22	−70.13	Ram Pasture, MA
Beta-102060	cupule	x	600 ± 40	43.63	−70.50	Saco R., ME
Beta-15788	maize	x	555 ± 85	40.96	−72.23	Sebonac, NY
Hart 2003						
A0192	cooking residue	x	1231 ± 44	43.13	−76.76	Hunter's Home
A0193	cooking residue	x	1286 ± 40	43.13	−76.76	Hunter's Home
A0196	cooking residue		1138 ± 40	43.13	−76.76	Hunter's Home

Fortsetzung auf der nächsten Seite

Lab. Nr.	**Material**	**A**	**C14-Alter**	**Breite**	**Länge**	**Fundort**
A0197	cooking residue	x	1247 ± 48	43.13	−76.76	Hunter's Home
A0198	cooking residue		1211 ± 46	43.13	−76.76	Hunter's Home
GX-27484	cooking residue		1180 ± 40	43.13	−76.76	Hunter's Home
GX-27485	cooking residue	x	1280 ± 40	43.13	−76.76	Hunter's Home
GX-27486	cooking residue		1130 ± 40	43.13	−76.76	Hunter's Home
A0226	cooking residue	x	1461 ± 43	43.02	−76.77	Kipp Island
A0225	cooking residue	x	1470 ± 43	43.02	−76.77	Kipp Island
A0227	cooking residue	x	1428 ± 41	43.02	−76.77	Kipp Island
GX-26450	cooking residue	x	1410 ± 40	43.02	−76.77	Kipp Island
GX-27558	cooking residue		1360 ± 40	43.02	−76.77	Kipp Island
A0228	cooking residue		1260 ± 39	43.02	−76.77	Kipp Island
GX-26448	cooking residue		1280 ± 40	43.02	−76.77	Kipp Island
GX-26451	cooking residue		1240 ± 40	43.02	−76.77	Kipp Island
GX-26452	cooking residue		1170 ± 40	43.02	−76.77	Kipp Island
GX-27559	cooking residue		1210 ± 40	43.02	−76.77	Kipp Island
GX-26453	cooking residue		1220 ± 40	43.02	−76.77	Kipp Island
A0190	cooking residue	x	1425 ± 45	43.38	−76.33	Wickham
A0191	cooking residue		1228 ± 42	43.38	−76.33	Wickham
A0194	cooking residue		1648 ± 47	43.38	−76.33	Wickham
A0195	cooking residue	x	1450 ± 43	43.38	−76.33	Wickham
Fritz 1994, Long 1989						
AA-3314	maize		450 ± 40	18.46	−97.39	Coxcatlan XII
AA-3315	maize		1560 ± 50	18.46	−97.39	San Marcos zone D
AA-3309	maize		1860 ± 45	18.46	−97.39	Coxcatlan XI
AA-3307	maize		1900 ± 60	18.46	−97.39	Coxcatlan XIII
AA-3313	maize		3740 ± 60	18.46	−97.39	Cueva Coxcatlan
AA-3312	maize		4040 ± 100	18.46	−97.39	Cueva Coxcatlan
AA-3308	maize		4090 ± 50	18.46	−97.39	Cueva Coxcatlan
AA-3306	maize		4150 ± 50	18.46	−97.39	Cueva San Marcos
AA-3310	maize	x	4600 ± 60	18.46	−97.39	Cueva San Marcos
AA-3304	maize	x	4680 ± 50	18.46	−97.39	Cueva San Marcos
AA-3305	maize	x	4700 ± 60	18.46	−97.39	Cueva San Marcos
AA-3311	maize	x	4700 ± 110	18.46	−97.39	Cueva San Marcos
Smith 1997						
Beta-85432	maize		2560 ± 60	23	−100	Romero's cave
Beta-85431	maize	x	3930 ± 50	23	−100	Romero's cave
Beta-85433	cob	x	3890 ± 60	23	−100	Valenzuela's cave
Beta-85434	cob fragment		1380 ± 60	23	−100	Valenzuela's cave
Conard 1984						
NSRL-295	maize		250 ± 300	39.25	−90.5	Koster, Sq. 193-61
NSRL-296	maize		600 ± 400	39.25	−90.5	Koster, Sq. 411-12
NSRL-300	maize		450 ± 500	39.8	−89.4	Jasper Newman
NSRL-301	maize		0 ± 300	39.7	−90.7	Napoleon Hollow

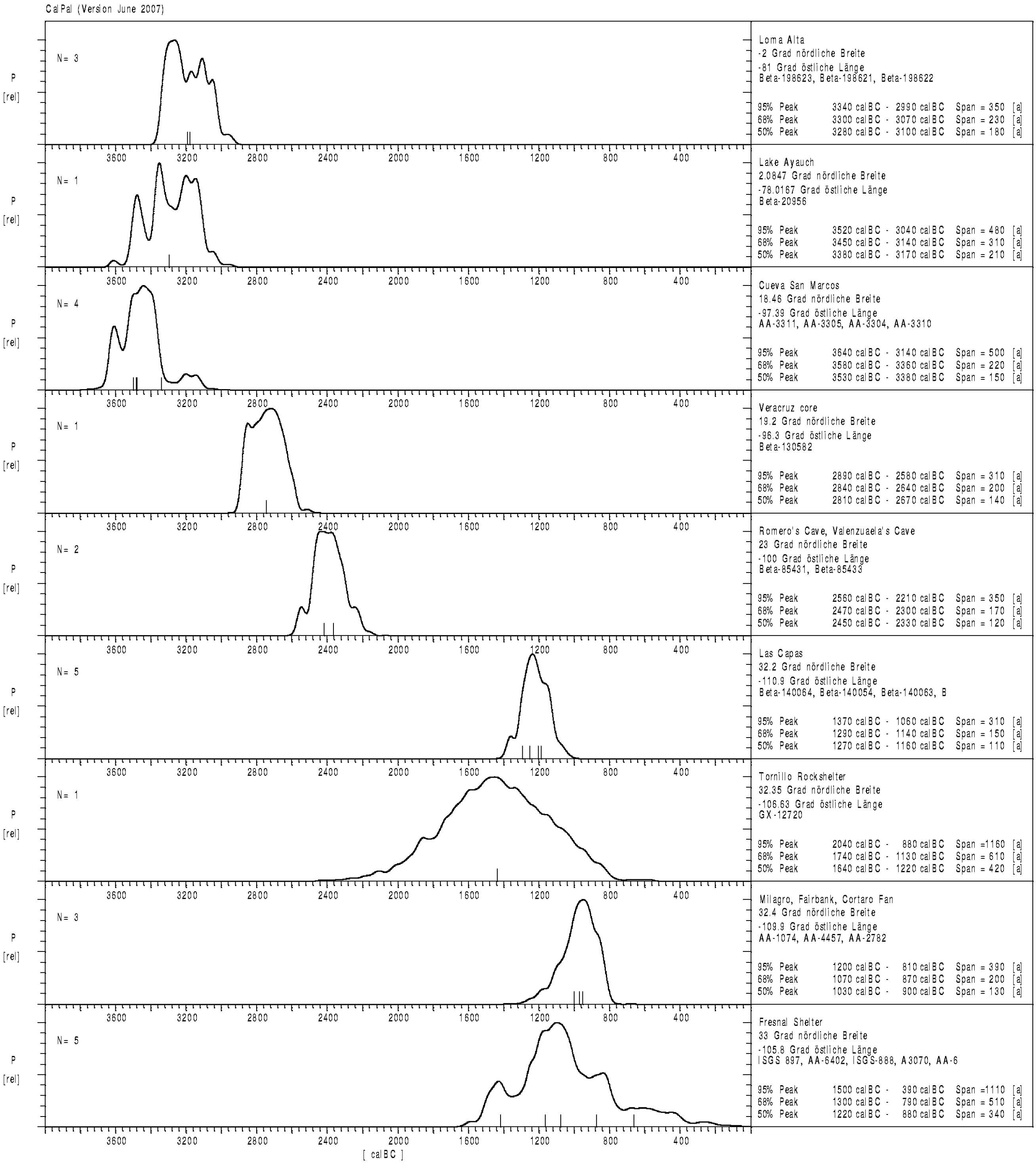
Fortsetzung auf der nächsten Seite

Lab. Nr.	Material	A	C14-Alter	Breite	Länge	Fundort
NSRL-302	maize	x	1450 ± 350	39.25	−90.4	Crane, 56E1-03
Bush 1989						
Beta-20956	associated	x	4570 ± 70	2.0847	−78.0167	Lake Ayauch
I-13,306	associated		7010 ± 130	2.0847	−78.0167	Lake Ayauch
Sluyter 2006						
OS-1339	Wood charcoal layer		2440 ± 35	19.2	−96.3	Veracruz core
OS-1332	Hardwood		3240 ± 65	19.2	−96.3	Veracruz core
OS-2528	N. reclivata		5450 ± 35	19.2	−96.3	Veracruz core
Beta-130582	Pollen fraction	x	4150 ± 50	19.2	−96.3	Veracruz core
OS-3190	R. mangle peat		5610 ± 60	19.2	−96.3	Veracruz core
OS-1334	R. mangle peat		6290 ± 50	19.2	−96.3	Veracruz core
OS-3176	R. mangle peat		6470 ± 85	19.2	−96.3	Veracruz core
Zarrillo 2008						
Beta-198623	cooking residue	x	4470 ± 40	−2.	−81.	Loma Alta
Beta-198621	cooking residue	x	4470 ± 40	−2.	−81.	Loma Alta
Beta-198622	cooking residue	x	4460 ± 40	−2.	−81.	Loma Alta
Whitehead 1965						
—	estimate	x	2100 ± 100	36.60	−76.45	Lake Drummond
Bartlett 1969						
UCLA-1335	associated		3170 ± 60	9.5	−80.	Gatun basin
UCLA-1353	associated		6230 ± 80	9.5	−80.	Gatun basin
UCLA-183	associated		7300 ± 130	9.5	−80.	Gatun basin
Crawford 2003						
TO-4586	cupules		1040 ± 60	42.7	−79.5	Lone Pine
TO-4584	kernel		1060 ± 60	42.7	−79.5	Grand Banks
TO-4585	cupules		1250 ± 80	42.7	−79.5	Grand Banks
TO-5308	cupules		1500 ± 150	42.7	−79.5	Grand Banks
TO-5307	cupules		1570 ± 90	42.7	−79.5	Grand Banks
Beta-53451	cupules	x	1090 ± 60	42.11	−73.72	211-1-1, NY
Beta-53452	cupule	x	1130 ± 70	42.11	−73.72	211-1-1, NY
TO-8150	cupule		1270 ± 100	42.7	−79.5	Meyer, ON
TO-7039	kernel		1150 ± 100			Forster, ON
Adair 2003						
UCR-3357	Zea mays		200 ± 50			Trowbridge
Beta-75015	Zea mays		310 ± 60			Trowbridge
Beta-75016	Zea mays		400 ± 60			Trowbridge
AA-36090	Zea mays		220 ± 40			14LT304
AA-36092	Zea mays		295 ± 40			14LT304
AA-36119	Zea mays		930 ± 45			Quarry Creek
AA-36120	Zea mays		975 ± 40			Quarry Creek
UCR-3356	Zea mays		1880 ± 50			Quarry Creek

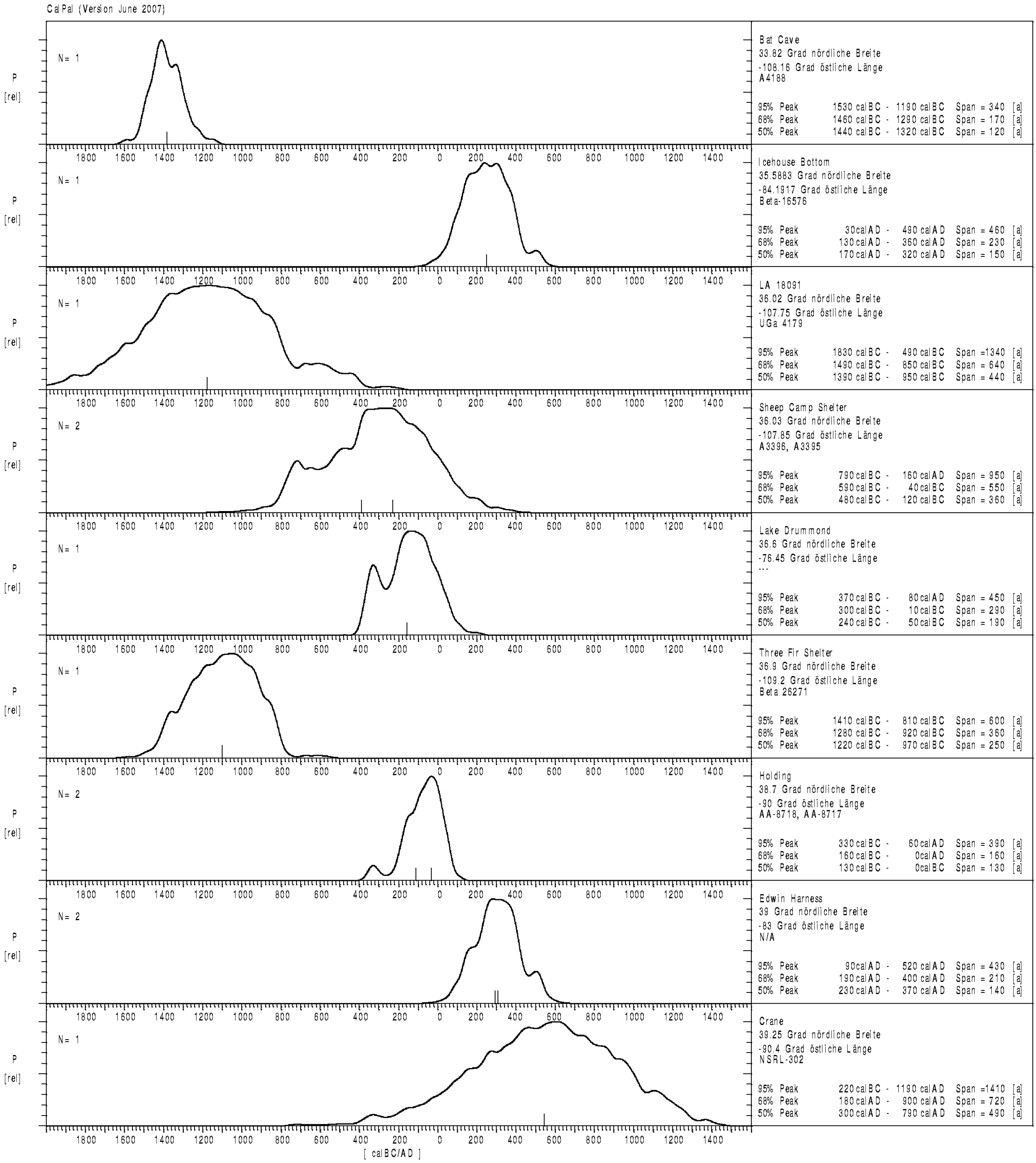
Fortsetzung auf der nächsten Seite

Lab. Nr.	Material	A	C14-Alter	Breite	Länge	Fundort
UCR-3355	Zea mays		900 ± 40			McPherson
AA-36114	Zea mays		345 ± 35			Radio Lane
AA-36115	Zea mays		390 ± 35			Radio Lane
AA-36116	Zea mays		305 ± 45			Radio Lane
AA-36101	Zea mays		1165 ± 40			Avoca
AA-36102	Zea mays		1220 ± 40			Avoca
AA-36097	Zea mays		1050 ± 40			Andrews
AA-36098	Zea mays		1040 ± 40			Andrews
AA-36113	Zea mays		925 ± 60			Two Deer
AA-41420	Zea mays		598 ± 39			14RH301
AA-36107	Zea mays		785 ± 40			Patterson
AA-36104	Zea mays		350 ± 35			El Quartelejo

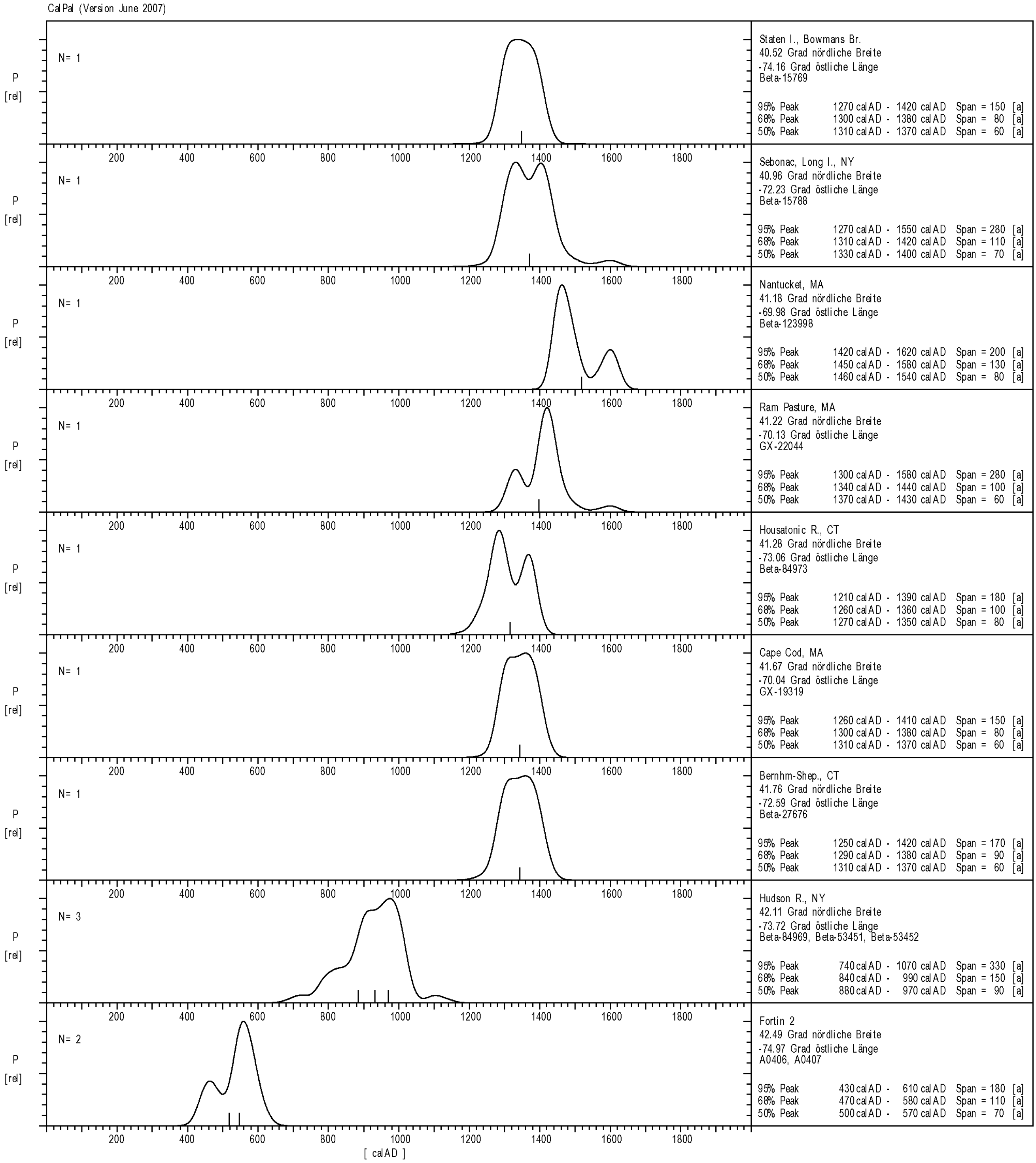
Tabelle 4: Vollständige Liste aller in der aufgeführten Literatur enthaltenen relevanten Datierungen mit Kennzeichnung der für die Auswertung ausgewählten.



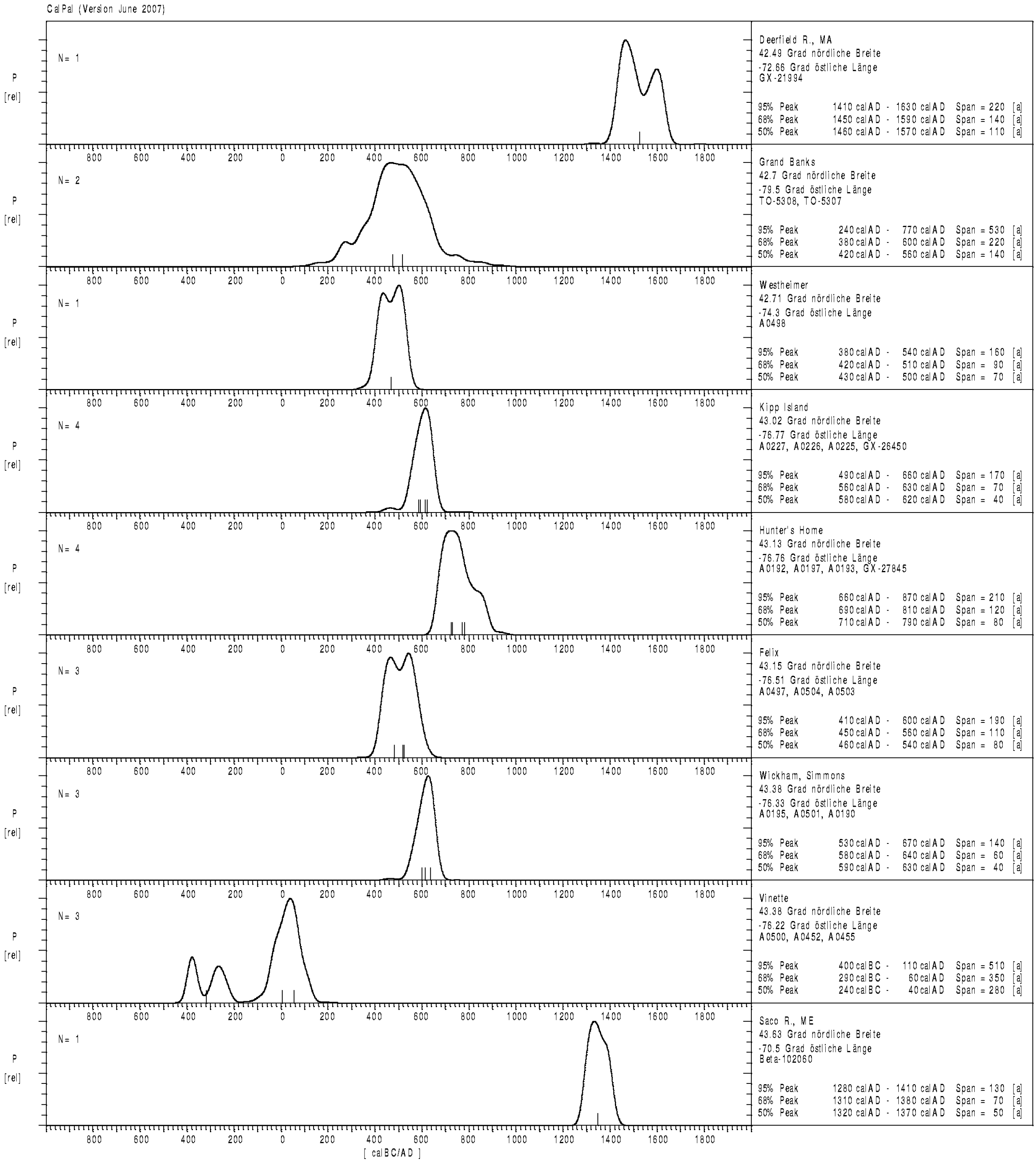
Tafel 1: Fundstellen südlich von 33° nördlicher Breite.



Tafel 2: Fundstellen zwischen 33° und 40° nördlicher Breite.



Tafel 3: Fundstellen zwischen 40° und 42.5° nördlicher Breite.



Tafel 4: Fundstellen nördlich von 42.5° nördlicher Breite.

B Abstracts der Zeitschriftartikel

Axtell 2002

Population growth and collapse in a multiagent model of the Kayenta Anasazi in Long House Valley.

Robert L. Axtell, Joshua M. Epstein, Jeffrey S. Dean, George J. Gumerman, Alan C. Swedlund, Jason Harburger, Shubha Chakravarty, Ross Hammond Jon Parker and Miles Parker

Long House Valley in the Black Mesa area of northeastern Arizona (U.S.) was inhabited by the Kayenta Anasazi from about 1800 before Christ to about anno Domini 1300. These people were prehistoric ancestors of the modern Pueblo cultures of the Colorado Plateau. Paleoenvironmental research based on alluvial geomorphology, palynology, and dendroclimatology permits accurate quantitative reconstruction of annual fluctuations in potential agricultural production (kg of maize per hectare). The archaeological record of Anasazi farming groups from anno Domini 200-1300 provides information on a millennium of sociocultural stasis, variability, change, and adaptation. We report on a multiagent computational model of this society that closely reproduces the main features of its actual history, including population ebb and flow, changing spatial settlement patterns, and eventual rapid decline. The agents in the model are monoagriculturalists, who decide both where to situate their fields as well as the location of their settlements. Nutritional needs constrain fertility. Agent heterogeneity, difficult to model mathematically, is demonstrated to be crucial to the high fidelity of the model.

Barlow 2002

Predicting Maize Agriculture among the Fremont: *An Economic Comparison of Farming and Foraging in the American Southwest*.

Variation in the costs and benefits of maize agriculture relative to local foraging opportunities structured variation in the relative intensity of agricultural strategies pursued by prehistoric peoples in the American Southwest. The material remains of Fremont farmers and horticulturists, long identified as the northern peripheryöf Southwestern archaeological traditions, are examined as a case representing extreme intersite variation in the economic importance of farming. New data quantifying the energetic gains associated with maize agriculture in Latin America are compared to caloric return rates for hunting and collecting indigenous foods. These data suggest that prehistoric maize farming was economically comparable to many local wild plants, but that intensive farming practices were most similar to very low-ranked seeds. The model predicts a continuum of prehistoric strategies that included horticulture within a system of indigenous resource collection and high residential mobility at one end, and at the other sedentary farmers heavily invested in agricultural activities with residences maintained near fields during a significant portion of the growing season. Differences in agricultural strategies should have been strongly influenced

by the effects of local ecology on the marginal gains for time spent in maize fields and the abundance of key, high-ranked wild foods, not harvest yields per se. Increasing agricultural investments are expected with decreasing opportunities to collect higher-ranked foods, while decreases in time spent farming are expected only with increases in alternative economic opportunities.

Bartlett 1969

Fossil Maize from Panama.

Abstract. Wild maize, agricultural maize, and associated Manihot fossil pollen indicative of early agriculture after about 7300 years ago have been discovered in the Gatun basin, Panama. The course of rising sea level in the Canal Zone during the past 11,300 years is calculated.

Benson 2003

Ancient maize from Chacoan great houses: Where was it grown?

pnas100-13111-Supplement.zip

In this article, we compare chemical (87Sr/86Sr and elemental) analyses of archaeological maize from dated contexts within Pueblo Bonito, Chaco Canyon, New Mexico, to potential agricultural sites on the periphery of the San Juan Basin. The oldest maize analyzed from Pueblo Bonito probably was grown in an area located 80 km to the west at the base of the Chuska Mountains. The youngest maize came from the San Juan or Animas river floodplains 90 km to the north. This article demonstrates that maize, a dietary staple of southwestern Native Americans, was transported over considerable distances in pre- Columbian times, a finding fundamental to understanding the organization of pre-Columbian southwestern societies. In addition, this article provides support for the hypothesis that major construction events in Chaco Canyon were made possible because maize was brought in to support extra-local labor forces.

Benz 1990

Studies in Archaeological Maize I: The "Wild" Maize from San Marcos Cave Reexamined.

Cobs of the earliest known archaeological maize from San Marcos Cave in the Tehuacan Valley were reexamined to estimate their morphological similarity to extant Mexican maize races. Cursory examination of these 7,000-year-old specimens aroused suspicion that they are not very closely related morphologically to any thusfar-described modern Mexican race. Statistical comparison of the Tehuacan specimens with 30 races of Mexican maize fully confirmed this suspicion. However, the inclusion in our statistical analysis of an extant race of popcorn from Argentina morphologically similar to the Tehuacan specimens indicated that the two were virtually indistinguishable. These findings imply that the earliest maize from Tehuacan already was fully domesticated, its cobs exhibiting a morphology one would expect had maize evolved from teosinte by way of catastrophic sexual transmutation (Iltis 1983).

Boyd 2006

Archaeobotanical evidence of prehistoric maize (Zea mays) consumption at the northern edge of the Great Plains.

Analysis of starch granules, phytoliths, and plant macrofossils from archaeological features and carbonized food residue provides important new insight into the extent of prehistoric maize (Zea mays) consumption on the North American Great Plains. These data suggest that consumption of maize, and probably other cultigens, was widespread on the eastern Canadian Prairies between approximately AD 1000 and 1600. Domesticated plants may have been grown locally, acquired through trade, or transported into the region following dispersal of family groups from horticultural villages located elsewhere. However, the lack of strong artifactual evidence of gardening, and the small-scale nature of sites on the eastern Canadian Prairies indicate that local horticulture, if practiced, was non-intensive.

Bush 1989

A 6 000 year history of Amazonian maize cultivation.

We present pollen and phytolith evidence for maize (Zea mays L.) cultivation in lowland Ecuadorian Amazonia as early as 5,300 radiocarbon years BP (before present), equivalent to about 6,000 calendar years BP'. This date for maize cultivation is more than 2,000 years earlier than any previously reported from the Amazon basin2. Although maize has been cultivated for at least 7,000 years in Mexico3'4, the manner of its dispersal through South America is still uncertain2'6. Evidence from coastal Ecuador6 suggests that maize had been taken south across the equator by 7,000 years BP. The oldest macrofossil evidence from Ecuador, however, is from about 3,400 years BP7. Our discovery of Zea microfossils in Amazonian lake sediments from Ecuador at about 6,000 years BP suggests that maize cultivation spread into the Amazon lowlands soon after its arrival in South America.

Coltrain 2002

Climate and Diet in Fremont Prehistory: *Economic Variability and Abandonment of Maize Agriculture in the Great Salt Lake Basin*.

Research reported here is based on the stable isotope (6'3C, 615N) and radiocarbon chemistry of Fremont burials from wetlands lining the eastern shores of the Great Salt Lake (GSL). Bone collagen stable isotope signatures covary with reliance on maize and intake of animal protein, facilitating useful reconstructions of past diet. Among the GSL Fremont, economic strategies vary over time with an initial increase in reliance on maize (A.D. 400-850)followed by a period of marked economic diversity (A.D 850-1150) then a return to reliance on wildfoods (afterA.D. 1150). During the period of greatest economic diversity, male andfemale diets vary significantly and male diets are correlated with status differences evidenced by grave goods. There is also a clear temporal correlation between the rapid abandonment of maize agriculture and significant moisture anomalies in regional tree-ring chronologies and pollen profiles. These results are discussed in the context of recent arguments regarding economic diversity, social complexity, and the demise of the Fremont.

Conard 1984

Accelerator radiocarbon dating of evidence for prehistoric horticulture in Illinois.

With the development of direct detection radiocarbon dating, which uses an accelerator as part of a highly selective mass spectrometer, it is now possible to determine the age of milligram samples of organic materials1"5. One application of accelerator dating is in evaluating scanty, sometimes controversial evidence for early horticulture throughout the world. We have now used the technique to date small samples of carbonized, cultivated plant remains from archaeological sites in Illinois. The results, reported here, establish (1) that squash was introduced by 7,000 yr ago, 2,500 yr before eastern North American records previously reported; (2) that horticulture involving indigenous plants had begun by 4,000 BP in eastern North America with domestication of Iva anniio, a small-seeded annual; (3) that anomalous discoveries of Archaic period maize represent contaminants; and (4) that introduction of maize by initial Middle Woodland times (-2,000 BP) is questionable.

Crawford 1997

Dating the Entry of Corn (Zea Mays) into the Lower Great Lakes Region.

Five accelerator mass spectrometer (AMS) dates on corn (maize or Zea mays) from the Grand Banks site, Ontario, range from cal A.D. 540 to 1030. These are the earliest directly dated corn samples in the Lower Great Lakes region. The presence of corn during the Princess Point Complex, a transitional Late Woodland phase preceding the Ontario Iroquoian Tradition, is confirmed as is an early presence of the Princess Point culture in Ontario. Maize appears to have spread rapidly from the Southeast and/or Midwest to Ontario. The corn cupules and kernel remains are fragmentary, as they are elsewhere in the Eastern Woodlands during this period. The limited morphological data indicate that the corn is a diminutive form of Eastern Eight-Row, or Eastern Complex, maize.

Diehl 1996

The Intensity of Maize Processing and Production in Upland Mogollon Pithouse Villages A.D. 200–1000.

Analyses of the size, shape, and wear on western Mogollon manos and metates reveal that the dietary importance of maize remained low and stable from the Early Pithouse period (A.D. 200-550) through the Georgetown phase (A.D. 550-700). The consumption of maize increased during the San Francisco phase (A.D. 700-825/850) and continued to increase through the Three Circle phase (A.D. 825/850-1000). Changes in the ubiquity of charred pieces of maize (Zea mays) from paleoethnobotanical samples also indicate an increase in maize consumption from the Early Pithouse period through the Three Circle phase. The onset of increased maize consumption roughly coincided with the introduction of an improved variety of eightrow maize, around A.D. 650-700 (Upham et al. 1987). The analyses presented in this study do not agree with recent suggestions (Gilman 1987; Mauldin 1991) that maize consumption in the western Mogollon region remained stable and low until the Classic Mimbres phase (A.D. 1000-1150).

Elson 2002

Lava, Corn, and Ritual in the Northern Southwest.

Fifty-five pieces of lava with impressions of prehistoric corn have recently been recovered from NA 860, a small habitation site near Sunset Crater Volcano in northern Arizona. Archaeological, geological, and botanical information suggest that husked ears of corn were deliberately placed in the lava's path when the volcano erupted in the mid-to-late eleventh century A.D. Over 40 kg of basalt lava containing the hardened corn casts were then taken to NA 860 located 4 km away from the lava flow. At the site, the rocks underwent lithic reduction to expose the casts. We suggest that these corn rocksäre indicative of ritual practices, perhaps serving as an offering made to appease the forces responsible for the eruption. Although both prehistoric and modern offerings are commonly associated with volcanoes in other parts of the world, this is the first evidence from the Southwest United States of possible ritual behavior related to volcanism.

Eubanks 1997

Reevaluation of the Identification of Ancient Maize Pollen from Alabama.

Fearn and Liu (1995) reported positive identification of a large Poaceae pollen grain recovered from a lake bed core in Alabama dating to 3500 B.P as Zea mays. Reinterpretation of old data and new data reported here indicate this identification is questionable. Review of the evidence at hand indicates the most likely identification of the pollen grain in question is Tripsacum, although it could be primitive maize, teosinte, or Zea ïndiana,ä hybrid between Tripsacum and teosinte. Until the sample size is expanded and a firm identification can be made, caution is urged in interpretations about the significance of thisfindfor early maize agriculture in eastern North America.

Eyre-Walker 1998

Investigation of the bottleneck leading to the domestication of maize.

ABSTRACT Maize (Zea mays ssp. mays) is genetically diverse, yet it is also morphologically distinct from its wild relatives. These two observations are somewhat contradictory: the first observation is consistent with a large historical population size for maize, but the latter observation is consistent with strong, diversity-limiting selection during maize domestication. In this study, we sampled sequence diversity, coupled with simulations of the coalescent process, to study the dynamics of a population bottleneck during the domestication of maize. To do this, we determined the DNA sequence of a 1,400-bp region of the Adh1 locus from 19 individuals representing maize, its presumed progenitor (Z. mays ssp. parviglumis), and a more distant relative (Zea luxurians). The sequence data were used to guide coalescent simulations of population bottlenecks associated with domestication. Our study confirms high genetic diversity in maize-maize contains 75is more diverse than its wild relative, Z. luxurians-but it also suggests that sequence diversity in maize can be explained by a bottleneck of short duration and very small size. For example, the breadth of genetic diversity in maize is consistent with a founding population of only 20 individuals when the domestication event is 10 generations in length.

Fearn 1995

Maize Pollen of 3500 B.P. From Southern Alabama.

A large Gramineae pollen, positively identified as corn (Zea mays), from the sediments of Lake Shelby in coastal Alabama at a stratigraphic level securely dated to 3500 B.P. predates any other evidence for corn in eastern North America by at least 1,000 years. Currently, the most frequently cited and accepted date for corn in eastern North America is approximately 1800 B.P. from macrobotanical remains; however, several paleoecological studies have reported corn pollen in older contexts. The Lake Shelby pollen adds to a growing body ofmicrofossil evidence supporting the presence of maize in eastern North America much earlier than the macrobotanical records indicate. Corn was probably present in eastern as well as western North America by 3000 B.P.

Fearn 1997

Identification of Maize Pollen: Reply to Eubanks.

Eubanks bases her identification of the fossil pollen grain from Alabama as Tripsacum primarily on her calculated spinule density. To make those calculations, she used only our published photograph, and she assumed a grain expansion of 35 percent. She ignores the fact that the spinule density of the fossil pollen grain is actually the same as that of similarly treated Zea mays pollen. While there is always the possibility of a misidentification or of long-distance transport, the most likely interpretation remains that the 3500 B. P pollen grain is Zea mays and that it represents limited cultivation of ancient corn in southern Alabama.

Hart 2003

Phytolith Evidence for Early Maize (Zea Mays) in the Northern Finger Lakes Region of New York.

The timing of crop introductions, particularly of maize (Zea mays), has been of long-standing interest to archaeologists working in various regions of eastern North America. The earliest confirmed macrobotanical evidence for maize in New York is A.D. 1000. We report on the results of accelerator mass spectrometer (AMS) dating, phytolith analysis, and stable carbon isotope analysis of carbonized cooking residues adhering to the interior surface of pottery sherds from three sites in the northern Finger Lakes region of New York. Maize, squash (Cucurbita sp.), wild rice (Zizania aquatica), and sedge (Cyperus sp.) were identified in phytolith assemblages dating to as early as the first half of the calibrated seventh century A.D. The results demonstrate that low 613C values on cooking residues cannot be used to preclude the possibility that maize was cooked in vessels. Two of the maize-bean-squash crop triad were present in New York at least 350 years earlier than previously documented, and the Northern Flint Corn Complex was present in New York by at least the first half of the seventh century A.D. This research highlights the potential of cooking residues to provide new insights on prehistoric plantbased subsistence.

Holst 2007

Identification of teosinte, maize, and Tripsacum in Mesoamerica by using pollen, starch grains, and phytoliths.

pnas104-17608-Supplement.html, pnas104-17608-Supplement.zip

We examined pollen grains and starch granules from a large number of modern populations of teosinte (wild Zea spp.), maize (Zea mays L.), and closely related grasses in the genus Tripsacum to assess their strengths and weaknesses in studying the origins and early dispersals of maize in its Mesoamerican cradle of origin. We report new diagnostic criteria and question the accuracy of others used previously by investigators to identify ancient maize where its wild ancestor, teosinte, is native. Pollen grains from teosinte overlap in size with those of maize to a much greater degree than previously reported, making the differentiation of wild and domesticated maize in palynological studies difficult. There is presently no valid method for separating maize and teosinte pollen on a morphological basis. Starch grain analysis, a recently developed tool of archaeobotany, appears to be of significant utility in distinguishing the seeds of teosinte from maize. We propose that the differences in starch grain morphology and size between wild and domesticated

maize defined in this study may be associated with domestication genes in Zea that have been documented in the starch biosynthesis pathway. As previously reported, phytoliths effectively discriminate the female reproductive structures of Tripsacum, teosinte, and maize. Multiproxy microfossil studies of archaeological and paleoecological contexts appear to be effective tools for investigating the earliest stages of maize domestication and dispersals.

Hutchinson 1998

Regional Variation in the Pattern of Maize Adoption and Use in Florida and Georgia.

Dietary reconstruction using carbon and nitrogen stable isotopes from archaeological human bone samples from coastal Georgia anil northern and Gulf Coast Florida dating between 400 B.C. and A.D. 1700 serves to Illustrate the complexity of the agricultural transition in that region. Isotope analysis of 185 collagen samples drawn from early prehistoric, late prehistoric, and contact-period mortuary sites encompasses two major adaptive shifts in the region, namely the adoption of maize agriculture in late prehistory and the increased emphasis on maize during the mission period. Prior to European contact- and especially before the establishment of Spanish missions among the Guale, Yamasee, Timucua, and Apahichee tribal groups-diet was strongly influenced by local environmental factors. Before contact, coastal and inland populations had different patterns of food consumption, as did populations living in Georgia and Florida. Coastal populations consumed more marine and less terrestrial foods than inland populations. In general, maize was adopted during the eleventh century A.D. by virtually all Georgia populations. However, with the exception of the Lake Jackson site, a major Mississippian center in northern Florida, Florida populations show little use of maize before contact. Following European contact, maize became widespread, regardless of location or habitat within the broad region of Spanish Florida. Missionization appears to have been an important factor in the convergence of native diets toward agriculture and away from foraging. This increased emphasis on maize contributed to a decline in quality of life for native populations.

Jaenicke-Després 2003

Early Allelic Selection in Maize as Revealed by Ancient DNA.

Maize was domesticated from teosinte, a wild grass, by 6300 years ago in Mexico. After initial domestication, early farmers continued to select for advantageous morphological and biochemical traits in this important crop. However, the timing and sequence of character selection are, thus far, known only for morphological features discernible in corn cobs. We have analyzed three genes involved in the control of plant architecture, storage protein synthesis, and starch production from archaeological maize samples from Mexico and the southwestern United States. The results reveal that the alleles typical of contemporary maize were present in Mexican maize by 4400 years ago. However, as recently as 2000 years ago, allelic selection at one of the genes may not yet have been complete.

Kidder 1993

Subsistence and Social Change in the Lower Mississippi Valley: *The Reno Brake and Osceola Sites, Louisiana*.

There are few systematic analyses of late prehistoric subsistence practices in the Lower Mississippi Valley. Nonetheless, traditional scenarios attribute the advent of large-scale social and political complexity during the Coles Creek (ca. A.C. 700-1200) and early Mississippi (ca. A.C. 1200-1500) periods to maize agriculture and a consequent food surplus. Subsistence studies, however, do not substantiate claims for intensive maize cultivation prior to A.C. 1000. The goal of the Osceola Project is to characterize subsistence practices and changes through time and to relate these patterns to innovations in social and political organization during the nearly 1500 years leading up to and including the Mississippi period. Information from several sites in the Tensas Basin of Louisiana points to a late Middle Woodland and early Late Woodland pattern of reliance on wild local foods, possibly supplemented by limited plant food production. Corn is found first in Late Coles Creekperiod contexts (ca,. A.C. 1000-1200) but was not necessarily an important dietary staple. Data from the Osceola Project suggest that the initial construction of planned sites with large earthen mounds during the Coles Creek period predates the appearance of an intensified food production economy by at least several hundred years.

Kohler 2008

The Neolithic Demographic Transition in the U. S. Southwest.

Maize agriculture was practiced in the U.S. Southwest slightly before 2000 B. C., but had a negligible impact on population growth rates until the development or introduction of more productive landraces; the ability to successfully cultivate maize under a greater variety of conditions, with dry farming especially important; the addition of beans, squash, and eventually turkey to the diet; increased sedentism; and what we infer to be the remapping of exchange networks and the development of efficient exchange strategies in first-millenium-A.D. villages. Our estimates of birthrates and growth rates are derived from the proportions of immature individuals among human remains. These proportions are somewhat affected by warfare in our region, and perhaps also by climate. Nevertheless, there is a strong identifiable Neolithic Demographic Transition signal in the U.S. Southwest in about the mid-first-millennium A.D. in most subregions, visible a few hundred years after the introduction of well-fired ceramic containers, and more or less contemporaneous with the first appearance of villages. Independent genetic data derived from the mitochondrial genomes of present-day indigenous populations of the Southwest are also consistent with the hypothesis that a major demographic expansion occurred 1500–2000 years ago in the Southwest.

Little 1995

The Late Woodland Diet on Nantucket Island and the Problem of Maize in Coastal New England.

Carbon and nitrogen isotope ratios of () bone collagen from six burials of the Late Woodland Period at Nantucket Island, Massachusetts, and (2) a wide range of potential dietary materials provide data for evaluating coastal diets. Archaeological and historical data give evidence for the availability and use of dietary items. The bases of the food chains and trophic levels define the possible food groups: terrestrial C_3 and C_4 plants and their consumers, marine C_3 or C_4-like plants and their consumers, and marine carnivores. From these data, computer analysis of multiple linear mixing equations relating isotope ratios of human bone collagen to those of dietaryfood groups shows allowable ranges of these food groups in the diet. The results argue for a diet of 40-65 percent oceanic animals, with the rest consisting of substantial amounts of animals from salt marsh and eelgrass meadows or of maize, and minor amounts of C_3 plants and their consumers.

Little 2002

Kautantouwit's Legacy: Calibrated Dates on Prehistoric Maize in New England.

This paper (1) presents four new AMS dates taken directly on prehistoric maize found in New England; (2) collects in one place and in a common format the 16 currently available dates directly on maize from the region; (3) shows, by comparing dates on charcoal or shell associated with 10 of these maize samples, that charcoal and shell are not reliable proxies for dating maize; and (4) draws several archaeological inferences from the dataset. First, a cluster of dates between about cal A.D. 1250 and 1450 that are temporally concentrated but spatially widespread suggests a relatively sudden increase in the archaeological visibility of maize in New England at this time. The increase in visibility roughly coincides with an increase in maize consumption in the midcontinent, although further studies are needed to clarify the timing of the latter. Second and even more striking is the simultaneous increase in the archaeological visibility of beans as well as maize in New England during the same period, finally, preliminary evidence suggests that these increases may be related to the use of soils fertilized by alluvial limestone or old shell midden material.

Long 1989

First Direct AMS Dates on Early Maize from Tehuacan, Mexico.

ABSTRACT. The Tehuacan region in Central Mexico is thought to be the locale of origin of Zea mays, or maize, a cultivated plant pivotal in the development of agriculture in the Americas (MacNeish, 1981, 1985). The age of the earliest maize, and its rate of dispersal are thus important components of cultural development in the New World. We have secured permission from the Federal Government of Mexico to date critical specimens from Tehuacan, which represent what are probably some of the earliest known stages of maize evolution. Twelve Zea mays samples have been dated, six from Cueva San Marcos and six from Cueva Coxcatlan. These were selected as having the best stratigraphic control and correlation with previously dated charcoal samples, and to represent the most ancient maize. Corn from Cueva San Marcos is oldest: four of the six specimens from this cave were within statistics of 4700 BP (uncalibrated). The oldest known domesticated corn is thus no older than 3600 cal BC (dendro-calibrated in calendric years).

Long 2001

Validity of AMS Dates on Maize from the Tehuacan Valley: *A Comment on Macneish and Eubanks*.

MacNeish and Eubanks (2000) reject the AMS radiocarbon dates on maize from the Tehuacdn Valley, claiming that the specimens were contaminated with a substance called Bedacryl. We do not believe that the dated fragments were contaminated, and we review the processes by which they were selected and analyzed. We also describe Bedacryl and conclude that, had it been present as a contaminant, the resulting I4C ages should have been older rather than younger than expected. Considered along with recent AMS dates on cuitigens from Tamaulipas, it seems evident that post-depositional disturbances in rock-shelter sites sometimes caused mixing of older and younger objects. Direct AMS radiocarbon daring is currently the best and least destructive way to determine whether or not an individual plan! specimen is the same age as seemingly associated wood charcoal.

MacNeish 2000

Comparative Analysis of the Rio Balsas and Tehuacan Models for the Origin of Maize.

This paper examines the archaeological and biological evidence for shifts in human subsistence strategies during the transition from hunting and foraging to maize agriculture as posited in the Rio Balsas, or lowland origin of maize, model and the Tehuacdn, or highland origin of maize, model. These are two different interpretations of the genetic evidence for the ancestry of maize, the archaeological evidence for plant exploitation, and the ecological evidence for paleoenvironments and climate change in the two regions. In contrast to Panama, where there is good evidence for progressive intensification of human forest disturbance by 10,000 B.P, horticulturalforest clearing by 8000 B.P, and slash-and-burn agriculture by 6000 B.P., the evidencefor Mesoamerica, where maize agriculture originated, fits a different picture of biocultural evolution. The lowland regions of Mexico, Guatemala, Belize, and probably Honduras, were apparently undisturbed, semi-evergreen forests around 10,000 B.P. New findings from experimental maize genetics, combined with the comprehensive archaeological picture from Tehucdn, Oaxaca, Tamaulipas, and the Valley of Mexico, support a highland Mesoamerican origin of maize.

MacNeish 2001

A Response to Long's Radiocarbon Determinations That Attempt to Put Acceptable Chronology on the Fritz.

Long and Fritz argue that AMS dates on early maize were rejected because MacNeish suspected they were contaminated with bedacryl. In fact a letter from MacNeish to Long in 1988 addressed several possible explanations for the problems with the dates. The dates were rejected because they were inconsistent with well-established stratigraphic sequences and associated artifacts and ecofacts. The evidence is briefly summarized here, and the inconsistencies in [he Arizona dates pointed out. It appears that the problem lies less with possible contamination with bedacryl, and more with the treatment of the samples by the Arizona laboratory.

Matsuoka 2002

A single domestication for maize shown by multilocus microsatellite genotyping.

pnas099-06080-Supplement.zip

There exists extraordinary morphological and genetic diversity among the maize landraces that have been developed by preColumbian cultivators. To explain this high level of diversity in maize, several authors have proposed that maize landraces were the products of multiple independent domestications from their wild relative (teosinte). We present phylogenetic analyses based on 264 individual plants, each genotyped at 99 microsatellites, that challenge the multiple-origins hypothesis. Instead, our results indicate that all maize arose from a single domestication in southern Mexico about 9,000 years ago. Our analyses also indicate that the oldest surviving maize types are those of the Mexican highlands with maize spreading from this region over the Americas along two major paths. Our phylogenetic work is consistent with a model based on the archaeological record suggesting that maize diversified in the highlands of Mexico before spreading to the lowlands. We also found only modest evidence for postdomestication gene flow from teosinte into maize.

McClung 2005

Radiocarbon Dates From Soil Profiles in the Teotihuacán Valley, Mexico: *Indicators of Geomorphological Processes*.

ABSTRACT. Radiocarbon dates largely obtained from bulk soil samples in 24 soil profiles in the Teotihuac·n Valley, Mexico, are reported insofar as they represent a first step towards developing a sequence of soil formation, erosion, vegetation change, and human impact during the Holocene. Limitations of 14C dating in the area are considered, particularly the absence of charcoal in sediments and poor preservation of pollen. A broad temporal scheme is proposed to guide future research in which 4 periods are defined: 5000-2000 BP (relative stability with short, intermittent episodes of erosion); 2000-1500 BP (erosion-sedimentation, deforestation, and intensive agriculture); 1500-1000 BP (relative stability, depopulation, and partial recovery of the landscape); and 1000-500 BP (erosion- sedimentation, deforestation, and intensive agriculture).

Murphy 1971

Maize from an Adena Mound in Athens County, Ohio.

Abstract. The discovery of a carbonized ear of maize in an Adena burial mound at Athens, Athens County, Ohio, is the first indisputable evidence of Adena maize horticulture. The mound contained typical middle Adena features, including a bark prepared burial, and has yielded charcoal radiocarbon dated at 280 B.C. +/- 140 years.

Pearsall 1990

Antiquity of Maize Cultivation in Ecuador: *Summary and Reevaluation of the Evidence*.

Identification of maize phytoliths from the Preceramic Vegas and Formative period Real Alto sites, Guayas Province, Ecuador, has raised the issue of the antiquity of maize in Ecuador. This paper reviews how maize is identified using phytoliths and addresses criticisms of this technique. Our reexamination of the original Vegas and Real Alto samples using Piperno's three-dimensional variant method confirms the presence of maize in western Ecuador by at least 5000 B.C. Remains of charred maize from other sites suggest that more than one race was being utilized by the Formative period.

Perry 2006

Early maize agriculture and interzonal interaction in southern Peru.

Over the past decade, increasing attention to the recovery and identification of plant microfossil remains from archaeological sites located in lowland South America has significantly increased knowledge of pre-Columbian plant domestication and crop plant dispersals in tropical forests and other regions1-4. Along the Andean mountain chain, however, the chronology and trajectory of plant domestication are still poorly understood for both important indigenous staple crops such as the potato (Solanum sp.) and others exogenous to the region, for example, maize (Zea mays)5,6.Here we report the analyses of plant microremains from a late preceramic house (3,431 6 45 to 3,745 6 65 14C BP or ,3,600 to 4,000 calibrated years BP) in the highland southern Peruvian site ofWaynuna. Our results extend the record of maize by at least a millennium in the southern Andes, show on-site processing of maize into flour, provide direct evidence for the deliberate movement of plant foods by humans from the tropical forest to the highlands, and confirm the potential of plant microfossil analysis in understanding ancient plant use and migration in this region.

Pohl 2007

Microfossil evidence for pre-Columbian maize dispersals in the neotropics from San Andrés, Tabasco, Mexico.

pnas104-06870-Supplement.html

The history of maize (Zea mays L.) is one of the most debated topics in New World archaeology. Molecular and genetic studies indicate that maize domestication took place in tropical southwest Mexico. Although archaeological evidence for the evolution of maize from its wild ancestor teosinte has yet to be found in that poorly studied region, other research combining paleoecology and archaeology is documenting the nature and timing of maize domestication and dispersals. Here we report a phytolith analysis of sediments from San Andre' s, Tabasco, that confirms the spread of maize cultivation to the tropical Mexican Gulf Coast >7,000 years ago (7,300 calendar years before present). We review the different methods used in sampling, identifying, and dating fossil maize remains and compare their strengths and weaknesses. Finally, we examine how San Andre' s amplifies the present evidence for widespread maize dispersals into Central and South America. Multiple data sets from many sites indicate that maize was brought under cultivation and domesticated and had spread rapidly out of its domestication cradle in tropical southwest Mexico by the eighth millennium before the present.

Reber 2004

Identification of maize in absorbed organic residues: a cautionary tale.

Starchy grains are an essential part of human diet in most agricultural groups, and are attributed an important role in the development of complex societies. Maize is a starchy grain domesticated in Mesoamerica that was an important foodstuff throughout the Americas before Contact, and around the world afterwards. An experimental study of the degradation of maize lipids suggests that the unsaturated fatty acids comprising the majority of maize lipids degrade rapidly, producing a virtually unidentifiable organic residue after 3 months deposition. Compounds in maize lipids decompose variably, depending upon depositional environment, making calibration of organic residue degradation impracticable. Variable decomposition of components of absorbed organic residues makes a wider range of improved experimental studies important, and suggests that identifying maize, and by implication starchy grains, from chemical analysis of absorbed organic residues requires a wider range of approaches than those previously attempted.

Riley 1990

Cultigens in Prehistoric Eastern North America: Changing Paradigms *[and Comments and Replies]*.

The widely accepted view that eastern North America was a separate center of plant domestication has resulted in an increasingly isolationist perspective on the region's culture history and a neglect of research on the diffusion into it of tropical cultigens. New data on archaeobotanical macromorphologies, the chemical and chromosomal composition of archaeobotanical specimens, and the geographical distribution of archaeobotanical remains challenge old paradigms. In particular, the diffusion of tropical cultigens across the Caribbean must now be seriously considered. This paper reports on current research suggesting alternatives to existing paradigms in relation to four plants (maize, tobacco, beans, and chenopods) and stresses prehistoric eastern North America's relationship to, instead of isolation from, Mesoamerica and South America.

Riley 1994

Accelerator Mass Spectrometry (AMS) Dates Confirm Early Zea Mays in the Mississippi River Valley.

Two accelerator mass spectrometry (AMS) dates obtained from samples of Zea mays from the Holding site, 1 JMS1] 18, in the American Bottom near East St. Louis, Illinois, establish the presence of maize in the Mississippi Valley between 170 B.C. and A.D. 60. The dates finally establish the occurrence of Middle Woodland maize in Illinois and are the earliest dates thus far for maize east of the Mississippi River. Other reports of early Middle Woodland maize in the Midcontinent region should not be discounted unless AMS dating and other supporting information show the maize to be a contaminant at the site at which it occurs. Recent stable carbon-isotope experiments suggest that the relative contribution of maize to Middle Woodland diets is still an open question.

Rose 2008

Intra-Community Variation in Diet During the Adoption of a New Staple Crop in the Eastern Woodlands.

This study investigated intracommunity variation in diet during the introduction and adoption of a new staple crop (maize) into an indigenous horticultural system. Carbon and nitrogen isotopes of human bone collagen were analyzed from five sites in west-central Illinois, dating from the Middle Woodland to Mississippian periods, and the results contrasted with evidence from neighboring river valleys and the wider Eastern Woodlands area. Contrary to speculation, neither the initial adoption of maize nor subsequent intensification in its use were correlated with status, gender, or age. A striking bimodal distribution was observed in consumption of native and introduced crops; growing or eating small amounts of maize was apparently not practiced. Fluoride dating confirms the burials are contemporary, and the pattern persists over several hundred years. Possible explanations include issues related to the economics of maize growing, household requirements for storage, exchange, or levies, or individual taste. Also notable were earlier-than-expected dates for intensive exploitation of the maize in this area, in the early Late Woodland, possibly as early as A.D. 400. Nitrogen isotope ratios were higher for males at all sites and time periods; the cause may have been greater access to dietary protein, or could be the result of physiological differences.

Römkens 1998

Soil Organic ^{14}C Dynamics: *Effects of Pasture Installation on Arable Land*.

ABSTRACT. In a study addressing composition and recovery of soil carbon following pasture installation on arable land, radiocarbon isotope ratios were measured in size- and density-separated soil organic matter (SOM) fractions in a pasture and maize plot. The average soil carbon age increased with depth from 444 yr in the 0-30- cm layer to 2456 yr in the 60–80-cm layer in the pasture soils, and from 42 to 1625 yr in the maize-cultivated soil. Weight fractionation of the macro-organic matter (size >150 um) in a light (density <1.17 g cm-3) intermediate (1.17 g cm'3 < density < 1.37 g cm'3), and heavy fraction (density >1.37g cm-3) resulted in markedly different ages for different fractions with ages increasing from

2 yr in the light fraction to >3000 yr in the heavy fractions. 13C and 14C (accelerator mass spectrometry (AMS)) isotope ratios in the <20 um fraction in the 60-80-cm layer indicated that vertical displacement of colloidal organic material occurred during maize cropping. The physical fractionation method, in combination with natural level 13C and 14C analysis, resulted in a better insight in carbon dynamics that occur after the conversion of arable land to pasture.

Rue 1989

Archaic Middle American Agriculture and Settlement: Recent Pollen Data from Honduras.

Data on Late Archaic period (5000-1000 B.C.) agriculture and settlement in SE Mesoa-merica and Lower Central America are reassessed in view of recent findings. Pollen data from Lake Yojoa in western Honduras are presented to support a re-synthesis of views on the development of food production systems in the region. Traditional interpretations of the cultural sequence surest that the area was colonized by agriculturalists relatively late (1000 B.C.) . Pollen from a core taken at Yojoa indicate that the region was inhabited by people practicing slash-and-burn maize horticulture by 3000 B.C., probably as a supplement to hunting and gathering systems. These and other data from throughout Middle America show that diffusion of maize cultivation from Mexico occurred earlier than expected to many areas of the Central American tropics.

Schroeder 1999

Maize Productivity in the Eastern Woodlands and Great Plains of North America.

Archaeologists and ethnohistorians have long been interested in quantifying potential maize productivity for late prehistoric and early historic Native Americans of the Eastern Woodlands. Maize yields obtained by Native Americans using traditional farming techniques in the nineteenth century are compared to yields obtained by nineteenth- century Native Americans using plows, and nineteenth- and twentieth- century farmers in Illinois and Missouri. The result is a notion of average resource productivity for maize that is more reasonable and modest than previous estimates. In this study, the mean yield of maize for nineteenth-century Native American groups who did not use plows was 18.9 bu/acre (stdev=4.1) (1,185.4 kg/ha [stdev-254.1]). Yields on the order of 10 bu/acre (627.2 kg/ha) probably are closer to the average prehistoric yields that were available for subsistence purposes. The mean size of gardens cultivated by nineteenth-century Native American families without plows was .59 acre (stdev=.45) (.24 ha [stdev=.18]). These newly compiled data are used to generate a model of nuclear family household economy and minimal and maximal garden sizes given different levels of maize productivity and consumption. Population estimates made on the basis of previous assessments of high rates of resource productivity will need to be reevaluated.

Siemens 1988

Evidence for a Cultivar and a Chronology from Patterned Wetlands in Central Veracruz, Mexico.

The patterning found in certain wetlands of lowland Mesoamerica has added an important element to the subsistence system that may be attributed to pre-Hispanic inhabitants of the region. The form of the remains, largely expressed in terms of surface vegetation, suggests agriculture on planting platforms, separated by canals. The physical and chemical aspects of the stratigraphy have clarified depositional environments but have not indicated agricultural horizons. Maize phytoliths at about 1 meter below the surface in two Central Veracruzan wetlands do confirm the practice of agriculture. Associated ceramics indicate wetlands agriculture was practiced by A.D. 500 and perhaps earlier.

Simmons 1986

New Evidence for the Early Use of Cultigens in the American Southwest.

Recent excavations near Chaco Canyon in northwestern New Mexico have yielded evidence for the use of cultigens by the early second millennium B.C. and continuing into the first millennium B.C. This information comes from four sites, all of which have been radiocarbon dated. The evidence for the oldest use of a cultigen, maize, is in the form of pollen; however, macrobotanical specimens of maize or squash were also recovered from sites dating to the Late Archaic. These data are summarized, as are their significance and implications.

Sluyter 2006

Early maize (Zea mays L.) cultivation in Mexico: Dating sedimentary pollen records and its implications.

A sedimentary pollen sequence from the coastal plain of Veracruz, Mexico, demonstrates maize cultivation by 5,000 years ago, refining understanding of the geography of early maize cultivation. Methodological issues related to bioturbation involved in dating that record combine with its similarity to a pollen sequence from the coastal plain of Tabasco, Mexico, to suggest that the inception of maize cultivation in that record occurred as much as 1,000-2,000 years more recently than the previously accepted 7,000 years ago. Our analysis thereby has substantive, theoretical, and methodological implications for understanding the complex process of maize domestication. Substantively, it demonstrates that the earliest securely dated evidence of maize comes from macrofossils excavated near Oaxaca and Tehuaca'n, Mexico, and not from the coastal plain along the southern Gulf of Mexico. Theoretically, that evidence best supports the hypothesis that people in the Southern Highlands domesticated this important crop plant. Methodologically, sedimentary pollen and other microfossil sequences can make valuable contributions to reconstructing the geography of early maize cultivation, but we must acknowledge the limits to precision that bioturbation in coastal lagoons imposes on the dating of such records.

Smith 1989

Origins of Agriculture in Eastern North America.

As a result of research carried out over the past decade, eastern North America now provides one of the most detailed records of the origins of agriculture available. Spanning a full three millennia, the transition from forager to farmer in eastern North America involved the domestication of four North American seed plants during the second millennium B.C., the initial emergence of food production economies based on local crop plants between 250 B.C. and A.D. 200, and the rapid and broad-scale shift to maize-centered agriculture during the three centuries from A.D. 800 to 1100.

Smith 1997

Reconsidering the Ocampo Caves and the Era of Incipient Cultivation in Mesoamerica.

In northeastern Mexico, near Ocampo, Romero's and Valenzuela's caves have been central to explanations of agricultural origins in Mesoamerica for more than four decades. Along with caves in Tehuacdn and Oaxaca, these Öcampo caves"have provided almost all of the available evidence for the initial appearance of a number of key Mesoamerican crop plants, including maize, beans, and squash. This article reanalyzes the cultural and temporal context of five crop plant assemblages in the Ocampo caves: maize (Zea mays), bottle gourd (Lagenaria siceraria), and three species of squash (Cucurbita argyrosperma, C. moschata, C. pepo). Fifteen AMS radiocarbon dates on early domesticates both confirm the stratigraphic integrity of the two caves and substantially revise the temporal framework for initial appearance of core domesticates in northeastern Mexico, showing the transition to food production in Tamaulipas took place more recently than previously thought. A substantially foreshortened chronology for Ocampo crop plants confirms the northern periphery role of Tamaulipas in the origins of agriculture in Mexico, while also underscoring the need for establishing AMS-based archaeobotanical sequences across Mesoamerica to gain an adequate context for understanding the temporal, environmental, and cultural contexts of initial plant domestication in the region.

Tagg 1996

Early Cultigens from Fresnal Shelter, Southeastern New Mexico.

Fresnal Shelter is one offew known preceramic sites in southern New Mexico with evidence of early agriculture. Recent tandem accelerating mass spectrometer (TAMS) radiocarbon determinations on corn and bean samples indicate that cultigens were used at this site as early as 2945 ? 55 B.P. In addition to providing more evidence of Late Archaic agriculture in the desert regions of the American Southwest, these new data and other previously unpublished radiocarbon dates from the site also illustrate the problem of relying on wood charcoal dates in association with cultigens to determine the age of early agriculture.

Wang 2005

The origin of the naked grains of maize.

Huai Wang, Tina Nussbaum-Wagler, Bailin Li, Qiong Zhao, Yves Vigouroux, Marianna Faller, Kirsten Bomblies, Lewis Lukens & John F. Doebley

The most critical step in maize (Zea mays ssp. mays) domestication was the liberation of the kernel from the hardened, protective casing that envelops the kernel in the maize progenitor, teosinte1. This evolutionary step exposed the kernel on the surface of the ear, such that it could readily be used by humans as a food source.Here we show that this key event in maize domestication is controlled by a single gene (teosinte glume architecture or tga1), belonging to the SBP- domain family2 of transcriptional regulators. The factor controlling the phenotypic difference between maize and teosinte maps to a 1- kilobase region, within which maize and teosinte show only seven fixed differences in their DNA sequences. One of these differences encodes a non-conservative amino acid substitution and may affect protein function, and the other six differences potentially affect gene regulation. Molecular evolution analyses show that this region was the target of selection during maize domestication. Our results demonstrate that modest genetic changes in single genes can induce dramatic changes in phenotype during domestication and evolution.

Whitehead 1965

Prehistoric Maize in Southeastern Virginia.

Abstract. Five fossil maize-pollen grains were identified in a peat profile from Dismal Swamp. Extrapolation from the radiocarbon age of peat lower in the section suggests an age of 2200 years. The find suggests that a small clearing within the swamp was cultivated and thus supports the hypothesis that agriculture had diffused into coastal regions before the end of Early Woodland time.

Windes 1996

The Chaco Wood Project: The Chronometric Reappraisal of Pueblo Bonito.

The inventory and analysis of 4,294 pieces of wood remaining in Pueblo Bonito are described. This site, long a keystone for interpreting the Chacoan Phenomenon in the San Juan Basin of northwestern New Mexico, reveals a fascinating history in the procurement, use, and reuse of wood through time. The long use of the site portrays a complex picture of wood procurement for construction from the A.D. 800s through the early A.D. 1100s, and its reuse in both prehistoric and historic times. Major construction periods are tree-ring dated to the mid-A.D. 800s, between A.D. 1047 and 1049, and between A.D. 1077 and 1082. Many of the construction events appear causally related to decade-long wet periods, when food surplus could accumulate. The use of wood at Pueblo Bonito mirrors a larger system of cultural behavior important for our interpretation of the development and demise of the Chacoan system.

Zarrillo 2008

Directly dated starch residues document early formative maize (Zea mays L.) in tropical Ecuador.

pnas105-05006-Supplement.pdf

The study of maize (Zea mays L.) domestication has advanced from questions of its origins to the study-and debate-of its dietary role and the timing of its dispersal from Mexico. Because the investigation of maize's spread is hampered by poor preservation of macrobotanical remains in the Neotropics, research has focused on microbotanical remains whose contexts are often dated by association, leading some to question the dates assigned. Furthermore, some scholars have argued that maize was not introduced to southwestern Ecuador until 4150-3850 calendar years before the present (cal B.P.), that it was used first and foremost as a fermented beverage in ceremonial contexts, and that it was not important in everyday subsistence, challenging previous studies based on maize starch and phytoliths. To further investigate these questions, we analyzed every-day cooking vessels, food- processing implements, and sediments for starch and phytoliths from an archaeological site in southwestern Ecuador constituting a small Early Formative village. Employing a new technique to recover starch granules from charred cooking-pot residues we show that maize was present, cultivated, and consumed here in domestic contexts by at least 5300-4950 cal B.P. Directly dating the residues by accelerator mass spectrometry (AMS) radiocarbon measurement, our results represent the earliest direct dates for maize in Early Formative Ecuadorian sites and provide further support that, once domesticated 9000 calendar years ago, maize spread rapidly from southwestern Mexico to northwestern South America.