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OVERCOMING BIASES IN THE PALEODEMOGRAPHIC RECORD: ESTIMATING ADULT SKELETAL AGE AND POPULATION GROWTH, WITH AN EXAMPLE FROM THE ARCHAIC PERIOD OF THE EASTERN WOODLANDS, USA.

ABSTRACT: (1) A problem in paleodemography is that for any given prehistoric cemetery, each of a continuum of stable populations could have filled it with exactly the same age proportions. When the assumption of stationarity (*i.e.*, $r = 0$) is imposed on an extinct population which in fact had been growing during the occupation of the site, life expectancy is underestimated, sometimes by a great margin. (2) A second problem is osteological, and involves bias in the direct estimation of adult skeletal age. Whenever traditional bony sites play a large role in skeletal aging there is a tendency to under-estimate the age of the cemetery's oldest decedents. The result of this regression problem is usually an over-proportion of adults between ages 30 to 40 years.

An analysis of the hunter-gatherer population of the Ward site of Kentucky (15McL11) is an attempt to address these two biases. The *archaeology* of this site includes a brief history of major excavations in the Lower Green River, the material culture of the period known as the late-Archaic, the fauna and flora which were exploited by humans in this woodland setting 4500 years ago, and the conditions of the human burials. A presentation of the *physical anthropology* of the site includes an important pathology and widespread evidence of violence. Traditional methods of age estimation for children and adolescents produced the base of the cemetery age pyramid. However, to prevent the second bias adults were aged using only the auricular surface of the ilium.

Ethnographic anthropology has provided surveys of the total fertility performances of women from the few living primitive populations of Africa, Australia, and South America. To address the first problem, these fertilities have been used to complete the paleodemographic reconstruction (mortality and growth) of the extinct, pre-agricultural population of this study.

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 made from the portion 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 generally precluded the use of cemeteries, 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 contribution to the volume 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.

ARCHAEOLOGICAL SETTING AND HISTORY OF EXCAVATION

The Shell Mound Region consists of 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. Both 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 B. 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 great 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 information. Crude projections from the densities of the sampled areas at each site to the dark soils indicating the 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 related 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.

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. Tool assemblages 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 cast doubt on the original contention that horticulture was altogether absent (Webb and

Haag 1940). In fact, it has become increasingly clear that various starchy seeds (e.g., goosefoot, maygrass, and knotweed) were important components of the Late Archaic diet (Jefferies 1996). The worked flint at all of these sites reveals a rather continuous range from corner-notched to stemmed projectile points. There are large quantities of domestic artifacts, including drills and scrapers, some of which are obviously reworked points. Flint of high quality was regionally available, and was presumably highly valued.

While both large and small animals were common game, the majority of the 30,000 animal bone fragments recovered 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). Walnuts and especially hickory nuts compose the great majority of the identifiable plant remains at York-Render (15Bt92), from which 41 samples were flotated (Hensley 1994). In addition, more than 80% of the identifiable plant remains by weight at both Carlston Annis and Bowles were 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). Hickory nuts can be gathered only in October and November; however, 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. Several modern species of shellfish were found in great numbers at many sites; however, nineteenth century river regulation and other modern 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 available in abundance, and that both these pelicipods and hickory trees supported what can be called a harvesting economy (Winters 1974). This in turn promoted a new settlement pattern by Late Archaic times, by means of year-round access to a food source of very high quality.

While hickory nuts must be stored to support a population for more than a couple of months, freshwater mussels can be recovered during most of the year and, if necessary, even in the coldest season. However, shellfish 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 have been found in many skeletal populations associated with cold-water environments. For instance, they occur in high frequencies in the crania from the early-Formative lacustrine site of San Luis Tlatilco in Mexico, but not at all from the post-Classic--and much drier--site at Cholula (Marquez et al. n. d.). Mensforth and Baker (1996) examined crania from four of the Kentucky shell-mound 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 the Ward and Barrett sites, 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 Godfrey Ward farm in McLean County. Between February and September of 1938 a total of 16,000 square feet of the site (19%) was excavated by a W.P.A. crew under the immediate supervision of John B. Elliott. There were 162 ten-foot squares containing 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).

Only a few months after the project was begun in 1938, Godfrey Ward approached the crew supervisor and demanded moderate financial compensation for continuance 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 "Village". It is apparent that the last series of identified Ward burials was hastily catalogued and bagged. Burials recovered during the last week from a long trench were poorly identified. 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 (University of Kentucky Museum of Anthropology catalogue 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 individual pits. Most were tightly flexed and some 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 are indications of burial status not unlike those for adults. These might include a tooth necklace, a turtle carapace, a tool kit, or ankylosa beads, but drilled mussel shells are found only with adults, usually females. It is apparent that even neonatal infants had become members of both this society and its burial program.

It can be inferred on other grounds that death and burial were important rites of passage for members of this population. There is a pit from the habitation level with flexed burials in a circular arrangement. The pit comprises 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 efforts had been made to return the decedents back to the site for burial.

Children were aged on dental eruption, 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). Adults were very sexually dimorphic, especially in all 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 yet, 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 loci 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. Skeleton-based demographies tend to have (1) few infant deaths, and (2) high proportions of adolescent and young adult deaths relative to the elderly--the so-called “mid-age bulge” (Milner et al. 1989; Paine 1997). While we have argued, on biological grounds, that a degree of such a pattern in prehistory is for the most part real (Lovejoy et al. 1977), others suggest that it is an artifact of age estimation or the representativeness of the cemetery (Howell 1982; Johansson and Horowitz 1986; Milner et al. 1989; Paine 1989). Therefore, this analysis proposes 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. 1997; Meindl et al., in this session of SOMEDE).

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 even more important, the auricular surface reflects old age better than any other bony locus (Lovejoy et al. 1997). The individual errors made in assigning adult age to each Ward skeleton may be large, but they are 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, this Ward survivorship model is poor. However, these life expectancies are in the mid-20's, 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). Certainly, there is no support on demographic grounds for the claim that Ward (a so-called winter “settlement”) and Carlston-Annis (a summer “base camp”) represent different site “types” (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.

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-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 (Table 2).

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 numbers (fractions) of daughters born per woman per year in each five-year age class. The sum of these (**$\Sigma 5FB_x$**) is the gross reproductive rate (**GRR**), or the average number of daughters born to those women who lived to menopause. The total number of children born to these women, called the "total fertility rate" (**TFR**), is about twice the **GRR**. The stationary model indicates that all the women from this population who lived to age 50 would have to have averaged about 4.7 liveborn 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 primitive 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 estimated 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 much richer ecology than the !Kung. Hill and Hurtado (1996) estimate that Ache women who survive to the end of reproduction average eight children (Table 3). Similarly, 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 are hunter-gatherers, except for 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 their reduced fertility (Harpending 1994). In any event !Kung fertility performance seems to be unusually low by ethnographic standards. This and other comparisons (see below) to the best censused anthropological populations available suggest 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 than this (Table 3). Finally, there is a great range of mortality experience among these populations, as summarized by life expectancies at age 15. Again, the Ward stationary model represents the lowest value in this comparison.

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 "Malthusian" parameter). In the parlance of elementary algebra, there are more unknowns than equations, and therefore an exact solution is not possible without more information. But for the reconstruction of primitive demographies in general, and the Ward site in particular, the additional "equation" can be sought elsewhere. The issue is that there are many different stable population profiles--from moderate mortality/high fertility (with high 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 in turn specifies a *continuum* of solutions, each point of which contains both a mortality level ($\_{\mathbf{0}}$) 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 based upon an hypothesized growth rate.

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 intrinsic rate of growth (or its alias, the net reproductive rate, $\mathbf{R_0}$), the total fertility rate (**TFR**) is a measure independent of maternal mortality, the population growth rate, and age structure. Nevertheless, the choice of a specific value of **TFR** (if it were larger than the value that would have produced no growth, i.e., r = .00) 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*. A moderate amount of female infanticide, unrecovered by archaeologists, is also a possibility that should be addressed; therefore, in addition to the recovered infants, between 5-10% more individuals who died as neonates should be added to the female population.

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 precisely this rate of growth for much of the past century. Second, life expectancies at birth must also be much higher--mid-30's rather than the mid-20's. And despite moderate female infanticide (7.5%), newborn girls still enjoyed a longevity advantage ($\_{\mathbf{0}}$=24 years, males vs. $\_{\mathbf{0}}$=27 years females), which increases to a larger differential by age 15 ($\_{\mathbf{15}}$=22 years males vs. $\_{\mathbf{15}}$=27 years females).

Table 5 compares the new mortality profiles (**r** = +.025) with the Coale and Demeny West Model 8 for both sexes (Coale and Demeny 1966). While the new Ward 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). While the Ache population is extremely young, its census is not a product of stable vital rates. In this century the Ache experienced fluctuating growth between 1.5 and 3.5 percent per year, and the variability in growth rate 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 percent (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 is 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 lower estimates for mortality at Ward are due both to the assumption of a high-growth model and also to the decision to age all adults on the basis of the auricular surface. The estimates for the Ward cemetery age distribution are very close to those from Mensforth (1990) for the Carlston-Annis Site, because auricular surfaces played a large role in that analysis as well. (2) On the average, adult men from the Ward population did not live as long as women, a discrepancy we attribute to the high levels of violent conflict. (3) The pattern of prehistory remains: relatively low infant mortality coupled with high adult mortality. (4) The growth rate was about 2.5 percent per year.

The analysis is consistent with demographic theory and human biology in a number of aspects. A value of $\mathbf{r} = .025$ 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 are recorded in the cemetery age proportions. That is, any catastrophes, band dispersals, or abandonments would not have been recorded in the Green River cemeteries. Such a proposition has been called a “biphasic catastrophic” (Keckler 1997) or “sawtooth” pattern (Harpending 1997) of population size over time. This may have been a most common pattern 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. Successful outmigrations from the rich floodplain sites to the uplands or elsewhere in the region may have been common. In fact, it has become the consensus among archaeologists that the first prehistoric population explosion in Kentucky took place in the Late Archaic (Griffin 1967; Jefferies 1996; Pedde and Prufer in this volume).

Humans differ in many ways from their closest relatives, the African apes. But a most pronounced difference is their capacity for high rates of reproduction. The fertility rates for human females are much greater than for, say, chimpanzees. Since the Pliocene, the brainier, hairless, bipedal, high-fertility species of hominoid 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, not the exception in human prehistory.

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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

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

	Males		Females		
Age (x)	**l_x**	**$–_x$**	**l_x**	**$–_x$**	**FB_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

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

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

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

	Males		**Females**		
Age (x)	$\mathbf{l_x}$	**_**$\mathbf{_x}$	$\mathbf{l_x}$	**_**$\mathbf{_x}$	$\mathbf{FB_x}$
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:	$\mathbf{R_0}$	=	2.0 daughters/woman
Gross Reproductive Rate:	**GRR**	=	3.2 daughters/woman
Total Fertility Rate:	**TFR**	=	6.5 children/woman

Table 4: Ward Site Life Tables, Assuming High Rate of Growth (**r** = +.025)

	Ward (r =+.025)		Coale & Demeny West Model 8	
	Male	**Female**	**Male**	**Female**
Age (x)	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

Table 5: Ward Survivorships (Assuming **r** = +.025) Compared to Model “West” Level 8

	Forest Ache	Ward (r = +.025)
Age(x)	**C_x**	**C_x**
0-4	.20	.20
5-9	.18	.16
10-19	.15	.26
20-29	.17	.18
30-39	.15	.11
40-49	.09	.07
50 +	.07	.04
	1.01	1.02

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