Treponemal Disease, Tuberculosis and Subsistence-settlement Pattern in the Late Woodland Period West-central Illinois

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ABSTRACT

In later pre-Columbian prehistory (post AD 1000), the adaptation and intensification of maize agriculture and its correlate of aggregate village settlement (i.e. Mississippianization) is temporally and geographically variable. In the Midwest, consequential to the florescence of the major ceremonial centre of Cahokia (AD 1050–1300), the Mississippi River Valley alluvial plain in Illinois, known as the American Bottom, became a core area of this subsistence-settlement change. Much archaeological research has traced aspects of this transition in the Lower and Middle Illinois River Valley, but little is known outside of these areas. A skeletal sample from the remote hinterland area of the Upper Mississippi River in west-central Illinois was examined for arguable paleopathological correlates of sedentism (treponemal disease) and Mississippianization (tuberculosis). The Schroeder Mounds (AD 900–1100) adult skeletal sample (N=53) exhibited a high frequency of treponemal disease (13.2–15.1%). This result is consistent with paleopathological literature linking a 9+ % pre-Columbian North American prevalence with sedentism, challenging archaeologically based inferences that the hinterland was occupied by mobile forager-horticulturalists. A hallmark of Mississippianization is the presence of diagnostic cases of tuberculosis. No cases were observed in the Schroeder sample, suggesting a pre-Mississippian subsistence-settlement pattern. Copyright © 2013 John Wiley & Sons, Ltd.

Key words: agriculture; forager; Illinois; Late Woodland; Mississippian; sedentism; treponemal; tuberculosis

The late Late Woodland period in Illinois (AD 650–1000) was a time of major subsistence, settlement, demographic and sociopolitical change. After AD 900, it involved the intensification of maize agriculture, settlement nucleation and political centralization characteristic of the subsequent Mississippian period (AD 1050–1350) (Pauketat, 1998; Emerson and Lewis, 2000; McElrath et al., 2000). This transition in Illinois was apparently temporally and regionally variable (Esarey, 2000; Nansel and Green, 2000; Stoltman, 2000; Stoltman and Christiansen, 2000; Theler and Boszhardt, 2000). It was earliest in Southern Illinois with the rapid rise of Cahokia (AD 900–1050), the eventual largest Mississippian period settlement north of Mexico (Pauketat, 1998; Emerson and Lewis, 2000). The transition dynamics in Illinois varied considerably due to evident cultural heterogeneity, ecological context (e.g. river bottom versus upland), and differential Cahokian influence (e.g. Benn and Green, 2000; Emerson and Lewis, 2000; Emerson and Titelbaum, 2000, O’Gorman and Hassen, 2000; Simon, 2000; Stoltman and Christiansen, 2000; Styles, 2000). This is particularly true of Woodland settlements in the upper Mississippi River valley of west-central Illinois, which are geographically remote relative to the Mississippian culture core (Emerson and Lewis, 2000; Trader, 2011). Unfortunately, material culture is generally poorly represented in this area and subsistence-settlement reconstruction vacillates between forager-horticulturalists and sedentary agriculturalists (e.g. Benn and Lee, 2005; Hedman and Emerson, 2008, Trader, 2011).

Nonvenereal treponemal disease (yaws and treponarid) is a chronic disease transmitted by spirochetes of the genus Treponema via breaks in the skin. It is a disease commonly contracted in childhood, is endemic where it is found and is epidemiologically associated with compromised hygiene (Hackett, 1976; Auferheide and Rodriguez-Martin, 1998; Ortner, 2003). The paleopathological presence of the tertiary stage (i.e. bone disseminated) of chronic treponemal disease has a considerable antiquity in North America in general (i.e. Archaic Period, ca 6000 BC) (e.g. Hutchinson, 1993; Cook and Powell, 2005; Powell et al., 2005a; Powell et al., 2005b; Hutchinson and Richman, 2006; Smith, 2006) and Illinois...
in particular (ca 1000 BC) (Cook, 2005; Powell et al., 2005a). Generally speaking, the prevalence of pre-Columbian tertiary treponemal disease rises sharply from presedentary Archaic groups (5.8% overall) to the rise of village life ca 1000 BC (9.0%) (Cook and Powell, 2005:466). Indeed, despite archaeologically demonstrated changes in subsistence (i.e. agricultural intensification) and a dramatic increase in available osteological samples that post-date AD 1000, Cook and Powell record (2005:466) that the generic prevalence of treponemal disease in North America exhibits only a modest increase (10.8%). Although preservation, interobserver error, sampling bias and ecological variables may temper the veracity of this temporal comparison (Cook and Powell, 2005), various other regional meta-analyses have affirmed that sedentism is a valid paleopidemiological variable (e.g. Cassidy, 1984; Powell, 2000; Hutchinson et al., 2005:107; Powell et al., 2005b:157; Hutchinson and Richman, 2006; Smith, 2006; Smith et al., 2010).

Tuberculosis (TB), a paleopidemiologically complex pulmonary disease that disseminates to bone, is associated with aggregate living and compromised community health (Roberts and Buikstra, 2003). Despite a great antiquity (Mackowiak et al., 2005), it is paleopathologically absent in the Americas before AD 300 (Wilbur et al., 2008). In the pre-Columbian Midwest, the signature anterior vertebral kyphosis (i.e. vertebral body collapse) of the disease appears circum AD 900, paralleling maize-intensification (Stone et al., 2009). This implies that the diagnostic macroscopic bone changes of TB is absent in subsistence-settlement patterns that do not mirror Mississippianization.

The remote hinterland Late Woodland (AD 900–1100) Schroeder Mounds site (11HE177) is a burial context in west-central Illinois (Figure 1). It has had little bioarchaeological assessment (Hitzemann, 1997; Langford, 1999), has little available comparative paleopathological information (Hedman and Emerson, 2008) and has no subsistence-settlement context (Riggle, 1981; Kolb, 1982; Benn and Lee, 2005). An examination of periosteal reaction on the bones of the adults for the diagnostic changes of treponemal disease and TB may provide credible support for one or other hypothesis about the settlement pattern or Mississippianization of the people interred in Schroeder Mounds.

Materials and methods

The multiple-mound interment complex of Schroeder Mounds (Henderson County, Illinois) was a salvage archaeological excavation undertaken between 1975 and 1978. On the basis of ceramic attributes, it was originally assigned to the Late Woodland period Maples Mills phase (AD 800–1100), the core area of which is the CIRV (Riggle, 1981; Kolb, 1982).
diagnostic reliability (Smith disease were differentially identified Ubelaker, 2004; Ortner, 2003). Cases of treponemal (Aufderheide and Rodriguez-Martin, 1998; Buikstra and areas of bone loss (i.e. focal resorptive lesions) osteomyelitis (identified using three levels of to the bone (Ortner, 2003; Weston, 2012), including external cortex), diaphyseal expansion and circumscribed woven or lamellar [e.g. compact, striated] bone to the reactive change. None of the other fragmentary adult remains exhibited reactive bone change.

The adults were aged and sexed using standard nonmetric criteria (White and Folkens, 2005; Buikstra and Ubelaker, 1994). For those individuals missing sexable bone elements, sex-discriminating sectioning points for the highly dimorphic humeral and femoral head diameters (Bass, 1995; Purkait, 2003; Frutos, 2005) were calculated (x male + x female/2 ). The adults were segregated into three skeletally aged cohorts: young adult (~18 to ~35 years old), middle aged adult (~35 plus to ~50 years old), and old adult (50 plus years old) (Table 1).

The adult skeletons were examined for any macroscopic evidence of reactive change (i.e. proliferative or resorptive) to the bone (Ortner, 2003; Weston, 2012), including osteomyelitis (identified by a cloaca, sequestration and/or an involucrum), porotic pitting, periostosis (apposition of woven or lamellar [e.g. compact, striated] bone to the external cortex), diaphyseal expansion and circumscribed areas of bone loss (i.e. focal resorptive lesions) (Aufderheide and Rodriguez-Martin, 1998; Buikstra and Ubelaker, 2004; Ortner, 2003). Cases of treponemal disease were differentially identified using three levels of diagnostic reliability (Smith et al., 2011): pathognomonic (i.e. ectocranial stellate scarring, contiguous serpiginous cavitation and caries sicca), indicative (i.e. true [curved interosseous line] or pseudo-bowed [anterior periostosis] sabre tibiae [Ortner:2003:296], cavitating nodal lesions) and consistent with (i.e. nodal lesions without cavitations, focal resorptive external rib lesions or naso-palatal periostosis that are accompanied by reactive changes [e.g. periostosis, diaphyseal expansion] on at least one long bone). Other reactive change (i.e. diaphyseal expansion or periostosis on pathogenetically prediflected long bones [i.e. clavicles and anterior tibia]) are not considered supportable cases of treponemal disease (Hackett, 1976; Ortner, 2003; Smith et al., 2011).

Two levels of diagnostic reliability are applied to identifying TB in the Schroeder Mounds sample: pathognomonic (gibbus formation [(Pott’s disease)] and indicative (smooth-walled lytic lesions on anterior [primarily thoracic] vertebral bodies without neural arch involvement and anterior wedging). Although reactive changes such as focal resorptive lesions on visceral rib surfaces, destructive (e.g. abscessing, osteomyelitis and tuberculous arthritis) changes to the metaphyses and articular surface(s) of the large joints (knee, hip and elbow) or periostosis on long bone metaphyses are consistent with TB, these conditions will not be considered supportable indications of the disease unless they present as a suite (Marcik et al., 2006; Ortner, 2003; Stone et al., 2009).

The reactive changes on all paired bones, vertebrae, ribs, sterna/manubria and crania were recorded on standard forms (Buikstra and Ubelaker, 1994) and photographed. Fisher’s exact test was utilised to assess the pathology prevalence differences between sexes and age cohorts.

Results

Eighteen individuals or 34% (18/53) of the adult sample exhibited proliferative or destructive periostosis indicative of some infectious or inflammatory process (Table 2). Eleven of 18 cases (11/29, 37.9%) were females; four were male (4/17, 23.5%) with (barring sampling error) no sex bias (p = 0.3525). There are no cases of osteomyelitis (i.e. involucrae and sequestra). The most commonly affected bone was the tibia (13/18) followed by cases with either proliferative or resorptive focal lesions on one or more ribs (7/18). After these, the descending order of prevalence was the clavicle (6/18), fibula (6/18), cranium (4/18), radius (4/18), humerus (3/18) and femur (2/18). No reactive change was observed on any innominate, ulna, sacrum, sternum or manubrium.

Table 1. Age and sex distribution of the Schroeder Mounds adult sample

<table>
<thead>
<tr>
<th>Age category</th>
<th>Male</th>
<th>Female</th>
<th>Sex indeterminate</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young (18–35 years)</td>
<td>7/17</td>
<td>16/29</td>
<td>3/7</td>
<td>26/53</td>
</tr>
<tr>
<td>Middle age (35–50 years)</td>
<td>7/17</td>
<td>9/29</td>
<td>1/7</td>
<td>17/53</td>
</tr>
<tr>
<td>Old age (50+ years)</td>
<td>2/17</td>
<td>4/29</td>
<td>1/7</td>
<td>7/53</td>
</tr>
<tr>
<td>Total</td>
<td>16/17</td>
<td>29/29</td>
<td>5/7</td>
<td>50/53</td>
</tr>
</tbody>
</table>

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No vertebra displayed infectious or inflammatory reactive change.

One individual (burial 12) has reactive change restricted to a single bone; four individuals (burials 2, 25A, 69, 81A and 81B) solely display focal (resorptive or proliferative) rib lesions (Table 2). The remaining eleven individuals (including the four with reactive changes on the cranium) exhibit periostosis on multiple bones (Table 2). Seven individuals with multiple bone involvement (burials 10, 48, 37A, 51, 68, 70 and 96) have reactive changes consistent with trauma (i.e. diaphyseal misalignment). Twenty one percent of all tibiae exhibit some level of proliferative periostosis (18/86). Seven individuals (burials 11, 48, 103, 23A, 104, 110 and 37A) (Table 2) who preserve both tibiae (7/42) exhibit this bilaterally. All affected clavicles (7/78), fibulae (7/81), radii (4/86), femora (3/88) and humeri (3/93) co-occur with tibial proliferative periostosis.

Paired comparisons of cases with any type of periostosis by age at death (Table 1) indicates that there is no significant difference between the young (9/26) and middle age at death (6/17) cohorts ($p = 0.6079$, one tailed), or either with the old age cohort (1/7 vs. 9/26, $p = 0.2937$, one tailed; 1/7 vs. 6/17, $p = 0.3065$). If the affected sample is reduced to those ageable individuals exhibiting multiple bone involvement ($N = 10$), there is still no statistically significant difference between the young and middle aged samples (5/26 vs. 4/17, $p = 0.5111$). However, the results are tentative given the incumbent sampling error.

**Treponemal disease**

Out of the 18 individuals with some form of reactive remodelling of the bones, 7 (7/53, 13.2%) display the

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Table 2. Pathological cases in the adult sample

<table>
<thead>
<tr>
<th>Burial number</th>
<th>Age (years)</th>
<th>Sex</th>
<th>Pathognomic/indicative</th>
<th>Non-specific</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>30–40</td>
<td>M</td>
<td>Cranium: cavitating and stellate lesions, endocranial plaque of lamellar and fibro bone R. humerus: cavitating node</td>
<td>L. tibia: healed node L. radius: diaphyseal expansion</td>
</tr>
<tr>
<td>11</td>
<td>?</td>
<td>?</td>
<td>L. and r. tibia: sabre shins (pseudo-bowing)</td>
<td>L. fibula: distal diaphyseal expansion (traumatic) 3 ribs: 4 pseudarthroses (trauma), with active external focal lesions, one healed focal lesion</td>
</tr>
<tr>
<td>48</td>
<td>50+</td>
<td>F</td>
<td>Cranium: cavitating lesions, stellate scars L. clavicle: healed trauma L. humerus, mid diaphysis: nodal periostosis, L. and r. tibia, l &amp; r. femur, l &amp; r. distal fibula: diaphyseal expansion</td>
<td></td>
</tr>
<tr>
<td>96</td>
<td>35–50</td>
<td>F</td>
<td>Cranium: healed cavitating lesions</td>
<td>L. tibia, l. fibula: anterior periostosis L. rib: healed trauma (misalignment)</td>
</tr>
<tr>
<td>103</td>
<td>25–35</td>
<td>M</td>
<td>L. and r. tibia: sabre shins (pseudo-bowing)</td>
<td>L. radius: diaphyseal expansion, R. fibula: diaphyseal expansion</td>
</tr>
<tr>
<td>23A</td>
<td>25–40</td>
<td>F</td>
<td>Cranium, r. malar: stellate scar L. and r. tibia: sabre shins (pseudo-bowing)</td>
<td></td>
</tr>
<tr>
<td>104</td>
<td>25–35</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>30–40</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>25–35</td>
<td>F</td>
<td>Single rib, visceral surface: focal lesion</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>18–25</td>
<td>F</td>
<td>Single rib, external surface: focal lesion</td>
<td></td>
</tr>
<tr>
<td>25A</td>
<td>25–40</td>
<td>M</td>
<td>Cranium, healed traumatic lesion (1.5 cm diameter)</td>
<td></td>
</tr>
<tr>
<td>51</td>
<td>25–35</td>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>68</td>
<td>25–35</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>69</td>
<td>40–50</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>45–55</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>81A/ 81B</td>
<td>40–50?</td>
<td>M?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*a*Treponemal disease, tuberculosis.
pathognomonic or indicative classification level of treponemal disease (Table 2). Four individuals (burials 10 [Figure 2a], 48, 96 and 23A) have pathognomonic cavitating, stellate and/or nodular ectocranial lesions. Burial 10 (male, aged 30–40 years) additionally has ectocranial perforation and discrete areas on the endocranial cortex of woven and lamellar plaque (Figure 2b, c), a cavitating node on the humerus (Figure 2d) and a healed node on the tibia. Burial 23A additionally has pseudo-bowed (anterior proliferative periostosis) sabre tibiae (Figure 3a) (Table 2). Three of the pathognomonic treponemal cases exhibit reactive change indicative of traumatic injury: Burial 10 has three rib pseudarthroses, burial 96 has a single misaligned rib and burial 48 (female, 50+ years) has a traumatic injury of the right clavicle (i.e. diaphysis misaligned and shortened). The co-association of trauma with treponemal disease is not unusual, as ectodermal injury is reportedly a common point of entry for the spirochete (Ortner, 2003; Powell and Cook, 2005).

Three individuals exhibit reactive change at the indicative level of diagnostic reliability. Burials 11 (age/sex indeterminate) and 103 (male, 25–35 years) have pseudo-bowed sabre tibiae (Figure 3b, c). Burial 104 (female, aged 25–35 years) has a cavitating node on the right tibia, a healed node on both tibia (Figure 4a, b, c), and diaphyseal expansion of the right clavicle.

One additional individual has reactive bone changes consistent with treponemal disease but is not a supportable case. Burial 110 (female, aged 30–40 years) exhibits non-cavitating nodes on both tibiae (Figure 5a, b, c) and diaphyseal expansion of the clavicles (Table 2). If this possible case is included in the tally of treponemal cases, the Schroeder Mounds sample has a minimum of 13.2% and a maximum of 15% (8/53, 15.1%). Consistent with the literature (Cook and Powell, 2005), there is no sex difference in the maximum case sample ($N = 8$, $p = 0.3657$, one tailed).

**Tuberculosis**

No individuals exhibit reactive changes on any vertebral body that suggest infection or inflammation (e.g., ventral destruction, ventral periostosis and fistular defects). There are also no adult individuals who exhibit reactive changes at the metaphyses or the large joints. Therefore, there are no pathognomonic or indicative cases of TB.

The only presenting pathology on three individuals are resorptive or proliferative rib lesions on the pleural surface of one to three rib fragments (3/53, 5.3%). Burial 81A is comingled with ribs from a second individual (Burial 81B) and each display healed cavitating lesions and active perforating lesions (Figure 6a). Burial 2 has a single rib with a discrete striated elevation (Figure 6b). TB cannot be excluded as the causative agent (Kelley and Micozzi, 1984; Yao and Sartoris, 1995; Lambert, 2002; Mays et al., 2002; Roberts and Buikstra, 2003; Raff et al., 2006; Nicklisch

Figure 2. Burial 10 (male, aged 30–40 years) exhibiting the following: (a) perforating lesions on the left frontal and stellate lesions on the posterior left parietal, (b) frontal perforating lesions, (c) remodelled fiberbone on the endocranial surface of the frontal, and (d) a nodal lesion on the humerus.
et al., 2012), but other conditions such as pneumococcal infection (Aufderheide et al., 2008), inhalation of *Nicotiana* (Charlton, 2004), actinomycosis and blastomycosis (Buikstra and Williams, 1991; Pfeiffer, 1991) also manifest as reactive responses on the visceral surface of ribs. Therefore, the pleural surface rib lesions are currently best interpreted as non-specific reactive change.

**Non-specific pathology**

Including the possible treponemal case (burial 110), and the 3 individuals with visceral rib surface lesions (i.e. burials 2, 81A and 81B), 11 individuals (11/18, 61%) exhibit proliferative periostosis that is not diagnostic of a specific disease process (Table 2). These 11 include 4 of the 7 individuals (Burials 37A, 51, 68 and 70) who additionally display reactive change to traumatic injury.

Resorptive external rib lesions are the only presenting pathology on two individuals (burials 25A and 69). Therefore, 5 of the 11 nondiagnostic cases have reactive change limited to the ribs. Resorptive cavitating rib lesions (Figure 6c) are part of the suite of reactive changes on Burial 37A (bilateral periostosis of the tibiae, and healed traumatic injury [angulation of the distal right radial diaphysis, right clavicle with a misaligned diaphysis]). Burial 37A and the five other individuals (6/11) all exhibit some form of reactive change (diaphyseal expansion and periostosis), to at least one tibia (Table 2).

Figure 3. Anterior periostosis on the tibiae resulting in sabre tibiae on the following: (a) burial 11, (b) burial 103, and (c) burial 23A.

Figure 4. Burial 104 (a) has multiple nodal lesions on both tibiae; (b) a healed and (c) a single cavitating one are illustrated.
Discussion

An implicit goal of bioarchaeological inquiry is archaeological problem solving using patterns of morbidity, mortality, and disease prevalence (Larsen, 1997; Smith, 2012). When judiciously applied, this inquiry can result in new insights about societal, subsistence or settlement patterning that is otherwise unobtainable or ambiguously reflected in the material culture. The Schroeder Mounds skeletal sample straddles the time of the pivotal socioeconomic (maize intensification) and demographic change (clustered permanent settlement) that characterises Mississippianization. Much of this process in Illinois has been archaeologically framed in the American Bottom (e.g. Cahokia), the lower Illinois River Valley (LIRV) and the CIRV (McElrath et al., 2000). However, the paleopathological correlates have not been unequivocally secured. Late Woodland subsistence and settlement in west-central Illinois is only generally understood (Collins, 1997; Benn and Green, 2000; Emerson and Titelbaum, 2000) and there is a lack of comparable paleopathological data (Hedman and Emerson, 2008). However, the paleopathological co-association of sedentism with a high skeletal sample prevalence (i.e., ~9± %) of tertiary treponemal disease (Cook and Powell, 2005:466; Hutchinson and Richman, 2006, Powell et al., 2005b:157;
Smith, 2006) and the presence of the pathognomonic signature of TB (i.e. ventral vertebral lytic lesions and Pott’s disease) (Roberts and Buikstra, 2003) may be useful benchmarks to evaluate the Schroeder Mounds material.

Archaeological context: remote hinterland subsistence/settlement

The Schroeder Mounds site is physiographically located on a bluff top overlooking the Mississippi River floodplain, an environment that is amenable to forager farming or permanent homesteading (Kolb, 1982). However, the paucity of material culture and the apparent heterogeneity of late Late Woodland (AD 900–1100) ceramics-defined cultures in Illinois impede modelling of the subsistence-settlement pattern (Benn et al., 1992; Schroeder, 1998; Alex, 2000; Benn and Green, 2000; Esarey, 2000; Green and Nolan, 2000; Stoltman, 2000; Stoltman and Christiansen, 2000; Theler and Boszhardt, 2000; Benn and Lee, 2005; Hedman and Emerson, 2008; Hedman and Emerson, 2008; Trader, 2011). Complicating the subsistence-settlement reconstruction, Schroeder Mounds is culturally located at the Mississippian frontier and at the interface of at least three contemporary regional late Late Woodland phases that have considerable synonymy of (primarily ceramic) material culture.

Originally affiliated with the Maples Mills phase (AD 750–1000) of the CIRV (Riggle, 1981; Kolb, 1982), Schroeder Mounds is also located at the eastern perimeter of the Minotts phase (AD 950–1100) of eastern Iowa (Alex, 2000; Benn and Green, 2000), and may be temporally and spatially included in the recently defined Louisa phase (AD 800–1200) of south-eastern Iowa and the east bank of the Mississippi River trench (Benn and Green, 2000; Benn and Lee, 2005). Significant for contextualising Schroeder Mounds, Louisa phase material culture has been recovered in riparian archaeological contexts in Henderson County, Illinois (Benn, 1987; Alex, 2000; Benn and Lee, 2005; Fishel, 2008). The settlement pattern of the Louisa phase is unknown, but it has tentatively been postulated to be permanent base camps in conjunction with temporary (‘bivouac’) resource extraction sites (Benn and Lee, 2005; Fishel, 2008). Additionally, the ecological context of Schroeder Mounds is similar to the Sny Bottom alluvial plain (Figure 1) of the Mississippi River that is home to the coeval Poisson phase (AD 800–1100) (O’Gorman and Hassen, 2000). The archaeological material culture from the Maples Mills core area, the Minotts phase of Iowa, and the Poisson phase is interpretively vague and has been hypothesised to suggest a semisedentary hunting-horticultural economy (Alex, 2000, Esarey, 2000, Green and Nolan, 2000, O’Gorman and Hassen, 2000).

Treponemal disease and sedentism

In Illinois, there are tertiary stage treponemal cases from Late Archaic (2500–500 BC) hunter-gatherer contexts (Pete Klunk and Carrier Mills sites) with a <1% recorded prevalence (Cook, 2005; Cook and Powell, 2005). Smith (2006) observed a steep increase in treponemal disease prevalence in Tennessee with the transition to sedentism (<1% vs. 10.7%). Despite methodological and sampling problems, the overarching pattern of treponemal disease prevalence in pre-Columbian North America is a marked increase in chronic treponemal disease visibility with sedentism (Cook and Powell, 2005:466; Hutchinson and Richman, 2006; Powell et al., 2005b:157; Smith, 2006). The prevalence of pathognomonic and indicative treponemal disease cases in the adult Schroeder Mounds sample (13.2%) is consistent with sedentism. This conforms to the general model for more sedentary Late Woodland main river channel occupation (Green and Nolan, 2000; Simon, 2000) and tentatively suggests that the Louisa phase main (i.e. Mississippi River) channel base camps in Henderson County were indeed long-term residences.

Few Late Woodland sites in Illinois have been examined for the prevalence of treponemal disease (Cook, 2005). Three sites (Gibson, Joe Gay and Ledders) with published adult prevalence (9.3%) are LIRV and belong to the Late Woodland Jersey Bluff phase (AD 800–1350) (Cook and Powell, 2005). The hypothesised Jersey Bluff settlement pattern is the large long-term residence base camp (Farnsworth et al., 2000, Studenmund, 2000) which supports the interpretation for the Schroeder Mounds people. Although Illinois Mississippian period cases of treponemal disease are reported, there is no prevalence information (Cook, 2005).

Tuberculosis and the Late Woodland

Where TB is endemic, initial infection occurs in childhood by inhalation of bacteria from the airborne respiratory fluids of active pulmonary cases (Schluger, 2005). Most infected individuals remain asymptomatic (i.e. latent); however, compromised health (e.g. malnutrition and secondary chronic ailment) and differential strain virulence can result in progressive respiratory infection, which can be fatal in acute phases or become a chronic waxing and waning disease (Smith, 2003; Schluger, 2005; Phillips and Ernst, 2012). It is a disease epidemiologically...
associated with crowding and compromised community hygiene (Lawn and Zumla, 2011). TB often disseminates to extrapulmonary sites with predilections to the anterior vertebral, visceral rib surfaces, large joints and metaphyses (Kelley and Micozzi, 1984; Auferheide and Rodríguez-Martin, 1998; Ortner, 2003). The pathognomonic skeletal signature of TB is certainly gibbus formation (Pott’s disease); however, rib lesions, although not unique to TB (Buikstra and Williams, 1991; Pfeiffer, 1991; Lambert, 2002), can be diagnostically useful (Lambert, 2002; Mays et al., 2002; Raff et al., 2006).

Schroeder Mounds is located in the centre of one of two North American regional clusters where macroscopic evidence of pre-Columbian TB has been identified (Roberts and Buikstra, 2003: Table 4.1). Generally, TB was assumed to be limited to contexts that post-date AD 900 (Stone et al., 2009) and thereby co-associate with Mississippianization. However, suggestions of sampling bias (e.g. Roberts and Buikstra, 2003), biomolecular evidence (Millward et al., 2012) and evidence from Point Hope, Alaska (100 BC–AD 500) (Dabbs, 2009) challenge this assumption. Regardless of ultimate antiquity, Schroeder Mounds straddles the temporal horizon (AD 800–1100) when TB becomes unequivocally macroscopically evident.

In the LIRV, TB is not diagnostically present but biomolecularly demonstrated at the Jersey Bluff phase Schild site (AD 800–1050) (Braun et al., 1998; Millward et al., 2012). Approximately 15 km away, multiple cases of Pott’s disease were observed at the Jersey Bluff Hacker Mounds site (AD 1022–1185) (Mosher, 2012). The apparently coeval Mississippian component at Schild (AD 1000–1200) does have pathognomonic cases of TB (Raff et al., 2006). Perhaps epidemiologically significant, in the Mississippi River Valley and at the perimeter of the Jersey Bluff culture area, the Yokem Mounds site (AD 1330–1530) does not exhibit any pathognomonic cases of TB, yet individuals have tested positive for the presence of some form of TB (Millward et al., 2012). If some strain of (perhaps differentially virulent) TB is indeed endemic, subsistence-settlement strategy (i.e. Mississippianization) may be epidemiologically relevant as population density, settlement aggregation, diet (composition or malnutrition) and community hygiene may contribute to its visibility in the disseminated tertiary stage (Woods, 2004; Wilbur et al., 2008; Stone et al., 2009). Social isolation might be a barrier to disease transmission (McGrath, 1988). However, there apparently were no barriers to Late Woodland interpopulational gene flow (Droessler, 1979; Steadman, 1997). It is certainly possible that socioeconomic elements of Mississippianization that facilitated the ubiquity of tertiary TB were separable factors (e.g. farmstead versus aggregate village). Schroeder Mounds may have epidemiological common denominators with Yokem and the Late Woodland Schild samples but not Hacker Mounds, which are as yet archaeologically indeterminable but potentially bioarchaeologically discernable.

Conclusion and future directions

The paleopathological prevalence of tertiary stage treponemal disease in the Late Woodland communities of the Mississippi River Valley, who buried their dead in Schroeder Mounds, is consistent with other archaeologi- sample frequencies identified as sedentary. The absence of cases of pathognomonic TB suggests particular but not yet quantified, subsistence, community health and population aggregation characteristics. In the absence of baseline archaeological information, these interpretations provide points of departure for future bioarchaeological evaluations of Schroeder Mounds as well as underscore the need for comparative assessments with other terminal Late Woodland/Emergent Mississippian period samples from riverine west-central Illinois.

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