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The age of the common bean (*Phaseolus vulgaris* L.) in the northern Eastern Woodlands of North America

JOHN P. HART, DAVID L. ASCH, C. MARGARET SCARRY & GARY W. CRAWFORD*

This study addresses the lack of chronometric research on the common bean (Phaseolus vulgaris L.*) to establish precisely the timing of its adoption and spread across the northern Eastern Woodlands of North America. Bean and directly associated maize samples were subjected to accelerator mass spectrometry (AMS) dating. The results show that the common bean apparently spread rapidly upon its introduction to the region, becoming archaeologically visible from the Illinois River valley to southern New England in the calibrated late 13th century* AD*, some 200–300 years later than previously thought.*

Key-words: northeastern North America, maize-beans-squash agriculture, common bean, *Phaseolus vulgaris*, AMS dating

Research in the Eastern Woodlands of North America during the last quarter of the 20th century established that prehistoric agricultural systems centring on a suite of indigenous oily and starchy seeded annual plants began to evolve by 4000 BP (*c*. 2550 cal BC),[1] becoming wide-

1 In this article, years BP refers to radiocarbon age without adjustment for past atmospheric ^{14}C fluctuations; the BC/AD calendrical scale is reserved for dendrocalibrated dates. All calibrations were done with CALIB 4.3 (Stuiver *et al.* 1998).

* Hart & Asch, Research & Collections Division, New York State Museum, Albany NY 12230, USA. jph_nysm@mail.nysed.gov Scarry, Department of Anthropology, University of North Carolina, Chapel Hill NC 27599, USA. Crawford, Department of Anthropology, University of Toronto, Mississauga ONT L5L 1C6, Canada.

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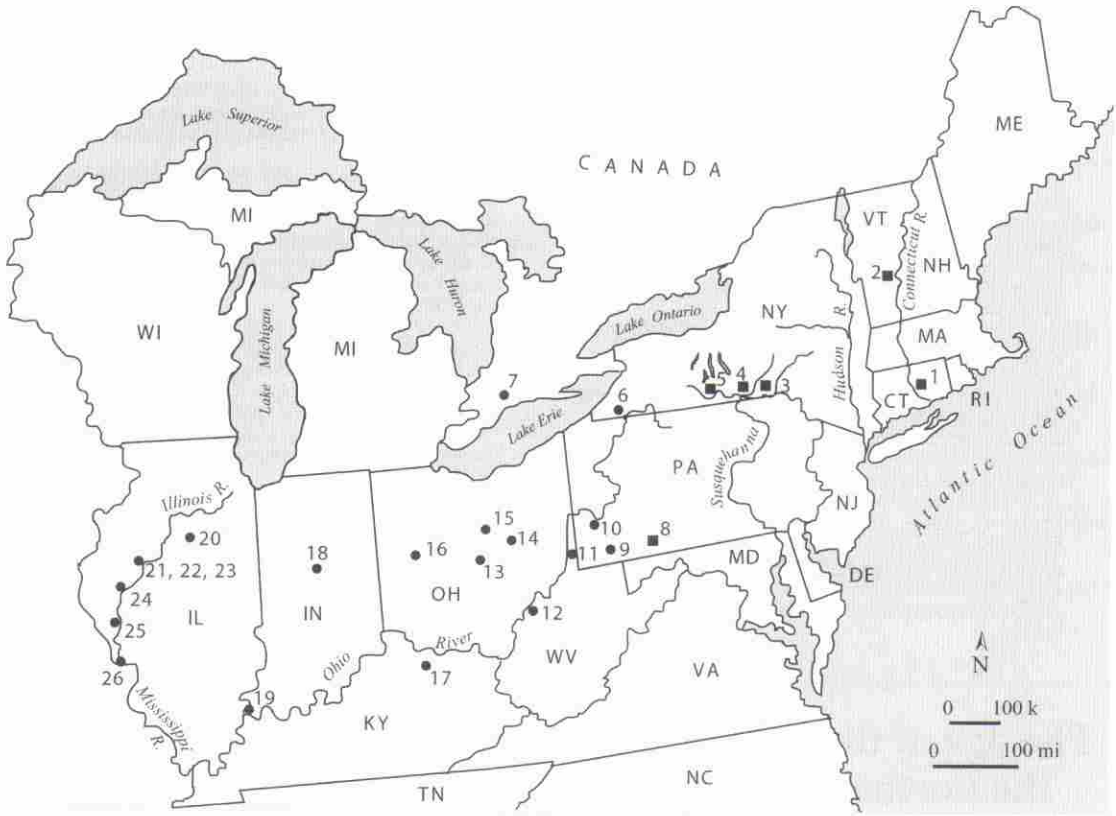

FIGURE 1. *General locations of archaeological sites listed in TABLES 1 &2 (● sites with samples dated for the current study, ■ sites with previously dated beans).*

site, provenance[1]	material	lab no.[2]	$\delta^{13}C$ (‰)	^{14}C BP	AD cal 2σ (intercepts)
(1) Burnham-Shepard[3]	bean	B-29619		550±60	1297 (1406) 1445
(2) Skitchewaug, F 32	bean	AA-29119	−25·9	670±45	1274 (1297) 1399
(2) Skitchewaug, F5a&b	bean	AA-29120	−24·4	765±50	1188 (1275) 1299
(2) Skitchewaug, F46	bean	AA-29121	−25·0	600±50	1289 (1327, 1346, 1393) 1428
(3) Broome Tech	bean	AA-31007	−27·3	380±40	1437 (1481) 1638
(4) Roundtop, F35	bean	AA-23106	−27·2	658±48	1276 (1299, 1374, 1376) 1404
(4) Roundtop, F35	maize	AA-21979	−8·7	675±55	1260 (1297) 1403
(4) Roundtop, F35	wood	AA-21980	−27·6	670±55	1262 (1297) 1403
(4) Roundtop, post mold	bean	AA-26540	−25·0	315±45	1453 (1528, 1551, 1633) 1661
(5) Thomas/Luckey, F78	bean	AA-29122	−27·7	695±45	1260 (1292) 1392
(8) Gnagey, F30	bean	AA-29117	−23·3	610±55	1283 (1323, 1350, 1390) 1428
(8) Gnagey, F13D	bean	AA-29118	−25·0	635±45	1282 (1303, 1368, 1383) 1409

1 Numbers correspond to site locations plotted on FIGURE 1.
2 AA = NSF Arizona AMS Facility, B = Beta Analytic, Inc.
3 Originally published in Bendremer *et al.* (1991). The Roundtop dates were originally published in Hart (1999b). All other dates were originally published in Hart & Scarry (1999).

TABLE 1. *AMS dates of common beans and associated maize and wood in the northeastern US.*

spread by 2000 BP (*c.* cal AD 15) (Asch 1994; Smith 1992). Except for the squash species *Cucurbita pepo* L., however, these were not the crops that dominated agricultural systems across the region at the time of European contact. Instead the 'three sisters' — squash, maize (*Zea mays* L.) and the common bean (*Phaseolus vulgaris* L.) — were the principal Native American crops of the early Historic period (Hurt 1987). *Cucurbita pepo* was domesticated both in eastern North America (ssp. *ovifera* (L.) Decker) and Mexico (ssp. *pepo*) (Decker 1988). Subspecies *ovifera* spread throughout the northern Eastern Woodlands as a result of human interactions, perhaps at first as a form with hard-shelled, bitter, inedible fruits (Asch 1994; Conard *et al.* 1984; Hart & Asch Sidell 1997; Smith 1992). Maize and a second squash species (*C. argyrosperma* Huber) were initially domesticated in Mesoamerica, and the common bean (hereafter 'beans') in Mesoamerica and northern South America (Fritz 1994; Kami *et al.* 1995; MacNeish & Eubanks 2000). These spread to the northern Eastern Woodlands through human interactions, perhaps *via* the American Southwest and Plains. The timing of the spread of these crops and the processes involved remain important issues for our understanding of prehistoric agricultural evolution (Asch 1994; Hart 1999a; Riley *et al.* 1990). In this article we provide new dates on beans that change our understanding of the history of this crop and maize-beans-squash agriculture in the northern Eastern Woodlands.

Northern Eastern Woodlands beans

The history of squash and maize in the northern Eastern Woodlands has been clarified over the past two decades as the result of intensive efforts to recover and identify archaeological plant remains, together with developments in accelerator mass spectrometry (AMS) that made it possible to date small, critical crop specimens directly. Remains of presumably cultivated *C. pepo* have been directly dated to as early as 7100±300 BP (NSRL-298) (cal 2σ 6498 (5988, 5940, 5929) 5476 BC) in the Midwest (Asch & Asch 1985) and 5695±100 BP (AA-7491) (cal 2σ 4775 (4522, 4509, 4503) 4341 BC) in the northeastern US (Petersen & Asch Sidell 1996), and there are some indications of its biological domestication as early as *c.* 4250 BP (*c.* cal 2900 BC) (Asch 1995: 62–3). The cushaw squash, *C. argyrosperma*, entered the region probably only a millennium ago (Fritz 1994). Maize has been directly dated to as early as 2077±70 BP (AA-8717) (cal 2σ 354 BC (90, 76, 59 BC) AD 72) in Illinois (Riley *et al.* 1994) and 1570±90 BP (TO-5307) (cal 2σ AD 258 (442, 448, 468, 482, 530) 657) southern Ontario (Crawford *et al.* 1997). The earliest direct date in the northeastern US is 1100±70 BP (B-53452) (cal. 2σ AD 776 (904, 910, 976) 1145) in eastern New York (Cassedy & Webb 1999). Stable carbon isotope analyses of human bone and measurements of maize quantities on archaeological sites suggest maize did not become an important crop throughout the region until after 1100 BP (Hart 1999a; Smith 1992).

For beans, in contrast to squash and maize, there has been a lack of direct AMS dating to establish firmly the first archaeological visibility of this crop in the northern Eastern Woodlands. Probably because beans arrived relatively late in time, the oldest apparent contexts in which they were found were not deemed controversial. It was long the conventional wisdom that beans were present in Mississippian and contemporaneous cultural contexts of the region, and palaeoethnobotanists estimated their probable time of arrival at 1150–950 BP (Ford 1985a; Griffin 1967; Yarnell 1976; 1986). Recent research in the northeastern US, however, has raised doubts about the validity of previous indirect dating of beans, which was based on apparent associations of the beans with radiocarbon-dated organic materials or temporally diagnostic pottery. In the northeastern US, direct AMS dating of beans from purportedly early contexts now suggests that they do not become archaeologically visible there until approximately cal AD 1300 (FIGURE 1, TABLE 1), some 200–300 years later than previously thought (Hart & Scarry 1999). Notably the Roundtop site in New York, one of the redated sites (Hart 1999b), was once cited by Yarnell (1976: 272) as having 'the earliest verified report of beans in the East' on the basis of a date of 880±60 BP (Y-1534) (cal 2σ AD 1005 (1163, 1173, 1180) 1282) on charcoal from a storage pit (not the pit from which beans were recovered).

Three areas remain in the northern Eastern Woodlands to the east of the Mississippi River valley where there are repeated reports of beans occurring in pre-AD 1300 contexts: the upper Ohio River basin, the central Ohio River basin, and the central and lower Illinois River

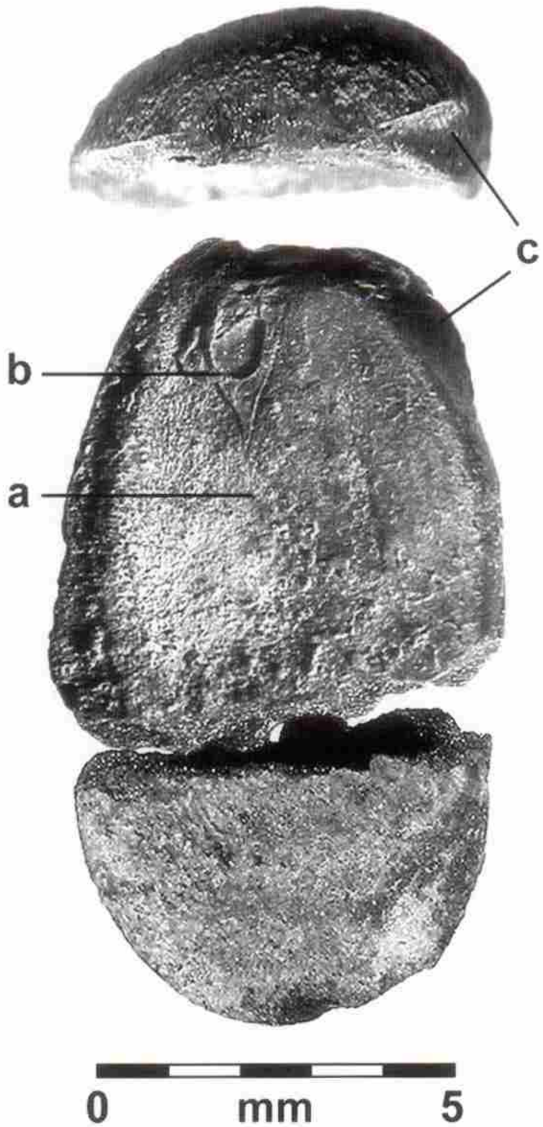

FIGURE 2. *Bean cotyledon fragment from the Sunwatch site:* a *inner face of cotyledon,* b *plumule,* c *notch in cotyledon for radicle.*

basin. In southern Ontario, beans have not been reported before AD 1200 and rarely before AD 1300 (Smith & Crawford 1997). Checking the potentially early Ontario records, Crawford found that only one bean identification can be confidently supported. An AMS date on this specimen from the Kelly site was obtained as part of the current study.

Many of the sites with beans supposedly in early contexts are multicomponent; have radiocarbon dates (usually on charcoal) that often are widely dispersed, have large standard deviations, or were obtained from cultural features that did not contain the beans; or they lack radiocarbon dates altogether. In light of the revised chronology that resulted from direct dating of beans in the northeastern US, there was an evident need to investigate the age of beans from purportedly early contexts across a wider region. The present project was undertaken to clarify the history of beans across the northern Eastern Woodlands from the Illinois River valley to the east and north. Rather than reassessing the age of any particular site or site components in order to date beans indirectly, the goal was to obtain direct evidence for the age of the earliest beans in the various drainage basins.

Sample selection and identification

Since a radiocarbon date potentially can be compromised by unrecognized organic contamination or by large counting or non-counting errors in the radiocarbon lab, paired samples of maize recovered from the same contexts were sought for dating from some sites. A discordant maize date could serve as a signal that dating results for one of the samples is erroneous. Twenty-five bean and 12 maize samples from 20 sites (FIGURE 1) were obtained from various curatorial facilities.[2] The sites included one from southern Ontario, four from the upper Ohio River basin, eight from the central Ohio River basin[3] and seven from the central and lower Illinois River basin. Lawrence Kaplan provided previously unpublished bean and maize dates from the Blain Village site in the central Ohio River basin. Together with the previously published dates from the northeastern US, there are now 51 dates from 26 sites available to address the issue of the spread of beans across the northern Eastern Woodlands from the Illinois River valley to southern New England.

2 Carnegie Museum of Natural History, Center for American Archeology, Dayton Museum of Natural History, Grove Creek Mound Historic Site, Illinois State Museum, Ohio Historical Society, University of Indiana, University of Massachusetts–Boston, University of Toronto, Western Illinois University, William S. Webb Museum.

3 Original plans were to date matching bean and maize samples from the Muir Site in Kentucky, from which beans have been reported in c. AD 1000 contexts (Rossen 1988: 258). Neither the beans nor any maize from the same contexts as the reported beans could be located at the curatorial facility.

site, provenance[1]	material	lab no.[2]	$\delta^{13}C$ (‰)	^{14}C BP	AD cal 2σ (intercepts)
(6) Onoville Bridge, F103	bean	AA-38454	−25·9	628±33	1290 (1304, 1366, 1385) 1404
(6) Onoville Bridge, F103	maize	AA-38455	−14·8	624±33	1291 (1305, 1355, 1365, 1386) 1405
(7) Kelly, F7	bean	TO-8963		770±50[3]	1164 (1271) 1298
(9) Campbell Farm, F352	bean	AA-40132	−27·1	462±38	1408 (1438) 1481
(9) Campbell Farm, F352	maize	AA-40133	−8·4	794±38	1164 (1258) 1286
(10) Portman, Trench 44	bean	AA-38456	−25·5	682±33	1277 (1295) 1390
(11) Saddle, F35	bean	AA-38457	−25·6	675±33	1278 (1297) 1392
(11) Saddle, F35	maize	AA-38458	−12·8	605±34	1296 (1326, 1348, 1391) 1412
(12) Blennerhassett F23 N1/2	bean	AA-38463	−28·6	277±33	1518 (1643) 1789
(12) Blennerhassett F23 S1/2	bean	AA-38464	−27·9	301±33	1484 (1637) 1658
(13) Blain Village, House 1[4]	bean	AA-16854		510±60	1304 (1421) 1478
(13) Blain Village, Pit 4 18-28[4]	maize	AA-16853		420±60	1408 (1448) 1637
(14) Baldwin	bean	AA-38459	−26·7	542±33	1321 (1408) 1437
(14) Baldwin	bean	AA-38460	−27·4	494±33	1401 (1428) 1447
(15) Gartner	bean	AA-38461	−27·7	579±33	1301 (1332, 1339, 1398) 1423
(15) Gartner	bean	AA-38462	−28·1	593±33	1298 (1328, 1344, 1394) 1416
(16) Sunwatch, F1/77	bean	A-0175	−26·5	652±42	1280 (1300, 1373, 1378) 1402
(17) Fox Farm, FG09 Tu2	bean	AA-38466	−26·0	683±33	1277 (1295) 1389
(17) Fox Farm, FG09 Tu2	maize	AA-38467	−15·7	592±33	1299 (1329, 1344, 1395) 1418
(18) Baker's Trails, F11	bean	AA-40134	−28·0	539±39	1314 (1409) 1440
(19) Murphy, 142.43.41	bean	AA-38966	−25·3	603±36	1297 (1326, 1347, 1392) 1412
(20) Noble-Weiting, F8	bean	AA-38964	−27·1	621±36	1290 (1312, 1354, 1387) 1408
(20) Noble-Weiting, F8	bean	AA-38965	−28·1	634±36	1286 (1303, 1368, 1383) 1404
(21) Orendorf, F761	bean	A-0177	-27·0	655±43	1277 (1298) 1399
(21) Orendorf, F761	maize	AA-38968	−10·0	698±33	1269 (1291) 1385
(21) Orendorf, F782	bean	AA-38967	−27·6	712±33	1262 (1286) 1381
(22) Morton, F3	bean	AA-38473	−25·2	675±33	1278 (1297) 1392
(22) Morton, F3	maize	AA-38474	−9·7	692±33	1274 (1293) 1387
(23) Larson, F140	bean	A-0176	−25·4	757±44	1212 (1277) 1298
(23) Larson, F140	maize	AA-38476	−8·8	704±33	1265 (1289) 1383
(23) Larson, House 75	bean	A-0174	−27·1	650±43	1280 (1301, 1372, 1378) 1403
(23) Larson, House 75	maize	AA-38478	−9·9	719±33	1259 (1284) 1379
(24) Hill Creek, F1-07C	bean	AA-38471	−25·9	734±33	1241 (1281) 1299
(24) Hill Creek, F1-07C	maize	AA-38472	−9·1	772±37	1211 (1268) 1293
(24) Hill Creek, F1-04PB	bean	AA-40135	−24·2	641±39	1283 (1302, 1370, 1381) 1403
(24) Hill Creek, F1-04PB	maize	AA-40136	−10·0	733±55	1213 (1282) 1387
(25) Worthy-Merrigan, 1243B	bean	AA-40138	−25·9	594±49	1291 (1328, 1344, 1394) 1430
(25) Worthy-Merrigan, 1243B	maize	AA-38470	−15·1	615±41	1289 (1319, 1352, 1389) 1413
(26) Pere Marquette, F22-01P	maize	AA-40137	−9·2	642±36	1284 (1302, 1370, 1381) 1402

1 Numbers correspond to site locations plotted on FIGURE 1.
2 A = Illinois State Geological Survey, AA = NSF Arizona AMS Facility, TO = AMS Facility at the University of Toronto.
3 Date corrected to a nominal base of $\delta^{13}C = -25$‰.
4 Lawrence Kaplan pers. comm. 2000.

TABLE 2. *AMS dates of common beans and associated maize from the current project.*

All specimens were examined by the authors prior to submission for assay: Scarry and Asch examined all but three of the bean samples to confirm the original identifications. Lawrence Kaplan identified the two beans from the Noble-Weiting site, and Crawford identified the bean from the Kelly site. Two thirds of the beans were also examined by Richard Yarnell. All specimens were carbonized; no evidence was found of preservatives or other contaminants that might affect sample carbon content. The bean samples mostly consisted of whole or partial cotyledons. From the position of the impression of the hypocotyl and plumule on the inner surface of the cotyledon, the notching of the cotyledon margin where the radicle was present before carbonization, and from the reniform shape of the cotyledon (FIGURE 2), one may infer that the specimens represent species of the subfamily Faboideae (Fabaceae), in which typically the embryonic axis is curved and the hilum marginal according to seed length (Delorit & Gunn 1986). On the basis of cotyledon size and shape, together with geographic considerations and knowledge that only one species of domesticated bean was present in eastern North America at European contact, the specimens could be identified as *Phaseolus vulgaris* (Kirkbride *et al.* 2000).[4] Rare specimens preserved the hilar area and portions of the thin seed coat. If a specimen was large enough, it was divided and a portion was retained for future analyses or for additional dating should the need arise. To substantiate identifications, samples were digitally photographed under low magnification prior to division. Sample width, length, thickness and weight were recorded.

Results

Results are presented in TABLE 2. No date is earlier than the late calibrated 13th century AD, consistent with the results obtained previously for the northeastern US. Of the 12 paired bean and maize samples from the current project and the northeastern US study, only 1 pair differed significantly at the ·05 level of significance (Ward & Wilson 1978). The discordant pair, from the Campbell Farm site in southwestern Pennsylvania, was excavated from a cultural feature with active rodent burrowing, which may have mixed beans and maize from different temporal contexts. Multiple bean dates were obtained from 10 sites during the two projects. Only at Roundtop (TABLE 1) are the dates significantly different, representing temporally distinct occupations at this site (Hart 1999b). The paired bean and maize dates and paired bean dates indicate that the dates obtained for this project are reliable.

Conclusions

The results of this project, coupled with the earlier findings for the northeastern US, suggest that the common bean spread rapidly throughout the region, becoming a regularly grown crop from the Illinois River valley to southern New England by the late calibrated 13th century AD, two to three centuries later than previously thought. Thus, all crop elements of maize-beans-squash agricultural systems were in place in the northern Eastern Woodlands only for about 250 years before initial observation by Europeans (Biggar 1924: 158, 183). One implication of the revised chronology is that what once seemed an anomalous absence of beans in the American Bottom during the Mississippian florescence at Cahokia (Lopinot 1992) actually is consistent with the crop's history elsewhere in the region. More generally, it is clear that the growing of beans in the northern Eastern Woodlands was *not* associated with the major intensification and range extension of maize agriculture that occurred around 1100 BP. This expansion has sometimes been attributed in part to the arrival of beans, whose high protein content and amino acid composition compensated for deficiencies of maize in the critical amino acids lysine and tryptophane (Kaplan 1965; Stoltman & Baerreis 1983). But the nutritional complementation model, and others that attempt to account for the *c.* 1100 BP agricultural expansion by pointing to benefits gained by growing and consuming maize and beans together, now can be rejected.

In some respects the history of beans in the northern Eastern Woodlands is similar to what Kaplan & Lynch (1999) have documented for Mexico and Andean South America: beans entered agricultural systems relatively late and once adopted, their spread was very quick relative to maize and squash. This in turn indicates that the processes involved in the spread of the three crops differed dramatically, affected by each of the crop's genetics and reproduction systems, human population structure, intra- and inter-human population interactions and the agro-ecological systems into which the crops were adopted (Asch 1994; Hart 1999a; 2001). To conclude, rather than basing an agricultural chronology solely on the apparent associations of crop remains with other dated materials or with temporally diagnostic artefacts, this study further emphasizes the importance of directly dating early crop remains to determine their earliest date of archaeological visibility (Conard *et al.* 1984; Crawford *et al.* 1997; Hart 1999a).

4 A poorly preserved specimen from the Pere Marquette site in Illinois could only be identified as a probable bean cotyledon by these criteria, making its sacrifice for an AMS date inadvisable. Consequently, only a sample of maize from the same context was submitted for assay (TABLE 2).

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