QUATERNARY RESEARCH 33, 94–101 (1990)

Early Holocene Pinyon (*Pinus monophylla*) in the Northeastern Great Basin

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Received February 9, 1989

Fine-grained excavation and analysis of a stratigraphic column from Danger Cave, northeastern Great Basin, suggests prehistoric hunter–gatherers were collecting and using singleleaf pinyon (*Pinus monophylla*) near the site for at least the last 7500 yr. Human use of the cave began after the retreat of Lake Bonneville from the Gilbert level, shortly before 10,000 yr B.P. In stratum 9, culturally deposited pine nut hulls appear in the sequence by about 7900 yr B.P. and are continuously present thereafter. A hull fragment in stratum 10 is directly dated to 7410 ± 120 yr B.P. These dates are at least 2000 yr earlier than expected by extrapolation to macrofossil records from the east-central and central Great Basin, and necessitate some revision of current biogeographical models of late Quaternary pinyon migration.

INTRODUCTION

The apparent early–mid-Holocene migration of singleleaf pinyon (*Pinus monophylla*), from the southern Great Basin to its modern northern limits near the Humboldt River, has been the subject of numerous investigations in the last 2 decades (Thompson, 1984; Madsen, 1986; Mehringer, 1986; Van Devender *et al.*, 1987). In this note, we discuss the chronology of singleleaf pinyon remains from Danger Cave, western Bonneville Basin, and their biogeographical implications.

Previous studies of plant macrofossils in the central and eastern Great Basin have suggested that pinyon did not arrive in the central Basin until after 6500 yr B.P., and migrated into the northeastern Basin to its modern limit near 42° N latitude (Fig. 1) some 1500–1000 yr thereafter. Records from the central and east-central Great Basin (Thompson and Hattori, 1983; Thompson, 1979, 1984, 1988; Wells, 1983) indicate that singleleaf pinyon grew as far north as 39°30′ by about 6250 yr B.P., but was apparently absent from the area prior to that time. Macrofossil records dating to 10,000–5000 yr B.P. from farther north of the central Great Basin are few, but a pollen sequence from the Ruby Marshes (Thompson, 1984), near the modern northern limits of the pine, suggests that it arrived sometime between 6700 and 4700 yr B.P. The chronology of this migration is of considerable biogeographic significance, but is also of great archaeological importance because pine nuts were a critical food resource to prehistoric humans inhabiting the central and northern Great Basin.

We sought to determine the impact of pinyon migration into the northeastern Great Basin on the subsistence practices of prehistoric inhabitants through a detailed analysis of intact archaeological deposits at Danger Cave (Fig. 1). Based on the currently available biogeographical data (e.g., Madsen, 1986), we assumed that singleleaf pinyon moved into the area of Danger Cave, about 40°45′ N latitude, shortly be-

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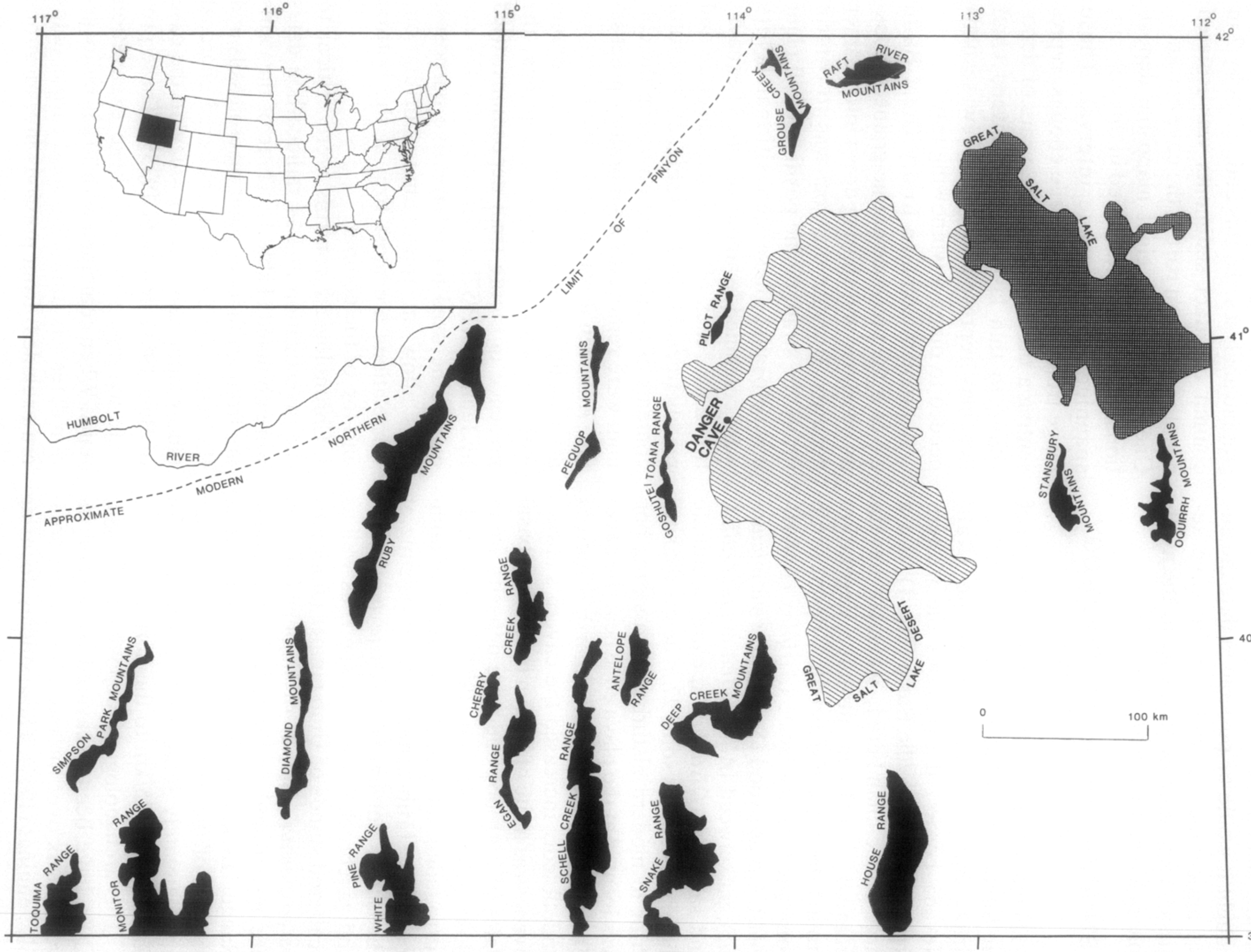

FIG. 1. Map showing location of Danger Cave and principal mountain ranges (above 2300 m) in the eastern Great Basin.

fore 5000 yr ago. Since the dry, well-stratified deposits were known to contain pine nut hulls apparently left by the cave's human occupants (Jennings, 1957), we thought it would be possible to date the initial appearance of hulls in the cave sequence and compare that date to the available paleoenvironmental record.

STRATIGRAPHY AND CHRONOLOGY OF DANGER CAVE

Danger Cave is on the southern margin of the Silver Island Range in the northeastern Great Basin. Located near the Utah/Nevada border, it overlooks the western arm of the Bonneville Basin (Fig. 1). It is a large single-chambered, wave-cut cavern situated at 1314 m altitude. Vegetation around the site consists of low desert scrub dominated by shadscale (*Atriplex confertifolia*). Greasewood (*Sarcobatus vermiculatus*), pickelweed (*Allenrolfea occidentalis*), and saltgrass (*Distichlis spicata*) dominate the playa margins some 27 m below the site. Prior to modern disturbance, a spring bog was located at the playa edge near the cave. The spring and associated marsh resources undoubtedly increased the cavern's attractiveness as a site of human habitation; basal dates of both bog and cave deposits are in close accord (Madsen, 1988). The uplands surrounding the cavern are presently dominated by shrub communities consisting of shadscale, horsebrush (*Tetradymia* spp.), and sagebrush (*Artemisia* spp.), as well as scattered stands of Utah juniper (*Juniperus osteosperma*). Stands of singleleaf pinyon are now found in the neighboring Toana Range, 18 km to the west, in the higher reaches of the eastern Silver Island Range approximately 30 km east, and in the Pilot Range, some 25 km to the north.

The archaeological deposits at Danger Cave have been excavated by several investigators over the past 50 yr, most notably Jennings (1957). These studies, focusing on the remarkable sequence of deposits spanning much of the late Wisconsin and Holocene epochs, have had tremendous impact on our understanding of Great Basin archaeology and the history of Pleistocene Lake Bonneville. We hoped to refine this sequence through higher resolution stratigraphic analyses. To this end, a 2 m by 2 m column of intact sediments was isolated near the southern part of the cave entrance. One hundred and eight mappable depositional events were identified in this column, spanning the Holocene interval. These range from culturally sterile eboulis, representing a thousand or more years of deposition, to thin layers of pickleweed chaff that may represent only the few seconds needed to dump a winnowing tray.

A problem common to dry Great Basin caves is the presence of fine-grained deposits overlying and shifting down into coarser deposits. Because our goal was to control firmly the stratigraphic position of all plant macrofossils, these depositional layers were combined for removal into 37 excavation units, each of which had discrete and readily traceable surfaces (Fig. 2). The total contents of each excavation unit in the column were removed for laboratory processing. Although it was not possible to associate exactly the stratigraphy of the column with the work of earlier excavations, the presence of sterile spall depositions, used by Jennings (1957) to define the DI–DV sequence he used for interpretive purposes, does allow an approximate correlation. Correlations are most firm at the bottom and top of the column.

Chronological controls were critical to the investigation and 14 radiocarbon dates were obtained (Table 1). Three of the dates are from artifacts or plant macrofossils and the remainder are from scattered charcoal (sheep dung and *Scirpus olneyi* in the case of Beta 19611 and Beta 19355). These provide average dates for these excavation units. When combined with 20 gas radiocarbon dates (six unreliable solid carbon dates are excluded) from previous investigations (Fry, 1976; Jennings, 1957), the Danger Cave sequence becomes one of the best controlled stratified occupational se-

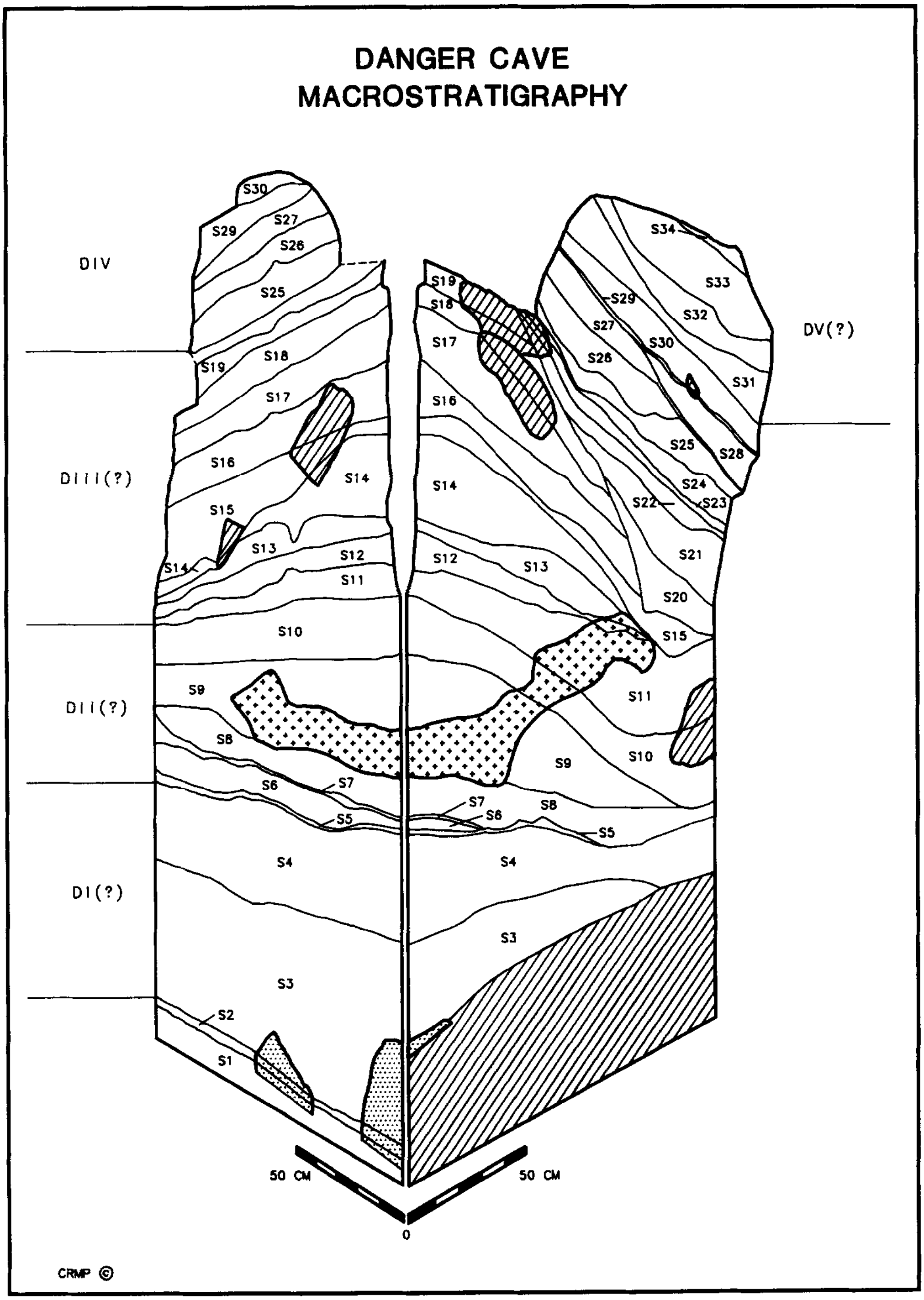

FIG. 2. Excavation units associated with sample column in Danger Curve. Uppermost were removed from adjacent column. DI(?)–DV(?) represent probable correlation of sequence with Jennings (1957) interpretive scheme.

TABLE 1. PINYON PINE REMAINS FROM DANGER CAVE COLLECTION UNITS

Collection unit	Macrofossils	Radiocarbon dates (yr B.P.)	Laboratory #
Stratum 37	No pinyon	330 ± 100	(Beta 23646)
Stratum 36			
Stratum 35		880 ± 100	(Beta 19335)
Stratum 34	76 hull fragments		
Stratum 33	No pinyon		
Stratum 32	No pinyon		
Stratum 31	31 hull fragments	2660 ± 90	(Beta 23647)
Stratum 30	15 hull fragments	4860 ± 110	(Beta 23648)
Stratum 29	28 hull fragments		
Stratum 28	5 hull fragments		
Stratum 27	25 hull fragments		
Stratum 26	55 hull fragments 1 seed in hull		
Stratum 25	20 hull fragments	5160 ± 100	(Beta 23649)
Stratum 24	91 hull fragments	5360 ± 70	(Beta 23650)
Stratum 23	9 hull fragments		
Stratum 22	4 hull fragments		
Stratum 21	11 hull fragments		
Stratum 20	3 hull fragments		
Stratum 19	11 hull fragments		
Stratum 18	21 hull fragments	6030 ± 90	(Beta 23651)
Stratum 17	93 hull fragments 1 strobilus fragment		
Stratum 16	48 hull fragments		
Stratum 15	35 hull fragments 3 strobilus fragments		
Stratum 14	25 hull fragments 4 strobilus fragments		
Stratum 13	No pinyon		
Stratum 12	4 hull fragments		
Stratum 11	No pinyon	7490 ± 120	(Beta 23652)
Stratum 10	130 hull fragments	7410 ± 120	(AA 3623)
Stratum 9	4 hull fragments	7920 ± 80	(Beta 23653)
Stratum 8	No pinyon		
Stratum 7	No pinyon		
Stratum 6	No pinyon		
Stratum 5	No pinyon	10,080 ± 130	(Beta 19333)
Stratum 4	No pinyon		
Stratum 3	No pinyon	9780 ± 210 9920 ± 185	(Beta 19336) (Beta 19611)
Stratum 2	Noncultural		
Stratum 1	Noncultural		

quences in North America. Fifteen of these dates span the period between 11,000 and 9000 yr B.P. and strongly suggest that the cave was initially occupied by humans following the retreat of Lake Bonneville from the Gilbert Level about 11,000–10,500 yr B.P., and after the desiccation that led to the development of the Great Salt Lake Desert (Currey, 1988; Grayson, 1988). They also suggest that the earliest depositions identified by Jennings (1957) as DI (Sand I/II interface–Sand II) and the lower part of DII were deposited over a relatively short span of several hundred years centered about 10,100 yr B.P.

PINYON REMAINS IN THE DANGER CAVE COLUMN

Remains of singleleaf pinyon were found in 24 of the 37 excavation units (Table 1).

Pinyon remains are represented mainly by pine nut hulls, but cone parts are also represented in several units. They are distributed consistently through the column in stratum 9 and above (Fig. 2). The abundance of all plant remains is drastically reduced below this level, probably because of decomposition (Grayson, 1988, pp. 29–31).

The earliest remains of singleleaf pinyon hulls are found in an excavation unit dated to 7920 ± 80 yr B.P. The morphology of these remains is consistent with that of singleleaf pinyon and inconsistent with any other biogeographically likely candidates (R. Lanner, personal communication, 1988). To determine whether these remains were contemporaneous with their enclosing matrix, a tandem accelerator mass spectrometer radiocarbon determination was made on a portion of a large readily identifiable hull fragment from stratum 10. The resulting date of 7410 ± 120 yr B.P. fits comfortably with extant dates of 7920 ± 80 yr B.P. from stratum 9 and 7490 ± 120 yr B.P. from stratum 11. The hulls associated with these dates are the oldest known pinyon remains from the northeastern Great Basin, and in fact the oldest directly dated pinyon remains north of the Eleana Range, at 37°07′ N latitude in southern Nevada (Spaulding, 1985). These dates are at least 2000 yr older than expected, given current chronological models of pinyon migration into the northeastern Basin (Lanner, 1985; Wells, 1983; Madsen, 1986).

The scarcity of needles, cone parts, and lack of evidence of rodent gnawing among the pinyon remains suggests that packrats or other rodents were not a major vector in the deposition of these remains, and it is unlikely that corvids deposited them in the cave interior. It therefore is highly probable that pinyon remains found in the Danger Cave deposits were brought there by humans. The consistent representation of pinyon remains through the sequence seems to indicate continued use of nearby stands of singleleaf pinyon (e.g., within 50 km of the site), rather than intermittent use of more distant stands.

If pinyon remains from Danger Cave do represent the existence of nearby pinyon woodlands, then the 7900 to 7400 yr B.P. dates should be regarded as a minimum age for the establishment of those stands, as humans may have deposited the remains in the cave after pinyon first migrated into the region.

BIOGEOGRAPHICAL IMPLICATIONS

The likely presence of singleleaf pinyon in the vicinity of Danger Cave more than 1500 yr prior to its appearance in the central Great Basin, and at least 2000 yr prior to its expected migration into the northeastern Basin, necessitates modification of current hypotheses on Holocene plant biogeography. Given the importance of pinyon in the investigation of such varied phenomena as the reconstruction of postulated atmospheric circulation changes (e.g., Thompson, 1984; Spaulding, in press) and prehistoric adaptive patterns (e.g., Simms, 1985; Madsen, 1986), there may be much wider implications as well. A number of different, but not necessarily mutually exclusive, scenarios can be developed to explain the presence of pinyon in the northeastern Great Basin by at least 7500 yr B.P.

One such scenario, suggested by Betancourt (1987) and Thompson (in press), is that the mid-Holocene "migration" of pinyon was primarily an elevational shift, rather than an extension of its range from south to north. According to this view, pinyon woodlands during the late Wisconsin and early Holocene occurred at lower altitudes than today and the absence of pinyon in late Pleistocene/early Holocene midden records in the study area is likely due to its restriction to lower slopes where no midden records exist. Because valley floors on the western and eastern margins of the Great Basin are more than 1000 m lower than those in the central Great Basin, pinyon may have existed along valley margins in the former, but not in the latter. Thus, an upward altitudinal shift would allow for actual migration of pinyon into the central

Great Basin, while an apparent similar migration into the eastern Great Basin is a product of sampling bias.

This hypothesis gains some support from the fact that haploxylon pine pollen, the morphological type including pinyon, is found in eastern Great Basin pollen records that span the last 30,000 yr (e.g., Spencer *et al.*, 1984). However, Thompson (in press, p. 27) suggests that palynological data in central and eastern Nevada indicate that pinyon "did not fill in the lower reaches of its elevational range until the late Holocene"; that is, elevational shifts were apparently from higher to lower altitudes, not the reverse. Given the paucity of midden records from the eastern Great Basin, this possibility cannot yet be rejected.

A second scenario is that singleleaf pinyon did migrate relatively rapidly and uniformly north from the southern Great Basin during the early Holocene, and that the lack of early Holocene records in the central and northeastern Great Basin is due to the spotty nature of the plant macrofossil record, rather than to the absence of pinyon. The number of early Holocene middens in the Great Basin is small (Thompson, in press) and, since these macrofossil records essentially represent point localities in time and space, the species distribution will be poorly reflected without data from many midden localities. With the increasing library of midden records, however, this possibility becomes much less likely. For example, there are now more than 40 such records from the Snake Range alone (Fig. 1), and there is still no evidence of pinyon in the range prior to about 6200 yr B.P. (e.g., Wells, 1983; Thompson, 1984). With such a large number of point localities, it seems doubtful that pinyon occurred prior to that time and, given the data presented here, equally doubtful that a rapid but uniform south-to-north migration took place. However, the number of midden records from the early Holocene constitutes only a small portion of this library, and the question remains open at present.

A third plausible explanation may be that pinyon migrated into different areas of the Great Basin along variable routes, in response to different physiographic and/or systematic atmospheric features. A number of climatic controls have been postulated to account for the current distribution of singleleaf pinyon (e.g., Beeson, 1974; West *et al.*, 1978; Thompson and Mead, 1982; Thompson and Kautz, 1983; Thompson, 1984) and it is not yet clear which control or set of controls is most critical. Regardless, given the differential clines for seasonal and absolute amounts of precipitation and seasonal and annual temperature ranges across the Great Basin (e.g., Houghton, 1969; Kay, 1982; Mitchell, 1976; Pyke, 1972), and differential physiographic features such as valley elevation and the elevation of topographic interconnections between adjacent mountain ranges (Wells, 1983), some differences in migration routes and migration rates should be expected. However, the probable migration route of pinyon represented by the Danger Cave pine nut hulls is unknown. Due to the extensive barrier created by the Great Salt Lake Desert, the most likely route of pinyon migration into the uplands of the region (e.g., the Toana or Silver Island ranges) would have been from the south, from either the Snake and/or Schell Creek Ranges via Antelope Range and/or the Deep Creek Mountains (Fig. 1). Because none of these ranges shows evidence of pinyon prior to 6200 yr B.P., the fact that it is present at least 2000 to 3000 yr earlier than expected in the Danger Cave area remains unexplained.

ACKNOWLEDGMENTS

This research was supported by National Science Foundation Grant BNS-8607545 and by grants from the Utah State Divisions of Water Resources and History. R. M. Lanner and R. S. Thompson graciously assisted in the identification of specimens. J. E. Kirkman gave valuable laboratory assistance. R. S. Thompson, W. G. Spaulding, P. S. Martin, and D. K. Grayson provided thoughtful reviews.

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