

## THE AGE OF COMMON BEANS (*Phaseolus vulgaris*) IN THE NORTHEASTERN UNITED STATES

John P. Hart and C. Margaret Scarry

---

A radiocarbon date of A.D. 1070 ± 60 was linked to the remains of maize (*Zea mays*), beans (*Phaseolus vulgaris*), and squash (*Cucurbita pepo*) at the Roundtop site in the Susquehanna River valley of New York by William Ritchie in 1969 and 1973 publications. This date established the presence of beans in the Northeast at an earlier time than in most other areas of the eastern United States, where they are generally rare before A.D. 1300. Subsequently beans have been reported in pre-A.D. 1300 contexts from at least eight other sites in the Northeast. Recent calibrated AMS dates on beans from Roundtop are no earlier than A.D. 1300 (Hart 1999a). Given that the original Roundtop date was responsible for the acceptance of early beans in the Northeast, the AMS dates suggested that beans may not become archaeologically visible there until ca. A.D. 1300. AMS dates on beans from four other sites, reported here, substantiate the Roundtop results. Beans and by extension maize-beans-squash intercropping are not evident in the Northeast before ca. A.D. 1300.

William Ritchie (1969, 1973) establece una relación entre la fecha 1070 ± 60 A.D., determinada por análisis de radiocarbono, y los hallazgos de maíz (*Zea mays*), frijol (*Phaseolus vulgaris*) y curcúbita (*Cucurbita pepo*) en el sitio Roundtop del valle del río Susquehanna en Nueva York. Esta fecha sugiere una temprana presencia del frijol en el noreste en relación a otras áreas del este de Estados Unidos, donde su hallazgo ha sido generalmente considerado raro antes de 1300 A.D. Posteriormente, la presencia del frijol antes de a 1300 A.D. ha sido registrada en por lo menos ocho otros sitios en el noreste. Fechas AMS calibradas recientemente indican la presencia del frijol en el sitio Roundtop después de a 1300 A.D. (Hart 1999a). Contrariamente a lo que la fecha original del sitio Roundtop sugiere, las fechas AMS indican que el frijol no es arqueológicamente detectable en el noreste hasta después de 1300 A.D. Fechas AMS correspondientes a la presencia del frijol en otras cuatro localidades apoyan los resultados del sitio Roundtop. No existe evidencia en el noreste de hallazgos de frijol y de intracultivo de maíz-frijol-curcúbita con antes de 1300 A.D.

In 1964, a crew from the New York State Museum under the direction of William Ritchie recovered the charred remains of maize (*Zea mays*), common beans<sup>1</sup> (*Phaseolus vulgaris*), and squash (*Cucurbita pepo*) from a large storage pit at the Roundtop site in the upper Susquehanna River valley of New York. In his published accounts of the site, Ritchie (1969, 1973) linked these remains to a radiocarbon date of A.D. 1070 ± 60 obtained on wood charcoal from a different pit feature. As a result of Ritchie's publications, there was wide acceptance of beans in the northeastern United States (hereafter Northeast) by the eleventh century A.D. In fact, this was the earliest date at that time for beans in the eastern United States (e.g., Kaplan 1971; Munson 1973; Yarnell 1976). Although Ritchie's date now calibrates to A.D. 1172 (Stuiver and Reimer 1993), it has remained the most widely cited date for the earliest beans and co-occurrence of maize, beans, and

squash in the Northeast through the 1990s (e.g., Riley et al. 1990; Snow 1995).

The Roundtop date has been somewhat anomalous because it pre-dates the archaeological visibility of beans in most of the eastern United States. Only in the Ohio River basin are beans reported from similarly early contexts (Fritz 1990; Riley et al. 1990). In the Illinois River valley, beans have been reported in twelfth- and thirteenth-century contexts (e.g., Asch and Asch 1985; Haberman et al. 1999; King 1993). Elsewhere, as related by Fritz (1990:398) "their conspicuous rarity before 600 or 700 B.P. . . indicates a minor subsistence role. . . until just before European Contact." In southern Ontario beans may occur as early as A.D. 1200, but they are rare before A.D. 1300 and have not been directly dated (Smith and Crawford 1997). Since Ritchie's publications, however, beans associated with maize and sometimes squash have been linked to radio-

---

John P. Hart ■ Anthropological Survey, New York State Museum, Albany, NY 12230

C. Margaret Scarry ■ Department of Anthropology, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599

American Antiquity, 64(4), 1999, pp. 653-658

Copyright © 1999 by the Society for American Archaeology

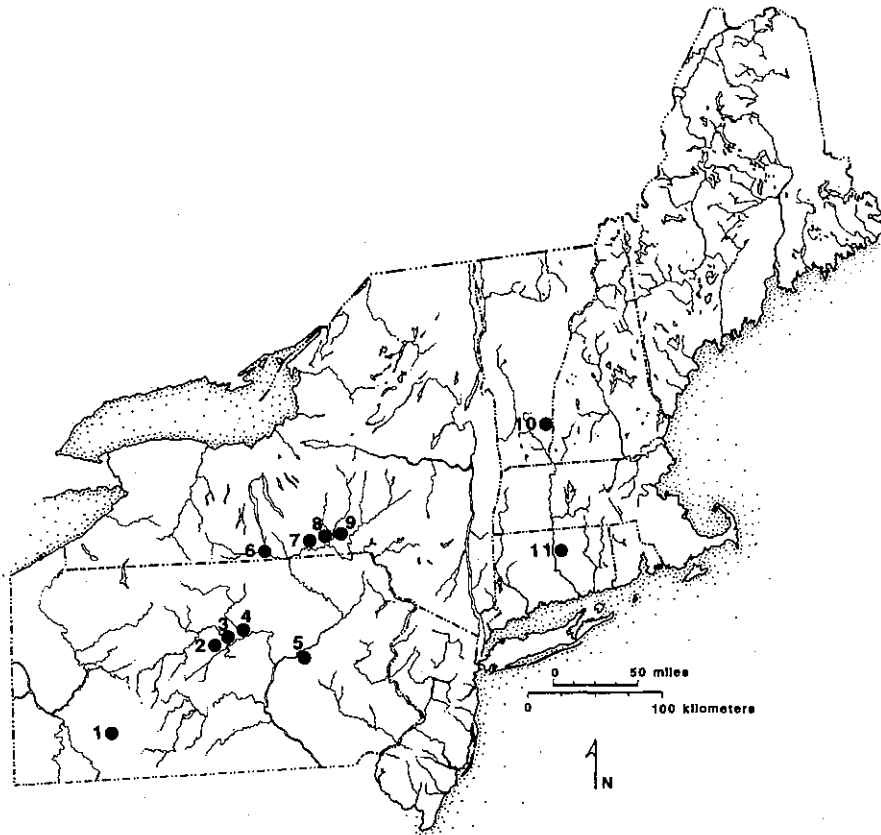


Figure 1. Locations of sites listed in Tables 1 and 2 (1. Gnagey; 2. Bald Eagle; 3. West Water Street; 4. Nash; 5. Catawissa; 6. Thomas Luckey; 7. Roundtop; 8. Broome Tech; 9. Boland; 10. Skitchewaugh; 11. Burnham-Shepard).

carbon dates that calibrate to the eleventh to thirteenth centuries A.D. from at least eight sites in the Northeast (Table 1). Seven of these are in the Susquehanna River basin of New York and Pennsylvania (Figure 1) (Hart and Asch Sidell 1996; Knapp 1996; Prez-zano and Steponaitis 1990).

These occurrences are seemingly supported by the report of beans from components dated to A.D. 920–A.D. 1030 and A.D. 1085–A.D. 1190 at the Gnagey site in southwestern Pennsylvania (George 1983). Gnagey is located in the upper Ohio River basin but near the Ohio and Susquehanna watershed. The site has pottery with stylistic attributes indicating that its inhabitants interacted with populations in the Susquehanna River basin, perhaps representing a proximate source for bean diffusion into the Northeast. The published wood-charcoal radiocarbon dates for this site calibrate to the eleventh to thirteenth centuries A.D. The earliest radiocarbon dates associated with beans in New England, on the other hand, are

from the Skitchewaugh site in the Connecticut River valley of Vermont where beans were recovered from pit features with wood-charcoal radiocarbon dates in the twelfth-century A.D. (Heckenberger et al. 1992). These dates calibrate to the thirteenth century A.D.

The presence of beans in the Northeast before they occur in most other regions of the Eastern Woodlands has posed a significant problem for those interested in crop diffusion. Riley et al. (1990) have proposed that beans arrived in the Northeast by an eastern diffusion pathway from Florida as opposed to later beans elsewhere in the Eastern Woodlands, which diffused across the Plains from the Southwest.

#### New Evidence: AMS Dates

While dates on materials associated with beans in the Northeast range from the eleventh to thirteenth centuries A.D., direct dates on beans tell a different story. Recent calibrated accelerator mass spectrometry (AMS) dates on beans and associated maize and

Table 1. Beans Reported from Pre-A.D. 1300 Contexts in the Northeastern United States (see Figure 1 for locations).

Site	Associated Dates (A.D.)	2σ Calibrated Date Range (A.D.) <sup>a</sup>	Comments	Source
Bald Eagle	910 ± 85 <sup>b</sup> 1070 ± 65 <sup>b</sup> 1150 ± 65 <sup>b</sup> 1010 ± 80 <sup>c</sup>	819 (1011) 1202 1019 (1172 <sup>c</sup> ) 1279 1042 (1256) 1298 972 (1111 <sup>c</sup> ) 1277	No beans were present in the samples provided for this study suggesting that the original identifications were erroneous. Beans were recovered from two features that were not radiocarbon dated and did not contain diagnostic artifacts. Pottery recovered from the site suggests occupations may date as late as A.D. 1300. Beans were recovered from a soil horizon with diagnostic artifacts that are typically associated with dates of A.D. 1000-1200. One bean sample was submitted for AMS dating by investigators. A single bean recovered from non-feature contexts was not available for this study.	Hay and Hamilton 1984 Prezanno and Steponaitis 1990
Broome Tech	1000-1200 <sup>d</sup>			
Catawissa	920 ± 70 <sup>e</sup> 1085 ± 50 <sup>e</sup>	893 (1022) 1215 1033 (1212) 1280		King 1992, 1999 George 1983
Gnagey	880 ± 80 <sup>b</sup> 950 ± 80 <sup>b</sup> 990 ± 75 <sup>b</sup> 1005 ± 80 <sup>c</sup> 1070 ± 80 <sup>c</sup> 1120 ± 75 <sup>c</sup> 1160 ± 75 <sup>c</sup> 1720 ± 70 <sup>e</sup> 960 ± 80 <sup>e</sup> 1595 ± 80 1715 ± 80 1070 ± 60 <sup>e</sup>	778 (984) 1158 889 (1021) 1216 901 (1034) 1243 903 (1120 <sup>c</sup> ) 1262 1000 (1172 <sup>c</sup> ) 1289 1024 (1218) 1296 1059 (1259) 1376 1484 (1659) 1950 890 (1025) 1226 1422 (1575 <sup>c</sup> ) 1954 1474 (1661) 1955 1018 (1172 <sup>c</sup> ) 1281	One bean sample from each of two features representing the early and late components are included in this study. Previously unpublished wood-charcoal radiocarbon dates are from Means et al. (1998). Beans reported to be associated with the eleventh-century occupation were not available for this study. Later components are present at this site. AMS dates on beans and associated maize and wood charcoal indicate beans are no earlier than A.D. 1300 (Hart 1999a). Beans were recovered from three radiocarbon-dated features and one undated feature. Dates at left are from features from which beans were recovered. Other dates from the site calibrate to the fourteenth and fifteenth centuries A.D. The three samples included in this study are from features previously radiocarbon dated to pre-A.D. 1300 and a previously undated feature. A bean sample from a previously undated feature is included in this study.	Ritchie 1969, 1973 Heckenberger et al. 1992
Skitchewang	F.51 F.33 F.46	1041 (1218) 1283 1041 (1225) 1291 1213 (1280) 1303		
Thomas	F.40	966 (1025) 1205		Knapp 1996
Luckey	F.47	1100 ± 80 <sup>c</sup>		
	F.4	1360 ± 70 1281 (1356 <sup>c</sup> ) 1441		
W. Water Street	1000-1200 <sup>d</sup>		Beans were not available for this study. A Contact period component also was present at this site.	Custer et al. 1996

<sup>a</sup> Struiver and Reimer (1993) done with CALIB 4.0.

<sup>b</sup> Wood charcoal dated from feature with reported beans.

<sup>c</sup> Wood charcoal date from component with reported beans.

<sup>d</sup> Estimated dates based on diagnostic artifacts.

<sup>e</sup> Mean of multiple intercepts.

Table 2. AMS Dates on Beans from Northeastern United States Archaeological Sites.

Lab number	Site/Provenience	<sup>14</sup> C (A.D.)	Calibrated 2σ Range and Intercepts (A.D.) <sup>a</sup>	Source
AA31007	Broome Tech	1570 ± 40	1437 (1481) 1638	Knapp and Versaggi <sup>b</sup>
B-23619	Burnham-Shepard	1400 ± 60	1297 (1406) 1431	Bendremer et al. 1991
AA29117	Gnagey F30	1340 ± 55	1283 (1323, 1350, 1390) 1428	This study
AA29118	Gnagey F13D	1315 ± 45	1282 (1303, 1368, 1383) 1409	This study
AA23106	Roundtop F35	1292 ± 48	1276 (1299, 1374, 1376) 1404	Hart 1999a
AA26540	Roundtop 45327	1635 ± 45	1453 (1528, 1551, 1633) 1661	Hart 1999a
AA29119	Skitchewaugh F32	1280 ± 45	1274 (1297) 1399	This study
AA29120	Skitchewaugh F51	1185 ± 50	1188 (1275) 1299	This study
AA29121	Skitchewaugh F46	1350 ± 50	1289 (1327, 1346, 1393) 1428	This study
	Skitchewaugh Pooled	1273 ± 29	1280 (1297) 1390	This study
AA29122	Thomas Luckey F78	1255 ± 45	1260 (1292) 1392	This study

<sup>a</sup> Calibrations done with CALIB 4.0.

<sup>b</sup> personal communication 1998

wood charcoal from Roundtop indicate that the earliest beans there date to around A.D. 1300. These dates are supported by the pottery assemblage from the pit where Ritchie's crew recovered maize, beans, and squash. This assemblage is later than the pottery assemblage of the pit from which the original radiocarbon date was obtained (Hart 1999a). Because Roundtop served as the foundation for acceptance of early beans in the Northeast and because there have been no earlier direct dates on beans in that region, the AMS dates suggested that beans may not become archaeologically visible there until the beginning of the fourteenth century A.D. (Hart 1999a). This in turn suggested a need to reevaluate the timing of the development of maize-beans-squash intercropping in the Northeast, which was the foundation of many agricultural systems at the time of European contact. To this end, we undertook to directly date beans from a number of pre-A.D. 1300 contexts.

Sites with beans reported from pre-A.D. 1300 contexts in the Northeast are listed in Table 1 along with associated radiocarbon dates and contextual information. Bean samples were sought from each of these sites and were made available from three: Bald Eagle, Thomas Luckey, and Skitchewaugh. Samples also were provided from Gnagey. All samples were examined by Scarry to confirm the original identifications of beans. No beans were present in the samples from Bald Eagle, suggesting that the original identifications were erroneous. Beans were confirmed at the other sites and six samples were submitted to the National Science Foundation AMS Arizona Facility for dating: two from Gnagey, one from Thomas Luckey, and three from Skitchewaugh. The results, along with AMS dates on beans from Roundtop and two additional Northeast sites, are presented

in Table 2. The six calibrated dates from this study and the earlier of the two Roundtop dates cluster around A.D. 1300. None of these dates is significantly different from the others at a 95-percent level of confidence using Ward and Wilson's (1978) chi-square test for independence as implemented in the CALIB rev. 4.0 program (Stuiver and Reimer 1993). The remaining dates are later. As at Roundtop, the AMS dates suggest that the beans originated from later components at these sites rather than those to which they were originally assigned.

Although not all of the sites with beans reported in pre-A.D. 1300 contexts were included in this study, our results strongly suggest that beans do not become archaeologically visible in the Northeast until around A.D. 1300. The three sites that anchored the evidence for pre-A.D. 1300 beans in the literature, Roundtop, Gnagey, and Skitchewaugh all yielded calibrated dates that are at or later than A.D. 1300. Although sample AA29120 from Skitchewaugh yielded an earlier date, it calibrates to A.D. 1275 and is not significantly different from the site's other two dates at the 95-percent level of confidence. The pooled calibrated date from the site has an intercept of A.D. 1297 and a 2σ range of A.D. 1280 to A.D. 1390.

#### Implications of the AMS Dates

There are a number of implications for the results of this study. First, there is no convincing evidence for the archaeological visibility of beans in the Northeast prior to c. A.D. 1300. This suggests that beans were adopted in the Northeast about the same time that they were in most other areas of the eastern United States (Fritz 1990; Riley et al. 1990; Yarnell 1993). Second, maize-beans-squash agriculture was

not established in the Northeast until the late thirteenth to early fourteenth centuries A.D. (compare to Chapdelaine 1993); given the AMS dates on beans, there is no convincing evidence for the co-occurrence of maize, beans, and squash before that time. Third, there is no longer a need to speculate that beans diffused to the Northeast via a different pathway (Riley et al. 1990) than they did to other areas of the eastern United States.

The presence of a crop in the archaeological record is a function of both its length and intensity of use. The longer and more intensively a crop was used at a given location, the greater was the probability for accidental loss, charring, and deposition in a context favorable for preservation over long periods of time regardless of preparation method. The greater the amount of the crop preserved in the archaeological record, the greater its chance of recovery by archaeologists (Hart 1999b). While taphonomic processes may explain the absence of beans from earlier contexts (Fritz 1990; Smith 1992), the results of this study strongly suggest it was not until around A.D. 1300 that these conditions were met for beans in the Northeast, consistent with most other areas of the eastern United States (Fritz 1990:398). It is at this time that beans were fully integrated into at least some agricultural systems and intercropped with maize and squash (compare to Munson 1973:130), both of which become archaeologically visible in the Northeast considerably earlier (Bendremer and Dewar 1994; Cassidy and Webb 1999; Crawford et al. 1997; Hart and Asch Sidell 1996, 1997). Contrary to various assertions in the literature, maize-beans-squash agriculture was not in place by the eleventh to twelfth centuries A.D. (cf. Chapdelaine 1993; Ritchie 1969; Snow 1995). Rather maize-beans-squash systems had evolved to a point at around A.D. 1300 where the three crops were used intensively enough together to co-occur in the archaeological record. In light of these findings, it should be clear that beans found in apparently earlier contexts in the Northeast should be directly dated to confirm that they originated from those contexts.

*Acknowledgments.* Richard George provided the Gnagey samples. Rosemary Cyr and James Petersen provided the samples from Skitchewaung. Conran Hay and Patricia Miller provided the samples from Bald Eagle. Timothy Knapp provided the sample from Thomas Luckey. Timothy Knapp and Nina Versaggi kindly permitted us to include the previously unpublished date from Broome Tech. The New York State

Museum provided funding for the AMS dates done for this study. Nancy Asch Sidell, Gary Crawford, Gayle Fritz, Christina Rieth, and two anonymous reviewers read and commented on earlier versions of this article. Jorge Arriagada did the Spanish translation of the abstract. Patricia Kernan drafted the figure.

### References Cited

- Asch, D.L., and N.B. Asch  
1985 Prehistoric Plant Cultivation in West-Central Illinois. In *Prehistoric Food Production in North America*, edited by R.I. Ford, pp. 149–204. Anthropological Papers No. 75. Museum of Anthropology, University of Michigan, Ann Arbor.
- Bendremer, J.C.M., and R.E. Dewar  
1994 The Advent of Prehistoric Maize in New England. In *Corn & Culture in the Prehistoric New World*, edited by S. Johannessen and C.A. Hastorf, pp. 369–393. Westview Press, Boulder.
- Bendremer, J.C.M., E.A. Kellogg, and T.B. Lary  
1991 A Grass-Lined Maize Storage Pit and Early Maize Horticulture in Central Connecticut. *North American Archaeologist* 12:325–349.
- Cassidy, D., and P. Webb  
1999 New Data on the Chronology of Maize Horticulture in Eastern New York and Southern New England. In *Current Northeast Paleoethnobotany*, edited by J.P. Hart, pp. 85–100. New York State Museum Bulletin 494. State University of New York, Albany.
- Chapdelaine, C.  
1993 The Sedentarization of the Prehistoric Iroquois: A Slow or Rapid Transition? *Journal of Anthropological Archaeology* 12:173–209.
- Crawford, G.W., D.G. Smith, and V.E. Bowyer  
1997 Dating the Entry of Corn (*Zea mays*) into the Lower Great Lakes Region. *American Antiquity* 62:112–119.
- Custer, J.F., S.C. Watson, and D.N. Bailey  
1996 A Summary of Phase III Data Recovery Excavations at the West Water Street Site (36CN175), Lock Haven, Clinton County, Pennsylvania. *Pennsylvania Archaeologist* 66(1): 1–53.
- Fritz, G.J.  
1990 Multiple Pathways to Farming in Precontact Eastern North America. *Journal of World Prehistory* 4:387–435.
- George, R.L.  
1983 The Gnagey Site and the Monongahela Occupation of the Somerset Plateau. *Pennsylvania Archaeologist* 53(4):1–97.
- Haberman, T.W., W. Green, and L. Forman  
1999 Plant Remains (Except Wood) from the Larson Site. Report submitted to the Illinois State Museum, Springfield, Illinois.
- Hart, J.P.  
1999a Dating Roundtop's Domesticates: Implications for Northeast Late Prehistory. In *Current Northeast Paleoethnobotany*, edited by J.P. Hart, pp. 47–68. New York State Museum Bulletin 494. State University of New York, Albany.  
1999b Maize Agriculture Evolution in the Eastern Woodlands of North America: A Darwinian Perspective. *Journal of Archaeological Method and Theory* 6:137–180.
- Hart, J.P., and N. Asch Sidell  
1996 Prehistoric Agricultural Systems in the West Branch of the Susquehanna River Basin, A.D. 800 to A.D. 1350. *Northeast Anthropology* 52:1–30.  
1997 Additional Evidence for Early Cucurbit Use in the Northern Eastern Woodlands East of the Allegheny Front. *Amer-*

- ican Antiquity* 62:523-537.
- Hay, C.A., and C.E. Hamilton  
1984 *The Bald Eagle Township Sewage Collection System Archaeological Project: Final Mitigation Research*. Technical Report No. 2. Department of Anthropology, Pennsylvania State University, University Park.
- Heckenberger, M.J., J.B. Peterson, and N. Asch Sidell  
1992 Early Evidence of Maize Agriculture in the Connecticut River Valley of Vermont. *Archaeology of Eastern North America* 20:125-150.
- Kaplan, L.  
1971 *Phaseolus*: Diffusion and Centers of Origin. In *Man Across the Sea*, edited by C.L. Riley, J.C. Kelly, C.W. Pennington, and R.C. Rands, pp. 416-427. University of Texas Press, Austin.
- King, F.B.  
1992 Floral Remains. In *The Prehistory of the Catawissa Bridge Replacement Site (36CO9), Columbia County, Pennsylvania*, by T.C. East, J.A. Adovasio, W.C. Johnson, and D.R. Pedler. Prepared for the Cultural Resource Management Program, Department of Anthropology, University of Pittsburgh.
- 1993 Climate, Culture, and Oneota Subsistence in Central Illinois. In *Foraging and Farming in the Eastern Woodlands*, edited by C.M. Scarry, pp. 232-254. University of Florida Press, Gainesville.
- 1999 Changing Evidence of Prehistoric Plant Use in Pennsylvania. In *Current Northeast Paleoethnobotany*, edited by J.P. Hart, pp. 11-26. New York State Museum Bulletin 494. State University of New York, Albany.
- Knapp, T.  
1996 *Stage 3 Data Recovery, Thomas Luckey Site (SUBi-888), Town of Ashland, Chemung County, New York*. Public Archaeology Facility, Binghamton University, State University of New York, Binghamton.
- Means, B.K., B.R. Fischler, and D.L. Ziegler  
1998 *Archaeological Data Recovery Site 36SO244, U.S. Meyersdale Bypass Project, S.R. 6219, Section B08, Somerset County, Pennsylvania*. Report prepared by Greenhorne & O'Mara, Inc., Mechanicsburg, Pennsylvania, for Pennsylvania Department of Transportation, Harrisburg.
- Munson, P.J.  
1973 The Origins and Antiquity of Maize-Beans-Squash Agriculture in Eastern North America: Some Linguistic Implications. In *Variation in Anthropology*, edited by D.W. Lathrap and J. Douglas, pp. 107-136. Illinois Archaeological Survey, Urbana, Illinois.
- Prezanno, S., and V.P. Steponaitis  
1990 *Excavations at the Boland Site 1984-1987: A Preliminary Report*. Research Report 9. Research Laboratories of Anthropology, University of North Carolina, Chapel Hill.
- Riley, T.J., R. Edging, and J. Rosen  
1990 Cultigens in Prehistoric Eastern North America: Changing Paradigms. *Current Anthropology* 31:525-542.
- Ritchie, W.A.  
1969 *The Archaeology of New York State*. Natural History Press, Garden City, New York.
- 1973 The Roundtop Site (Apl.1). In *Aboriginal Settlement Patterns in the Northeast*, by W.A. Ritchie and R.E. Funk, pp. 179-194. Memoir 20. New York Museum & Science Service, State University of New York, Albany.
- Smith, B.D.  
1992 *Rivers of Change: Essays on Early Agriculture in Eastern North America*. Smithsonian Institution Press, Washington, D.C.
- Smith, D.G., and G.W. Crawford  
1997 Recent Developments in the Archaeology of the Princess Point Complex in Southern Ontario. *Journal Canadien d'Archéologie* 21:9-32.
- Smith, I.F.  
1978 A Functional Interpretation of "Keyhole" Structures in the Northeast. *Pennsylvania Archaeologist* 46(1-2):1-12.
- Snow, D.R.  
1995 Migration in Prehistory: The Northern Iroquoian Case. *American Antiquity* 60:59-79.
- Stuiver, M., and P.J. Reimer  
1993 Extended <sup>14</sup>C Data Base and Revised CALIB 3.0 <sup>14</sup>C Age Calibration Program. *Radiocarbon* 35:215-230.
- Ward, G.K., and S.R. Wilson  
1978 Procedures for Comparing and Combining Radiocarbon Age Determinations: A Critical Review. *Archaeometry* 20:19-31.
- Yarnell, R.A.  
1976 Early Plant Husbandry in Eastern North America. In *Cultural Change and Continuity: Essays in Honor of James Bennett Griffin*, edited by C. Cleland, pp. 265-274. Academic Press, New York.
- 1993 The Importance of Native Crops during the Late Archaic and Woodland Periods. In *Foraging and Farming in the Eastern Woodlands*, edited by C.M. Scarry, pp. 13-26. University Press of Florida, Gainesville.

### Note

1. Throughout this article, the term "beans" refers only to the common bean (*Phaseolus vulgaris*).

---

Received December 28, 1998; accepted April 6, 1999; revised April 19, 1999.