

ESTIMATES OF AGE STRUCTURE AND MORTALITY FROM THE WARD SITE, A LATE-ARCHAIC POPULATION

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RESUMEN

A lo largo del Río Green en Kentucky se localizan cementerios prehistóricos muy antiguos que están asociados con sitios habitados. La arqueología del Arcaico tardío, biología esquelética y paleodemografía han sido descritas para el Indian Knoll (15Oh2) y Carlston-Annis (15Bt5), las cuales revelan distribuciones de edad jóvenes, altas tasas de dependencia y expectativas de edad cortas.

Más de 16 000 pies², representando 16% del Sitio Ward (15McL11) fueron cuidadosamente excavados en 1938. Evidencia de ocupación a lo largo del año, bienes mortuorios elaborados asociados con entierros de infantes, buenos niveles de preservación, supervisión cuidadosa de lo recobrado en todos los entierros y nuestra reevaluación del inventario del entierro sustentan la idea de un cementerio totalmente representativo de lo que alguna vez fue una población viviente. La edad de los subadultos se asignó usando métodos de análisis de dentición estándar, mientras que la edad de la población adulta del cementerio se fijó usando un sólo indicador, la superficie auricular del íleo. Estudios de campo que evalúan la fertilidad de poblaciones primitivas modernas fueron usados para completar la reconstrucción paleodemográfica de esta población presumiblemente pescadora-cazadora-recolectora sedentaria.

PALABRAS CLAVE: Paleodemografía, Arcaico tardío de Kentucky, superficie auricular, crecimiento intrínseco.

ABSTRACT

Very old prehistoric cemeteries associated with habitation sites are located along the Green River in Kentucky. Late-Archaic archaeology, skeletal biology, and paleodemographies have been described for Indian Knoll (15Oh2) and Carlston-Annis (15Bt5), which reveal young age distributions, high dependency ratios, and low life expectancies.

More than 16,000 ft², representing 16% of the Ward site (15McL11), were carefully excavated in 1938. Evidence of year-round habitation, elaborate grave goods associated with infant burials, good levels of preservation, careful supervision of the recovery of all burials, and our reassessment of the burial inventory all argue for a cemetery fully representative of a once living population. Subadults were aged using conventional dentition standards. The adult portion of the cemetery was aged with only one indicator the auricular surface of the ilium. Field study accounts of fertility performances in modern primitive populations were used to complete the paleodemographic reconstruction of this presumably sedentary fisher-hunter-gatherer population.

KEY WORDS: Paleodemography, Kentucky Late Archaic, auricular surface, intrinsic growth.

INTRODUCTION

The demographic reconstruction of an extinct society is a sampling process which may involve several potential sources of error. First, time and resources may not allow complete removal of the contents of a cemetery, and therefore demographic estimates can only be taken from the proportion of the site excavated. Second, soil and other conditions of interment, including any subsequent disturbance of the burials, as well as the care and skill of the excavators may all affect the representativeness of a cemetery. However, most important are aboriginal burial practices, some of which have prevented us from examining large portions of human demographic prehistory. Victims of violent conflict may not have been returned to the site for burial (Weiss 1973), and infanticides may not have been placed with the other neonatal deaths (Saunders 1992).

There is another reason why the most basic demography of extinct hunter-gatherer populations has not been available to us. Since high mobility may have precluded the use of a cemetery, few foraging populations anywhere in the world ever returned their members to a

common place of burial. This is unfortunate, because this lengthy prehistoric stage is the one most characteristic of our species, and is therefore most important to an understanding of its biology and evolution. This paper reports preliminary work in the paleodemography of what are quite possibly the first sedentary, non-agricultural populations in the eastern woodlands of North America. As such, these studies provide an important part to the story of human cultural and demographic evolution in the New World.

SETTING AND HISTORY OF EXCAVATION

The Shell Mound Region comprises both floodplain and uplands of the Lower Green River, from the area of the Big Bend in the southeast to its confluence with the Pond River in the northwest (Marquardt and Watson 1983). Many sites are found here, and at least a half dozen of these represent long-term late-Middle and Late Archaic habitations, with very large cemeteries. Carlston-Annis (15Bt5) and Read (15Bt10) are in the region of the Big Bend in Butler County. Bowles (15Oh13) and Chiggerville (15Oh1) are in Ohio County near Indian Knoll (15Oh2), perhaps the best known Kentucky shell-mound. Butterfield (15McL7) and Barrett (15McL4) are large habitation and cemetery sites in McLean County. These are near the Ward site (15McL11), the focus of this study, and together represent the easternmost localities in this series.

The first serious attempt to recover archaeological materials in this region was by Clarence Moore in 1915 at The Indian Knoll (Moore 1916). Many Green River sites were surveyed within the next decade and a half (Webb and Funkhouser 1932), and excavation subsequently began in earnest with the passage of the Emergency Relief Act in 1935. This created the Work Projects Administration which in turn provided large numbers of laborers for archaeological studies in the western coalfields of Kentucky. Under the supervision of William S. Webb, the large-scale field operations unearthed thousands of articulated human skeletons and tens of thousands of artifacts from Archaic sites by the beginning of World War II. Much of this material has never been analyzed (Jefferies 1990).

Although the Archaic sites were not completely excavated, the W.P.A. excavations had produced staggering quantities of informa-

tion. Crude projections from the densities of the sampled areas at each site to the dark soils indicating extent of prehistoric habitation reveal that Indian Knoll is not the only large Late Archaic ossuary in this region (table 1). At least one member of the Shell Mound Archaeological Project at Washington University at St. Louis concludes that many of these sites were long-term residential base camps, representing year-round primary habitation (Hensley 1994). If so, then Green River Archaic sites, with the possible exception of one of the levels at the Eva Site (40Bn12) in Tennessee (Lewis and Lewis 1961, Dye, 1996, but see Magennis 1977), may represent the earliest sedentary populations east of the Mississippi River.

Table 1
Crude Estimates of Sizes of Largest Known Green River Archaic
Cemeteries (Data from Hensley, 1994)

Green River Archaic Site	Percentage Excavated	No. Burials Recovered	Projected No. of Burials
Read (Bt10)	51	247	500
Butterfield (McL7)	14	153	1100
Carlston-Annis (Bt5)	21	390	1850
Indian Knoll (Oh2)	61	1178	1950
Barrett (McL4)	21	412	1950
Ward (McL11)	19	433	2300

THE WARD SITE IN CONTEXT

Webb and Haag (1940) claimed that the prehistoric inhabitants of the Cypress Creek villages built crude lean-tos, hunted and fished, and lacked ceramic vessels of any kind. Tools include grooved stone axes and hammer stones. The recovery of an early example of domesticated gourd in this region (Marquardt and Watson 1983) and the great numbers of pestles at the Ward and Barrett sites (Prufer and Pedde 1998) cast doubt on the original hypothesis that horticulture was altogether absent (Webb and Haag 1940). In fact, it has become increasingly clear that a variety of starchy weed seeds

(e.g., goosefoot, maygrass, and knotweed) were an important part of the Late Archaic diet (Jefferies 1996). The worked flint at all of these sites reveals a continuous range from corner notched to stemmed projectile points. There are large quantities of domestic artifacts, including drills and scrapers, some of which are obvious reworked points. The flint was local but of high quality, and highly valued (Prufer and Pedde 1998).

While both large and small animals were common game, the majority of the 30,000 animal bone fragments at Indian Knoll was deer (*Odocoileus virginianus*) (Webb 1946). In fact, it was the great quantity of deer bone at the surface of the Ward site that first attracted the attention of archaeologists. Squirrel, rabbit, raccoon, fish (especially freshwater drum), and reptiles (especially turtle) were more important resources for the Green River site inhabitants than were particular avian species (Hensley 1994).

Nuts are ubiquitous floral representatives in Archaic assemblages in the Midwest and Southeast (Chapman and Watson 1993). Walnut and especially hickory nut compose the great majority of the identifiable plant remains at York-Render (15Bt92), from which 41 samples were floated (Hensley 1994). In addition, more than 80% of the identifiable plant remains by weight at both Carlston-Annis and Bowles are hickory nut (Crawford 1982). Human paleofecal specimens recovered from both Salts Cave and Mammoth Cave range in radiocarbon dates from Late Archaic to Middle Woodland, and contain high percentages of hickory nutshell (Watson and Yarnell 1966). While hickory nuts are gathered only in October and November, both hickory nutmeat and oil can be stored.

Freshwater mussel shells either dominate the sites themselves, or, in the case of Ward, form massive deposits at the base of a nearby bluff. At least four modern species were found in great numbers at many sites; however, 19th century river engineering and other disturbances have made it difficult to ascertain the locations and sizes of prehistoric mussel shoals (Hensley 1991). Nevertheless, it is fair to say that they were there in abundance, and that both these and hickory trees supported what can be called a harvesting economy (Winters 1974). It can be argued that this in turn promoted a new settlement pattern by Late Archaic times, by means of year-round access to some food source of very high quality.

While hickory nuts must be stored to support a population for more than a couple of months, shellfish can be recovered during most of the year if necessary, even in the coldest season. However, aboriginal collectors would have risked hypothermic injury. Auditory exostoses are bony nodules which develop on the walls of the external auditory canal as a result of cold injury (Kennedy 1986). They are generally uncommon in human groups. Mensforth and Baker (1996) examined crania from four of the riverine sites. At Indian Knoll and Carlston-Annis, which are sites on the banks of the deep Lower Green River itself, they found the highest frequencies of this lesion ever reported. More than half of the Indian Knoll males had at least one auditory canal containing an exostosis, and most of these crania had exostoses in both. At Ward and Barrett, which are located on shallower tributaries, 20% of the adult males were affected. The rates in adult females were much lower (Mensforth and Baker 1996). These observations stand in contrast to ethnographic evidence that shellfish collection is primarily the role of women and children (Waselkov 1987). In any event, both cold water exposure and high incidences of obstructive hearing loss in these small settlements were very likely.

The Ward site is located on the farm of Godfrey Ward in McLean County. Between February and September of 1938, a total of 16,000 square feet of the site was excavated by a W.P.A. crew under the immediate supervision of John B. Elliott. There were 162 ten-foot squares which contained 62 features, and that year 433 human burials were catalogued (Webb and Haag 1940). Curators at the University of Kentucky Museum of Anthropology (UKMA) detected additional individuals in some of the mass and bundle burials. One of us (Mensforth) also reanalyzed the recovered and curated materials, and was able to resolve the status of several more cases, including seven previously unrecognized pairs and one bundle burial. Mensforth also designated four burial numbers as problematic due to damage or misidentification, and removed them from the demographic sample. An isolated late prehistoric occupation had associated burials; these were not included in the analysis. The final efforts to determine an unbiased demographic sample involved the elimination of the last entries to the field burial list (see below).

In September of 1938, Godfrey Ward approached the crew supervisor and demanded moderate financial compensation for the con-

tinuance of the archaeological excavation. This was not an acceptable arrangement, and over the next few days the crew conducted what was essentially a salvage operation, as they relocated their efforts to the nearby Kirkland site (15McL12), the other Cypress Creek AVillage@. It is apparent that the last series of identified Ward burials were hastily catalogued and bagged. Burials recovered during the last week from a long trench were poorly identified. Finally, there was both a preponderance of unrecognized bundles and also a dearth of infant skeletons toward the end of the field inventory. It was the judgment of the authors to eliminate this terminal series from analysis. Therefore, the paleodemographic analysis of the Ward site is confined to those burials with field numbers less than 432 (UKMA numbers less than 403).

RESEARCH STRATEGY AND OSTEOLOGICAL METHODS

Original field notes, photographs, skeletons, and grave goods were examined. Preservation of bones and teeth at Ward was excellent, although there was distortion of many crania, and fragmentation of whole skeletons. Except for bundle burials and a mass grave, which pose no problem in demographic reconstruction, nearly all skeletons were articulated and found in their own pit. Most were tightly flexed and decedents of all ages had grave accouterments. Neither bone surfaces nor tooth crowns were degraded, and there is no reason to suspect a differential loss of skeletons by age class in this cemetery. Fully one quarter of the skeletons was less than two years of age at the time of death. For many of these there were indications of burial status not unlike those for adults. These included a tooth necklace, a turtle carapace, a tool kit, and ankylosa beads, but drilled mussel shells were found only with adults, usually females. It is apparent that even neonatal infants had become members of both this society and its elaborate burial program.

Death and burial were important rites of passage for all members of this population. There is one pit with several flexed burials in a circular arrangement recovered from the habitation level, depicting two female and three male adult burials. Four have flint or antler projectile points imbedded in the chest or back. Violence was common at Ward, and apparently some effort was made to return the dead back to the site for burial.

Children were aged primarily by dental eruption standards, with supplemental information taken from longbone lengths. Adolescents were aged on the basis of epiphyseal union, and secondarily on postcanine dentition (see Mensforth 1990, for methods). Adults were sexed on the basis of the pelvis, although cranial morphology played a minor role in some cases (Meindl *et al.* 1985b, Mensforth 1990). Ward adults were very sexually dimorphic, especially in the posterior aspects of the pelvis.

Ward crania were nearly all present, but they were quite fragmentary, and therefore suture closure could not play much of a role in adult aging (Meindl and Lovejoy 1985). Dental attrition is so extreme in Archaic shell mound skeletons that the estimation of wear rates for even middle-aged adults is problematic (Lovejoy 1985, Mensforth 1990). There are two problems with the pubic symphysis: (1) As in the case of skulls, too many were fragmentary, and (2) more important, even a well-preserved pubic symphysis says very little about ages greater than 40 years (Meindl *et al.* 1985a; Lovejoy *et al.* 1997). These independent skeletal aging sites will always remain useful in ordering the adults in a cemetery from youngest to oldest. However, indicators which yield limited information about old age may produce biased estimates of the extreme portion of the survivorship function.

There are two discrepancies between skeletal and ethnographic distributions of ages at death. By comparison, skeleton-based demographics tend to have (1) relatively few infant deaths, and (2) high proportions of young adult deaths relative to the elderly, the so-called Amid-age bulge@ (Milner *et al.* 1989, Paine 1997). While we have argued on biological grounds that these patterns of prehistory were for the most part real (Lovejoy *et al.* 1977), others have suggested that the first is a product of poor cemetery representation and the second is an artifact of errors in age estimation (Howell 1982, Johansson and Horowitz 1986, Milner *et al.* 1989, Paine 1989).

This analysis employs a new solution to the problem of estimating adult age. It presents the adult portion of the cemetery age distribution based only on the iliac side of the sacro-iliac joint. Over the past years, osteologists at Kent State University have developed and tested the auricular surface for use as an age indicator (Lovejoy *et al.* 1985, Bedford *et al.* 1993, Meindl *et al.* 1995, Lovejoy *et al.* 1995, Lovejoy *et al.* 1997). Auricular aging may be very difficult to apply, but

it has two important advantages. First, auricular surfaces are more durable archaeologically, compared to commonly broken crania and missing pubic symphyses. Second, and more important, the auricular surface reflects old age better than any other bony site (Lovejoy *et al.* 1997). The individual errors which were made in assigning adult age to each Ward skeleton may be large, but they are probably not biased. It has been shown in cadaver populations of known age that the distribution of adult auricular ages can approximate quite well the actual age distribution (Lovejoy *et al.* 1985, Bedford *et al.* 1993).

PALEODEMOGRAPHIC MODELS

All models are based upon the demographic sample of 402 burials. To begin, stable (i.e., constant vital rates) and stationary (i.e., no population growth) demographic conditions were assumed for the duration of the prehistoric use of the cemetery (table 2). Under these conditions, expectation of life at birth is equivalent to mean age at death in the cemetery. Compared to modern populations, Ward survivorship is poor. However, these life expectancies are in the mid-20s, which are somewhat higher values than have been obtained from most paleodemographic studies. One exception is the Carlston-Annis life table which has virtually the same subadult proportions as Ward: 21.5% of the skeletons at Carlston-Annis were infants vs. 20.6% at Ward; 29.7% of the Carlston Annis skeletons were less than five years old vs. 30.8% at Ward (Mensforth 1990). Therefore, there is no support on demographic grounds for the claim that Ward (a so-called winter Asettlement@) and Carlston-Annis (a summer Abase camp@) represent different site Atypes@ (Winters, 1974), since infant and early childhood mortality in primitive populations tend to be very dependent upon climate and season. There are other reasons to infer year-round occupation at Ward and at other Green River sites as well (Prufer and Pedde 1998).

The stationary Ward life tables are typical of skeleton-based demographies in that the pattern of adult survivorship still contrasts with that of extant primitive populations in the usual ways. There is also a disadvantage in longevity for males. This amounts to a three-

Table 2
Ward Site Life Tables, Assuming Stationarity (i.e., $r = .00$)

Age (x)	Males		Females		FB _x
	l_x	\bar{e}_x	l_x	\bar{e}_x	
0	1000	24.0	1000	27.1	
5	692	29.2	692	33.6	
10	652	25.9	653	30.5	
15	610	22.5	610	27.4	.042
20	535	20.3	536	25.8	.114
25	470	17.7	472	24.0	.114
30	423	14.4	414	22.0	.092
35	343	12.2	367	19.5	.064
40	254	10.6	330	16.4	.027
45	192	8.2	293	13.2	.006
50	112	7.3	241	10.5	

Crude rates: $d = b = .039$ per person per year
 Net Reproductive Rate: $R_0 = 1.0$ daughter/woman
 Gross Reproductive Rate: $GRR = 2.3$ daughters/woman
 Total fertility Rate: $TFR = 4.7$ children/woman

year difference in life expectancy at birth between males and females, which increases to a five-year advantage for females by age 15. No attempt was made to sex subadult skeletons: the tables report that only 61% of both males and females survive to age 15.

The assumption of demographic stationarity, along with the cemetery age distribution, also determines the level of fertility. A general *pattern* of age-specific fertility rates in women (K_x) may be found in Weiss (1973: 34). The *level* presented for the Ward site (FB_x) is such that fertility balances mortality, with the result that there was no population growth (table 2). These figures represent the number of daughters born per woman per year in each five-year age class. The sum of these ($\sum FB_x$) is the gross reproductive rate (GRR), or the average number of daughters born to those women who lived to menopause. Given a slightly uneven sex ratio at birth, the total number of children, called the Atotal fertility rate@ (TFR), is 205% of the GRR. The stationary demographic model indicates that all the

women from this population who lived to age 50 would have to have averaged about 4.7 live-born children to keep the population size constant in the face of the mortality rates experienced by the remainder of the women (table 2). A comparison of this performance to the completed fertility of living populations is informative.

The Dobe !Kung are hunter-gatherers from the Kalahari desert of Botswana and Namibia. Prior to their recent sedentarization, !Kung women had children spaced more than four years apart. Howell (1979) reports that !Kung women who completed their reproductive years had about the same number of children as the estimate for Ward (table 3). The Ache of the forests of Paraguay were a foraging people prior to their settlement in 1973. They lived in a far richer ecology than the !Kung. Hill and Hurtado (1996) estimate that Ache women who survived to the end of reproduction averaged eight children (table 3). Anthropological demographers have recorded about eight liveborn children for both Yanomamo Indians of Venezuela (Neel and Weiss 1975) and native Australian Aborigines (see Jones 1963, in Weiss 1973) (table 3). All of these cultures represent hunter-gatherers, except the Yanomamo, who have been practicing a form of slash-and-burn horticulture for many generations. The nutritional limitations of the !Kung and their habit of prolonged breast-feeding may produce a post-partum amenorrhea which in turn suppresses ovulation and fertility. Alternatively, the fact that !Kung women suffer from infectious agents may be responsible for reduced fertility (Harpending 1994). In any event, !Kung fertility may be unusually low by ethnographic standards, and this brief survey of total fertility rates in the best censused primitive populations available suggests that the Ward stationary demographic model is incorrect.

There appears to be a common practice associated with high fertility. Perhaps a quarter of the Yanomamo and Ache newborn—usually females—are routinely killed at birth (Weiss 1975, Hill and Hurtado 1996). The infanticide level for Aborigines may actually be higher still. Finally, the ethnographic estimates of mortality are compared to that of the stationary Ward model (table 3). These are summarized as the expectations of life at age 15, which measures only adult longevity. There is a great range of mortality experience here, and, again, the estimates for Ward are the lowest.

Table 3
Demography of Primitive Populations (See Text for References)

Population	Infanticide	\ddot{e}_{15}	TFR
Ward Females (Stationary)	?	27.4	4.7
Dobe !Kung (Kalahari)	Very Low	54.1	4.9
Forest Ache (Paraguay)	High	43.3	8.1
Aborigines (Australia)	High	34.0	8.4
Yanomamo (Venezuela)	High	27.5	8.0

There is a fundamental problem in paleodemographic estimation. Weiss (1973) and Moore *et al.* (1976) were the first to explain this demographic truism to our field and to provide practical means under stable population theory for relating the age distribution of the cemetery to an intrinsic growth value (r , the AMalthusian@ parameter). In the parlance of elementary algebra, there are more unknowns than equations, and therefore no exact solution is possible. But for the reconstruction of primitive demographies in general, and the Ward site in particular, the additional Aequation@ can be sought elsewhere. The issue is that there are many different stable population profiles – from moderate mortality/high fertility (and a high rate of growth) to high mortality/moderate fertility (with low growth or decline), and every gradation in between – that would fill the Ward cemetery with the same age-class proportions. In effect, the work of the osteologist is completed once the cemetery age distribution has been determined. That distribution specifies a *continuum* of solutions, each point of which contains both a mortality level (\ddot{e}_0) and a fertility level (TFR), which in turn generates a growth level (r). How do demographers choose a specific point on this continuum? Bennett=s (1973) analysis of Point of Pines, Asch=s (1976) approach to Middle Woodland groups in the Lower Illinois Valley, and Muller=s (1997) models for the dynamics of Mississippian populations all argue for solutions (or ranges of solutions) based upon an hypothesized growth rate(s).

The approach to the problem in this analysis is somewhat different: for foraging populations a TFR, not a value for r , should determine the solution. It is proposed that a fertility level be chosen

from the ethnographies. In this case, a total fertility rate intermediate between the !Kung and the rest is selected as the one which may have best characterized the population that inhabited the Ward site and used its cemetery throughout its occupation: i.e., TFR = 6.50 (see Keckler 1997, Harpending 1997). Unlike the net reproductive rate (R_0), the total fertility rate (TFR) is a measure stripped of any maternal mortality, and therefore it is algebraically independent of the population growth rate. Nevertheless, the choice of a specific value of TFR (in excess of the stationary value) coupled with the cemetery age distribution and the assumption of demographic stability will fix both the life expectancies and the intrinsic rate of growth *upward*. The possibility of a moderate amount of female infanticide, unrecovered by archaeologists in 1938, is perhaps reasonable and will also be addressed: in addition to the recovered infants, 15% more neonates were added to the female *burial* population (which translates to about half that proportion in the high growth cohort presented below). ADiscounting@ methods for calculating the mortality,

Table 4

Ward Site Life Tables, Assuming High Rate of Growth ($r = +.025$)

Age (x)	Males		Females		FB _x
	l_x	e_x	l_x	e_x	
0	1000	34.4	1000	38.1	
5	845	35.1	802	42.3	
10	822	31.0	783	38.2	
15	794	27.0	760	34.3	.057
20	737	23.9	714	31.4	.156
25	682	20.6	669	28.3	.156
30	637	16.9	624	25.2	.126
35	550	14.2	582	21.8	.088
40	440	12.1	544	18.2	.036
45	353	9.4	501	14.5	.008
50	228	8.3	434	11.4	

Net Reproductive Rate: $R_0 = 2.0$ daughters/woman
 Gross Reproductive Rate: GRR = 3.2 daughters/woman
 Total Fertility Rate: TFR = 6.5 children/woman

Table 5
 Ward Survivorships (Assuming $r = +.025$)
 Compared to Model AWest@ Level 8

Age (x)	Ward ($r = +.025$)		Coale & Demeny West Model 8	
	Male	Female	Male	Female
	l_x	l_x	l_x	l_x
0	1000	1000	1000	1000
5	845	802	671	699
10	822	783	648	673
15	794	760	631	653
20	737	714	609	628
25	682	669	578	598
30	637	624	546	565
35	550	582	511	530
40	440	544	472	494
45	353	501	429	458
50	228	434	383	421
55	130	365	330	377
60	70	242	274	326
65	41	121	211	263

fertility, and census profiles of a stable population based on a non-zero intrinsic rate of growth (r) and a cemetery age distribution can be found in Weiss (1973).

An increase to the total fertility rate from 4.7 to 6.5 children accompanies two important changes (table 4). First, the intrinsic rate of growth is now assumed to have been 2.5% per annum. This is certainly a high rate, but not uncommon in modern primitive populations. In fact, both the Yanomamo and the forest Ache have averaged approximately this rate of growth for much of this century. Second, life expectancies at birth must also be much higher: mid-30's, rather than the mid-20's. And despite the female infanticide, newborn girls still enjoyed a longevity advantage ($\bar{e}_0 = 24$ years % vs. $\bar{e}_0 = 27$ years &&) at birth, which of course increased to a larger differential by age 15 ($\bar{e}_{15} = 22$ years % vs. $\bar{e}_{15} = 27$ years &&).

Table 6
 Comparison of Age-Class Proportions to the Census of a Living
 Population (Ache Data from Hill and Hurtado, 1996)

Age(x)	Forest Ache C_x	Ward ($r = +.025$) C_x
0	.20	.20
5	.18	.16
10	.09	.14
15	.06	.12
20	.08	.10
25	.09	.08
30	.07	.06
35	.08	.05
40	.06	.04
45	.03	.03
50	.02	.02
55	.02	.01
60	.03	.01
	— 1.01	— 1.02

Table 5 compares the new Ward mortality profiles ($r = +.025$) with the Coale and Demeny West Model 8 for both sexes (Coale and Demeny, 1966). While the new estimates have life expectancies at birth nearly equal to the Princeton model life tables, the patterns of survivorship are quite different. That is, the same discrepancy in paleodemography still exists: At Ward, there was relatively lower infant mortality and higher adult mortality.

The final implications concern the consequences of high yearly growth. The last table presents the living age pyramid of the forest Ache of Paraguay (table 6). The very young Ache population pyramid is not a product of stable vital rates. This century the small Ache population experienced high but fluctuating growth between 1.5 and 3.5 percent per year, and this variability left its irregular signature on the census. This is compared to the smooth hypothetical census for the

Ward population assuming constant stable growth of 2.5% (table 6). For the most part, these are populations with similar average ages.

CONCLUSIONS

The paleodemographic analysis of the Ward skeletal sample produces several conclusions: (1) Longevity at Ward was better than has been predicted for other prehistoric populations, especially Indian Knoll, for which both Cassedy (1972) and Kelley (1980) estimate mortality rates at the high extreme for human populations. The high estimate for longevity at Ward is due both to an assumption of high growth and also to the decision to age all adults on the basis of the auricular surface. On the other hand, the estimates for the Ward cemetery age distribution are very close to those of Mensforth (1990) for the Carlston-Annis Site, another Late Archaic Green River burial ground. (2) Ward women lived longer than men, which is probably related to the high levels of violence that characterized these societies. (3) The pattern of prehistory remains: relatively low infant mortality coupled with high adult mortality. (4) The intrinsic rate of growth rate was very high in Late Archaic times.

The analysis is consistent with demographic theory and human biology. A value of $r = .025$ is nearly a maximum rate, and may not have been sustained for very long in prehistoric times. In fact, this value predicts that the base populations would have doubled every 30 years. One implication is that high growth may have lasted for periods of a century or less, and this analysis assumes that only these periods were recorded in the cemetery age proportions. In other words, it assumes that any catastrophes or abandonments would not have been recorded in the Ward cemetery. Such a proposition has been called a biphasic catastrophic (Keckler 1997) or sawtooth pattern (Harpending 1997) of population size over time, and may have been a common demographic condition for successful foraging populations in prehistory. On the other hand, population growth during the end of the Hypsithermal climatic interval may have gone relatively unchecked for much longer periods of time. This analysis assumes that any dispersals or outmigrations comprised kin groups who approximated an age structure similar to that of the populations they

left behind. Successful outmigrations from the rich floodplain sites to the uplands or elsewhere in the region may have been common, a conclusion in support of the consensus among archaeologists that the first prehistoric population explosion in Kentucky took place in the Late Archaic (Griffin 1967, Jefferies 1996, Prufer and Pedde 1998).

The human species differs in many ways from its closest relatives, the African apes. A most pronounced difference is the human capacity for high rates of reproduction. The fertility rates for human females are much greater than for, say, chimpanzees. The brainier, hairless, bipedal species of ape is a relatively high-fertility hominoid, which since the Pliocene has experienced the highest levels and variances in growth rates of any of the apes. This is the hallmark of a colonizing species, and a major reason for both past human success and the current demographic peril. Archaeological demographers must come to expect that high intrinsic growth rates are the rule and not the exception in human prehistory.

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