N.B. Carrier's (1958) formula for r (rate of increase) contained an error. I calculate r correctly from date of the 27th Chacmool Conference in November, 1997

THE MORTALITY OF ONTARIO ARCHAEOLOGICAL POPULATIONS

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MARY JACKES
Department of Anthropology
University of Alberta

Abstract: Huron ossuaries have been cited as providing excellent material for palaeodemographic studies. If this is so we should be able to follow with ease the mortality trend from 1400 to 1650, thus identifying the effect of European contact. Ontario sites are examined for their suitability for palaeodemographic study. Few sites provide good data and of those several appear to present anomalies indicative of sample bias. The remaining sites are examined by use of standardized life tables. This allows comparison previously impossible because of methodological differences and problems of age assessment. It is concluded that mortality at least doubled after 1610, but it is shown that there is reason to suspect adult underrepresentation especially, although not exclusively, in historic period Ontario sites. It is suggested that Ontario samples presently available for demographic analysis should not be regarded as totally reliable. Brief reference is made to Arikara data which appears to be potentially more valuable for contact studies.

Résumé: On a allėqué que les ossuaires Huron ont donnédes matériaux excellents pour les études paléodémographiques. Si c'est vrai, nous pourrions facilement suivre le mouvement de mortalité de 1400 à 1650, en établissant l'influence du rapport avec les Européens. On examine les emplacements dans l'Ontario pour estimer leur aptitude à une étude paléodémographique. Il n'y a pas beaucoup d'emplacements qui fournissent de bonnes données et il y en a beaucoup parmi ceux-ci qui semblent donner des anomalies qui indiquent un parti pris pour on contre les échantillons. On examine les emplacements qui restent par moyen des tables de vie qui sont uniformisées. Cette manière d'agir permet la comparaison qui n'était jadis possible à cause des différences méthodologiques et des problèmes en estimant les âges. On conclut que la mortalité s'est doublée au moins après 1610, mais on démontre qu'on peut soupconner de la sous représentation parmi les adultes en particulier, mais pas exclusivement, dans les emplacements dans l'Ontario pendant la période historique. On suggère que les échantillons dans l'Ontario que sont disponibles en ce moment à l'analyse démographique ne doivent pa être acceptés totalement sans reproches. On fait mention brièevement de la donne Arikara qui paraît être potentiellement plus importante pour les études de rapport.

Key Words: **Ontario Iroquois, Palaeodemography, Contact Period, Ethnohistory.**

INTRODUCTION

It is an article of faith among Ontario physical anthropologists that the Huron and Neutral burials of Ontario provide excellent sources of data for demography. This is true, in that we are provided with reasonably large samples representative (we assume) of a relatively short period of time, thirty years and less. Because the time element is controlled to some extent we can also infer that, apart from war captives, those buried had some social and probably biological relationship to one another. The social and biological relationships are in fact not known with certainty, but it seems reasonable to suggest that those together in death, following elaborate community ceremonials, formed some corporate social unit in life.

The period during which large Huron and Neutral burial features were established was actually very short: from the beginning of marked dependence upon cultigens (ca. 1300 A.D.) to the destruction of Huron and Neutral society by the Iroquois (ca. 1650 A.D.), following upon the disruptive effects of European contact.

The geographic and chronological position of each skeletal sample must be known if Huron and Neutral burials are to be useful subjects of osteological research. It seems reasonable that Ontario populations living in the period before European contact, would have had different mortality rates from those of populations during the period from 1600 to 1650. This is the hypothesis to be tested.

Enquiry into the mortality patterns of populations through time is essential to the anthropological understanding of a group. The age structure of a population has a strong influence upon its social and cultural organization. This living age structure is a reflection of the interplay of nutrition and pathology, those factors which determine the age distribution of deaths. The age structure of a sample is so basic that it must be determined before the examination of growth patterns, sexual dimorphism, metric and non-metric variation and degenerative and pathological processes is undertaken. Study of the mortality pattern of a population is basic to an understanding of that population.

Huron ossuaries are large burial pits containing many individuals most of whom are disarticulated and mingled. Although they have been considered excellent sources of data for palaeodemographers (Howells 1960; Ubelaker 1981), and even though Huron burial patterns are fairly well known from Jesuit accounts of a burial at Ossossané

(Thwaites 1898 10: 279-305; see also Tooker 1964 and Trigger 1969, 1976), the amount of information available may mislead us into thinking we know more than we do. There are many questions not yet answered or for which the answers seem ambiguous. What social unit does an ossuary represent? How representative of the social unit is the sample? Is it possible that many subadults (not just infants) were buried elsewhere?

Ethnohistory and osteology may give rise to conflicting reconstructions as, for example, in the case of sex ratios of Huron ossuaries. Young males should be under-represented since it is said that those who died by violence or by drowning were not buried in the ossuary. Young men were also likely to die away from home, while hunting, trading or on war parties. However, in three cases there appear to be equal numbers of males and females: Kleinburg (Pfeiffer 1979) probably had a sex ratio of about 1:1 and this is also true of Fairty and Garland. In other sites there are more females than males among the dead. Ossossané has a male/female ratio of .94 (Katzenberg and White 1979), but the majority of males were apparently young (between 20 and 30). It seems that Maurice had many more females (.73; Jerkic 1975), and both Uxbridge (.83; Pfeiffer 1983) and Tabor Hill (.54 - the value is based only on skulls; Churcher and Kenyon 1960) may follow the same pattern. Sex ratios derived from ossuary material may well be subject to systematic errors; the first assessments for Kleinburg (Jackes 1977; Pfeiffer 1974; Saunders 1974) consistently gave the impression that 60% of the adults were females. Are we seeing a cultural practice reflected, or differential preservation, or errors in sex determination?

By comparison, Neutral burial grounds have not been excavated and studied to the same extent. Neutral burial practices are less well understood than those of the Huron, due to their complexity and to the lack of French knowledge of Neutral life in the seventeenth century. We assume that fairly limited time spans and restricted source areas apply to the Neutral as to the Huron, but we must be aware that both the source population and the duration of use of a Neutral cemetery are unknown. Fox and Kenyon (1982) suggest a time span of 30 years for the Neutral Grimsby cemetery, which may be double that of a Huron ossuary. But even if Neutral cemeteries cover relatively longer periods this does not make Neutral burial sites any less useful than those of the Huron in palaeodemography. Indeed, when short time spans are involved, short-term fluctuations may be reflected in the age distribution of the dead.

There can be no doubt that Neutral and Huron burial practices differed basically. For example, at Grimsby, all bodies were in more or less the same state of disarticulation, but without any cut marks. This is in strong contrast to the Huron ossuary at Kleinburg in which many of the proximal femora and cervical vertebrae had the score marks of disarticulation.

Finally, there may be apparent demographic differences between the Neutral and the Huron which are artifacts resulting from the different anthropological research techniques that are required by the varying burial practices. Huron disarticulation of the dead prevents the reconstruction of individuals. To estimate an age distribution, one must first estimate a minimum number of individuals and then juggle dental, pubic and other data of potential value to age assessment. One cannot use whole skeletons, checking one method of age assessment against another, giving due consideration to pathological and other relevant conditions. The Neutral practised multiple interment rather than ossuary burial, and while most skeletons are completely disarticulated, individual bundles are generally retained and not inextricably mixed as in a Huron ossuary burial (Hartney 1978; Jackes 1982; White 1966). This allows the possibility of more accurate age assessment.

THE AIM

In this paper I wish to examine the suggestion that Huron and Neutral burials of the period 1300 to 1650 A.D. are useful sources of palaeodemographic information which can be used to distinguish precontact from contact mortality.

Palaeodemography is the study of the age distribution of deaths through the use of life tables. While fertility rates are sometimes estimated, I do not believe they can be accurately assessed in palaeodemography using present methods of age estimation. The use of life tables has been criticized by Angel (1969: 428) but I think that the mortality quotient (q) derived is of comparative value. More basic criticisms have been made by demographers (Howell 1982; Petersen 1975) and recently Bocquet-Appel and Masset (1982) have stated that palaeodemography is a futile study. There is very little doubt that it is virtually impossible to estimate the age of adults over age 25 with much accuracy. As an example of the problems one need only refer to Meindl, Lovejoy and Mensforth (1983). This study was based on the comparison of real and estimated ages on a sample of known ages. Careful age assessments led initially to 41% correct age assessment by decade in individuals over age 20 (1983: 81). Review of methods led to 58% of age estimates falling within the correct decade, but at the expense of accuracy for the 20-30 and 50-60 year age categories. Comparison of the survivorship curves for the chronological and estimated ages lends dramatic support to the position of Bocquet-Appel and Masset. The study did not fully examine the problems of assessing the age of elderly individuals nor did it consider the particular problems of assessing the age of females to which Suchey (1979) has drawn attention.

To ignore the wealth of data provided by archaeological populations because of the difficulties is not acceptable. The difficulties must be circumvented. One solution lies in emphasis on the age distribution of those under 25 years of age. However, the mortality quotients for subadult ages are determined in part by the representation of adults in the sample. Therefore, it is imperative that there be complete excavation, full study of the entire sample available and reporting of all adult individuals. Exclusion of adults (e.g. those of indeterminate age and sex) will bias the result of any palaeodemographic analysis.

THE SITES: MATERIAL

Huron Ossuaries

Fairty

Fairty has been dated indirectly by association with the Robb Site for which Kapches (1981) suggests a date of between 1300 and 1350 A.D.. Anderson (1961) published Fairty as a pioneer effort in the full osteological analysis of an ossuary. He was cautious not to overstate the accuracy of his age estimation techniques and thus gave percentages for broad categories. He stated that 28.3% of the population was aged 24 to 29 (I used 23 to 29) and that 21.5% of Fairty people were aged 30 and over. Melbye (1981) attempted to distribute the Fairty adults more evenly from age 20 to 80. I believe that present ageing techniques do seriously underage adults, but I use an age distribution for Fairty which is closer to Anderson's original in order to facilitate comparison with other sites.

Garland

The date of this ossuary is uncertain. On the basis of a trade bead it may date between 1500 and 1550 A.D. (see Molto 1980: 92). Webb (1969) analysed the skeletal remains, noting that he received the material 10 years after it had been excavated, in a semi-sorted state, with few bone fragments present. The data from Garland are used here only in the form of cumulative percentages (Table 3), and they are very close to the almost identical pair of Fairty and Grimsby.

Kleinburg

No information on Kleinburg demography has yet been published except as mortality and survivorship curves by Katzenberg and White (1979). They state that the data were unadjusted but in fact the data had been adjusted for infant underrepresentation (Pfeiffer 1974). Jackes (1977) provided demographic information based on atlas and axis vertebrae. Pfeiffer (1984) has also worked on femoral cortical remodeling using Kleinburg material. Kleinburg demographic analysis must await full study (see also Pfeiffer this volume). The ossuary is dated to between 1580 and 1600 A.D. (Melbye, personal communication) on the basis of a limited number of trade goods. Villages known in the adjacent area are all dated to 1550 A.D. or earlier (Kapches in litt. 1984).

Maurice

This ossuary was studied by Jerkic (1975) who states that it dates to 1640 A.D.. In view of its apparently low mortality rates it is difficult to accept that the ossuary represents a period during which two severe epidemics and sundry episodes of famine are known to have occurred. The cumulative percentage profile for Maurice is very similar to Kleinburg (Table 3), and were it not for the abundant trade goods, the demography would suggest an earlier date for Maurice. The fact that the q values from ${}_5q_0$ to ${}_{25}q_{20}$ hardly vary around their mean of .05 suggests that the sample may be very incomplete and this is supported by the excavator's report that the ossuary had been potted several times before proper excavation.

Ossossané

This site can be dated with relative certainty to 1636 A.D. (Kidd 1953: 373), and the ceremonies that took place there are believed to be described by Le Jeune (Thwaites 1898 21: 293-305). This burial followed a period of great stress to the Huron. The year 1634 saw an epidemic whose nature is unknown (Jackes 1983), a period of famine and a major unsuccessful raid against the Seneca. The available data may not be very sound, for the site was dug in 1947-48 but not analyzed until the late 1970s and full studies have yet to be published. Nevertheless, the similarity of the mortality pattern to that of Grimsby (see below) may indicate that we are able to pick up the mortality trend of the post-contact period (relatively low childhood mortality and increased adult mortality).

Tabor Hill

The Tabor Hill study (Churcher and Kenyon 1960) was the first published attempt at the analysis of an ossuary. It is thus not surprising that the study provides no data suitable for inclusion here. All we can say is that 30% of the population died by either age 10 or age 16. The excavation, in 1956, was a salvage project.

Uxbridge

The ossuary has been excavated and analyzed with great care and a demographic study is available (Pfeiffer 1983). The suggestion that the population had an extremely high incidence of tuberculosis is supported by the demographic profile, in so far as the q values for ages 15 to 30 are concerned.

Neutral Cemeteries

Grimsby

Grimsby was excavated as a salvage operation in 1977 and the analysis was done at great speed prior to reburial of the bones. The excavation of this site represents one of the few complete excavations of an almost undisturbed Neutral cemetery. It is thus very difficult to make statements about the demography since Neutral burial practices are poorly understood and the multiplicity of types of interment at Grimsby make it a very complex site (Kenyon 1982). The burial practices were quite unlike those of the Huron and there seems to have been selection of individuals by age and sex for burial in certain multiple graves (Jackes 1982). Fox and Kenyon (1982) have suggested that the cemetery represents people from a wide area dying over a number of years.

Shaver Hill

Demographic data for this Neutral cemetery are available only in their broad outlines (Stothers 1971). It seems possible that infants and children are very underrepresented. The data indicate that 36% of the population died between the ages of 10 and 20 which makes Shaver Hill a unique case. I have not used the data from this site in the analysis below. The q values are as follows: .080 (q_0): .087 (q_5): .167 (q_{10}): .314 (q_{15}): .375 (q_{20}).

Several other Neutral cemeteries are of potential demographic value. Of these, Glen Williams is the most important. Unfortunately, the subadult age distribution for this site is not known, although an adult age distribution has been published (Hartney 1981a, b). I have estimated an age distribution on the basis of the mandibles (Hartney 1978). The maxillae provide a larger sample but the minimum number of individuals represented is uncertain. The Glen Williams q values of .201 (q_0): .084 (q_5): .087 (q_{10}): .085 (q_{15}): .116 (q_{20}) indicate low mortality. The Milton Site (Hartney 1978) provides incomplete information on a disturbed and damaged sample. Information is available on the age distribution of 243 individuals of the 369 excavated from the Orchid Site (Cybulski 1966, cited in Hartney 1978). This indicates low mortality and extreme infant underrepresentation: .059 (q_0), .063 (q_5), .067 (q_{10}), .060 (q_{15}), .118 (q_{20}). The Orchid Site was excavated as a salvage operation of already damaged material. It is not definitely Neutral, its dating is uncertain (see, e.g. Molto 1980; Patterson 1982), it may be multicomponent (White 1966), and there is still discussion over its stratigraphy (Noble, personal communication, 1982). Additional information on all sites discussed here is given in Table 1.

THE METHOD

Standardized life tables have been used here to facilitate interpretation. The demographic information has been prepared by casting the data into five year age categories from 0 to 24.9 years of age (this can be accomplished through equal distribution of individuals over all years in an age category or, as here, by reordering on the basis of graphed cumulative percentages). The final age category, which includes all other adults, is 25 years to some arbitrary final age, and deaths are treated as being evenly distributed over the years included in this category.

The breadth of the final category could be adjusted using a regression formula (see Table 7), for there is a high correlation between the final age which gives the correct $_5e_0$ for model and historical life tables and the juvenile/adult ratio proposed by Bocquet-Appel and Masset (1982). This method of estimating $_5e_0$ ignores the problem of infant underrepresentation, but this is justifiable. For example, the category $_5AD_0$ must include 360 individuals for the infant and early childhood representation to have an effect on the average age of death which equals the effect of only 20 adults in an adult category set at 25-65. If those 20 adults were in an age category set at 25-75, it would require 400 individuals under 5 years to equal their effect upon the average age at death. As another illustration of this, we would have to increase the Maurice sample by 517 individuals under 5 years of age, in order to equal the effect on the average age of death of raising the final age fom 65 to 81 years.

For the purposes of this paper the adult age category is set at 25-65, unless it is specifically stated otherwise. While 65 may be an appropriate final age for high mortality populations, it is used here simply to facilitate comparison and no statement is made regarding the supposed life span of the populations under consideration. Rather, this paper will explore the possibility of estimating mortality levels despite the fact that the length of life cannot be determined.

The data used are in all cases those which have not been smoothed or initially adjusted, and the standardized life tables thus produced allow comparison of basic statistics. The method of calculating the life tables is standard but the formula for $_5L_0$ $((l_0+l_5*5)/2)$, which assumes equal distributions of dead over the period from birth to 4.9 years, is probably used only by palaeodemographers. It has the value of compensating for infant underrepresentation in the life expectancy at birth or average age at death calculation.

Using standard scores (Z) of q values for a large number of cemetery populations both within and beyond North America, concentrating on the four 5 year age categories between 5 and 24.9 years of age, three basic mortality patterns are distinguishable (Table 2). The low mortality group (Group L) is characterized by a mean infant and early childhood mortality rate (here $_5q_0$ and not $_1q_0$) of 22 to 28. The ratio of 5-14.9/20+ (proposed by Bocquet-A ppel and Masset 1982) has a mean of .159, and those over 25 years make up 53-57% of the dead.

The second pattern of mortality (Group I) applied only to published data from Arikara sites and a number of sites in the Illinois and Mississippi basins. They all show high mortality among infants and young children. Since no Ontario sites fall within this category, I will not describe it further. It is, however, a general mortality category into which many American and other archaeological populations fall when analysis is based on a very large number of sites.

The final category (Group A) is one into which very few sites fall and it is significant that three of these are Fairty, Ossossané and Grimsby, which always group together, whatever the method of analysis or the number of variables used. There is a very specific marker for this final mortality category, namely a high percentage of adolescent and young adult deaths. The 10-20 year age group constitutes 15 to 16% of the dead, whereas in those cemetery populations with low mortality or even high early childhood mortality, adolescents make up only 8-10% of the sample. Characteristically, in this grouping with high adolescent mortality rates, $_5q_0$ is quite low, the mortality rate being 27 to 32 per thousand (compare this to the Arikara value of 52).

The low childhood mortality rates are not necessarily anything more than a reflection of bûrial practices or differential preservation. The exclusion of infants from Huron burials is an accepted fact (Thwaites, 1898 10: 273; Kapches 1977) and one which is supported by this study. For example, Table 3 shows the cumulative percentages of the dead up to age 25 for a number of North American skeletal samples. In analyses of the data all differences are overridden by 0-5 representation and thus Ontario site s group by themselves, together with a few United States sites deficient in infants (e.g. Turner contains no individuals under 12 months of age, cf. Black 1979).

Adjustment for infant representation is essential if any comparison based on $_5e_0$ is required. Adjustment cannot

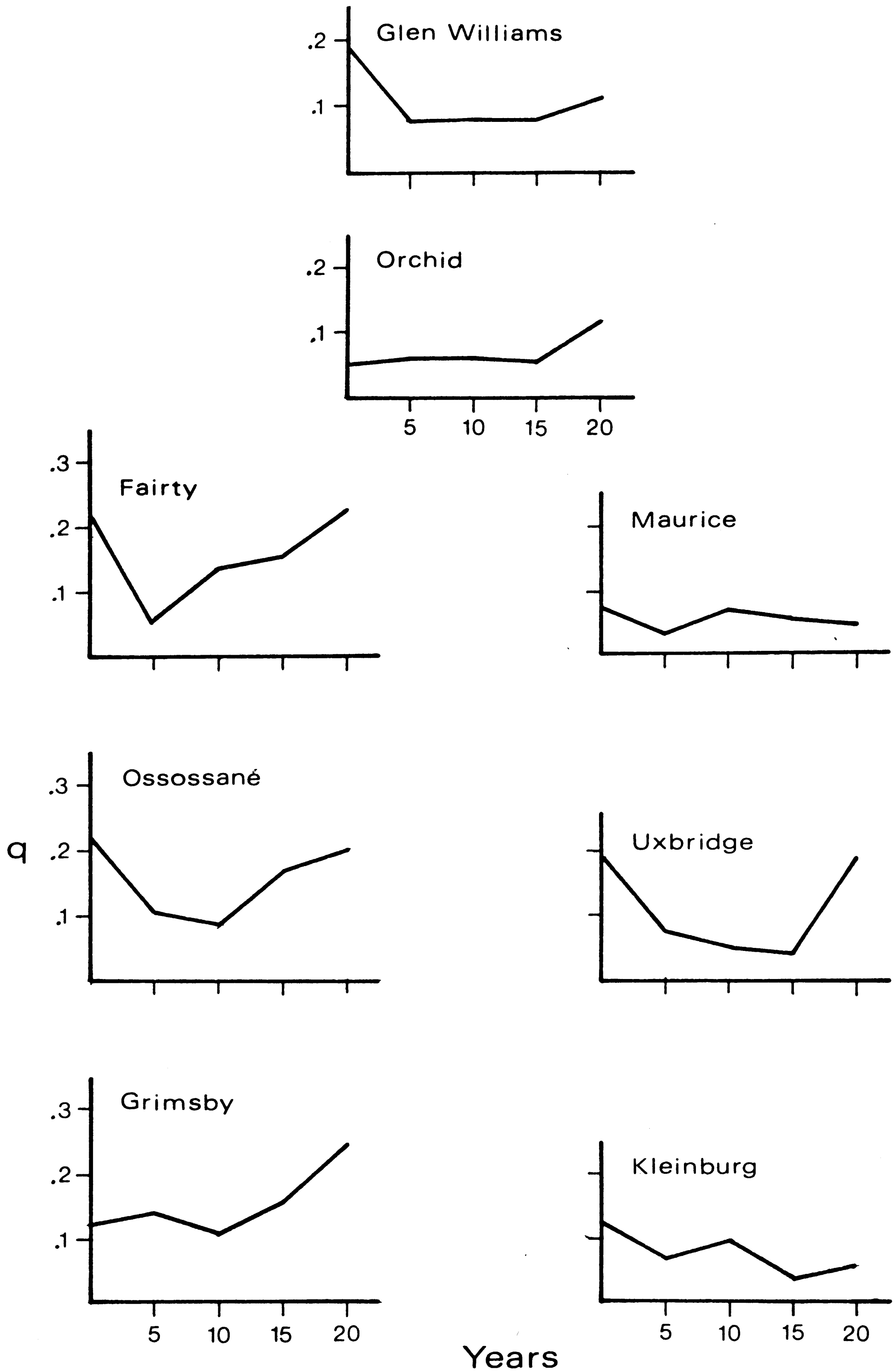


Fig. 1 Mortality curves for Ontario sites.

be accomplished through regression or use of model tables (which would require unwarranted assumptions about infant mortality) and so here it is achieved by use of the mean *q* value for $_5q_0$. The mean *q* values are derived from 28 American archaeological skeletal samples which were differentiated into the three individual mortality groups previously mentioned. The mortality pattern groups were established through cluster analysis of standardized *q* values (*z*-scores) and checked by principal component analysis (Nie *et al.* 1975 and Wishart 1978). The adjustments thus relate to specific mortality patterns and are not arbitrary. The adjustments used are very conservative: .311 for the high mortality group and .277 for the low mortality group. The value of .311 is used for Fairty, Ossossané and Grimsby and it derives from the mean of the Midwest sites in the high mortality group (Libben: Lovejoy *et al.* 1977; Schild Late Woodland: Droessler 1981; Dickson Late Woodland Acculturated Mississippian: Lallo 1973). It is virtually equivalent to the Libben value. The value of .277 derives from several low mortality Midwest sites, Nanjemoy (Ubelaker 1974) and Point of Pines (Bennet 1973). The low mortality pattern is equivalent to West Level 3 (Coale and Demeny 1966), at which level $_5q_0$ would be .473. Coale and Demeny's high levels of mortality for the West family are themselves estimations and it appears possible that they overestimate infant mortality, at least with regard to North American archaeological sites. I regard the problem of infant adjustment as insoluble and use the method suggested here only to allow the comparison of palaeodemographic data.

THE RESULTS

The Ontario sites in the high mortality category are Fairty, Ossossané and Grimsby. Those in the low category are Uxbridge, Kleinburg and Maurice. Two other Ontario populations may provide data good enough for us to use here. These are Glen Williams and Orchid and both appear to fall within the low mortality group. Were it not for Fairty and Maurice, we could say that lower mortality is characteristic of the pre-contact group of sites and high mortality characterises the contact period grouping.

Differences in pre- and post-contact mortality do not explain the available evidence on Ontario palaeodemography. Maurice may well be a sample that we should exclude on the grounds of bias. I have already noted the unusual *q* values for this site and this is graphically illustrated in Figure 1. The virtual equivalence of the 0-5 and 10-15 age group mortality rates makes bias a certainty. Fairty is a much more problematic site. Of all the sites I have examined, both North American and other, I have found no other in which very low 0-1 values are followed by, in succession; high 1-4, extremely low 5-10, uniquely high 10-15, and very high 15-20 and 20-2 5 values. There is thus a possibility that the Fairty sample does not provide good demographic data.

Fairty can be viewed in several ways. First, there is some evidence from the United States, specifically at Schild, Dickson Mounds, and Libben, that sites dating to the Late Woodland period (just prior to the introduction of a greater degree of dependence on cultivated plants) had elevated mortality. Fairty may be included in this grouping. The populations of such sites may not have been in demographic equilibrium; they may not have been stationary. Lowered representation of infants among the dead and an increased proportion of older individuals would be the mark of such populations, precisely as is found for the high mortality group. It is, of course, reasonable to suggest that Grimsby and Ossossané are also samples of populations in decline.

The Carrier (1958) method of estimating the demographic parameters of non-stationary populations is often used in anthropological research. The method as used here is outlined in Table 4 and checking it (by use of the formula $D_x(1\text{-}r)^{a,b}$) against the values derived from the Coale and Demeny model tables (West Family highest mortality levels) shows that the method is reasonably accurate. It gives, for r= -.01%, something in fact just less than that level of decline. Adjusting Fairty according to this method does not, however, alter the basic aberrant mortality curve (the general form of the curve remains constant whatever value is given to r).

One further method of adjustment would be to assume that the Fairty representation of adults is deficient. Since *q* values are altered by the proportional representation in the following, not the preceeding age categories, *q* values are affected by adult representation in just the same way that survivorship is affected by infant representation. Increasing the adult sample size does indeed bring Fairty closer to other sites, but we cannot simply assume that Fairty is unique because of adult representation. Indeed all sites which fall into the high mortality category have an extremely high representation of individuals between 10 and 20 years. Fairty, with 20% in this age category, has the highest representation of adolescents of any site examined, but Grimsby and Ossossané (and Schild, Late Woodland) are not far behind. The question at issue is the cause of this apparent high adolescent mortality, unparalleled in the demographic literature.

There is no evidence that the high mortality group is simply a result of consistently inaccurate age assessments. The information on Libben (Lovejoy *et al.* 1977) and the methods employed there (see Meindl, Lovejoy and Mensforth 1983) and the data on the two components of the Schild site, Late Woodland and Mississippian (cf. Droessler 1981), all indicate something other than problems of age estimation. Individuals between ages 10 and 20 would be expected to have a low risk of mortality, except perhaps for instances of trauma and childbirth. With Fairty there is no reason to expect some unique infectious disease or other single factor as the cause of death. Rather, the very low $_5q_5$ value suggests bias in the sample.

MORTALITY AND THE CONTACT PERIOD 1620 - 1650

We may legitimately assume that the demographic profiles of Grimsby and Ossossané reflect in some manner the documented epidemics of infectious diseases introduced among the Huron and Neutral, mostly through the agency of French fur traders and priests. It is extremely difficult to define the nature of the epidemics which it is believed devastated the populations of the coastal regions of Canada and New England. There is firm evidence of smallpox in New England in 1633 and among the Mohawk in 1634, and there is also possible evidence of smallpox osteomyelitis among the Neutral by at least that period and possibly before (Jackes 1983). In virgin soil populations, as in all populations, those aged 10 to 20 are the least likely to succumb to smallpox (Dixon 1962).

Measles and/or chicken pox may also have attacked the Indians of Ontario in the 1630s but these diseases have a characteristic U-shaped mortality curve (youngest and oldest people most affected). Perhaps only the 1918-1919 influenza epidemic (Burnet and White 1972: 97) and respiratory tuberculosis (Preston 1976) are known to have been particularly dangerous to late adolescents. A disease which has been interpreted as influenza (Trigger 1976: 526) afflicted the Huron in 1636, causing many deaths at Ossossané but not until the autumn following the May Feast of the Dead. There seems little doubt that the unusual demographic profile of Uxbridge (Pfeiffer 1983) is partly attributable to the effects of tuberculosis, but there is no similar evidence of bone pathologies indicating unusually high tuberculosis incidences in the Grimsby and Ossossané samples.

We know with reasonable certainty that the people of Ossossané were in close contact with the French. We know too that those of Grimsby were specifically excluded from sustained contact with the French by the Huron. Nevertheless, contact had occurred. The Grimsby cemetery contained the skeleton of a high status Neutral woman who was in all probability fathered by a European (Jackes n.d.; Kenyon 1977).

The Grimsby cemetery

Our understanding of this site is hampered by several unresolved problems of interpretation which we must examine before embarking on a demographic analysis.

Can the cemetery be analyzed as a single demographic unit?

Fox and Kenyon (1982) suggest that the cemetery represents a span of about 30 years, covering the period of contact. On the basis of trade beads they distinguish three phases (II, IIIA and IIIB), each about ten years in duration. The Grimsby skeletons should then allow us to discern differences in mortality over the contact period. It might be possible to differentiate the initial impact of introduced diseases from the final period in which social breakdown overtook infectious disease as the main cause of mortality. Phase II is represented by only 26 individuals, too few for analysis. There are 114 individuals identified as belonging to Phase IIIA and 106 individuals in Phase IIIB.

Of the individuals in Phase IIIA, only 23% are age 25 years and older. Thus, the mortality profile for Phase IIIA shows an exceptionally early mean age of death. Phase IIIA includes two graves, Features 9 and 11, that contain large numbers of subadults. Therefore, the high mortality curve may be a function of sample bias. If the frequency of adults over 25 is increased from 23% to 43%, the resulting *q* curve is almost indistinquishable from the *q* curve for the total Grimsby sample. Could the lack of adults be the result of the initial impact of epidemics?

It is unlikely that the epidemics of 1630 to 1640 would result in an age distribution of deaths in which 26% were adolescent and only 23% over age 25. This pattern has not been documented for any smallpox epidemic and is improbable for any other form of epidemic.

During the smallpox epidemic in Iceland in 1707, in which almost 95% of the population contracted smallpox and 25% died (Steffensen 1977), 19.4% of the deaths were among those aged 10- 20, whereas 60% of those who died were 25 and over. Similarly, during the epidemic at Anyho in Northamptonshire from September 1723 to December 1724, 16% of the deaths were in the 10-20 age group and 56% were among those 25 and over (Creighton 1965 2: 520). The distribution of Phase IIIA deaths is inconsistent with such patterns. The probable cultural significance of the distribution is underlined by the fact that 80% of the 25 sexed adults in Features 9 and 11 were female. In the two epidemics mentioned above there was no difference in mortality between the sexes.

Phase IIIB (n = 167) includes two large graves, Features 1 and 62. Feature 62 contained 103 people in an elaborate oval arrangement. Within the oval it is possible to discern groupings by interacting factors: status, physical condition with reference to disability, genetic ties, sex and age. The grave did not contain many juveniles, but did have many males and older females. It seems likely that this grave represents a cultural rather than a biological phenomenon. On the other hand, Feature 1 contained 16 or 17 individuals and seems to represent the disorganized, hurried burial of the dead from one specific short period. The mortality profile for Phase IIIB is very similar to the overall mean mortality curve for the 7 sites with high mortality that form Group A (Fairty, Ossossané , Libben, Grimsby, Mobridge 2, Dickson Late Woodland Acculturated Mississippian, Schild Late Woodland).

The pattern suggested by Features 9, 11 and 62, namely that women and children were buried together much more often than men and children, may well characterize Grimsby burial practices (Jackes n.d.). Older men especially were most often buried together and separated from children. It thus seems very unlikely that we can derive demographic meaning from the distribution of individuals in graves. Although 83% of individuals have been assigned to a time period, it does not seem likely that we can distinguish mortality differences between one period and the next. Table 5 demonstrates that at Grimsby significantly more adult males than females were buried in Phase IIIB graves and significantly more older individuals (both sexes) were buried in Phase IIIB. This confirms the general impression that males, especially older males, were separated from subadults in burial. The distribution of bead types is thus perhaps not controlled by time alone but also by other factors such as status association.

Since the Phase IIIA and Phase IIIB individuals together provide a demographic profile (age and sex distribution) which is biologically possible, it may be reasonable to assume that the demography of the total cemetery adequately represents the mortality of the last 20 years of Neutral occupation in the Grimsby area.

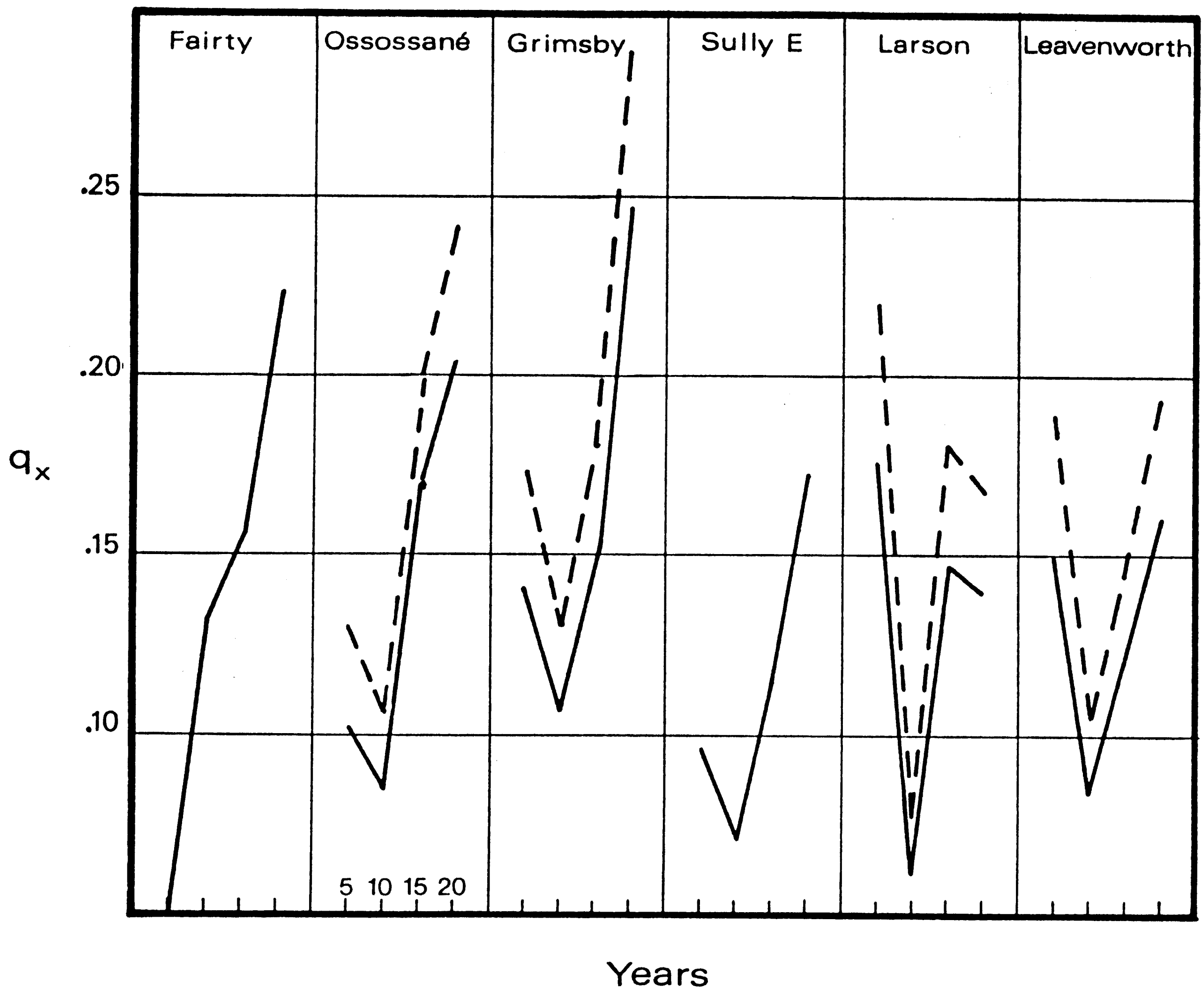
Does the cemetery represent a social unit from which useful demographic data could be derived?

Fox and Kenyon (1982) suggest that Grimsby might be a ceremonial centre rather than a village cemetery. If they are correct, then we would have a very biased sample of the dead, with many high status males and quite a few high status older females. Although status does seem to underlie the Grimsby burial patterns, it is not possible to demonstrate specific biases for the entire cemetery. There are biases, but they are generalized. Nothing indicative of an extraordinary burial pattern by age and sex is seen at Grimsby. Figure 2 compares the standardized q curves for Grimsby with those from other high mortality or contact sites; the Arikara village cemeteries (data from Bass *et al.* 1971; Owsley and Bass 1979), Ossossané and Fairty. Only Fairty has an abnormal pattern.

What was the duration of the cemetery?

Neutral villages may have been inhabited for longer periods than Huron villages which were shifted every 8 to 15 years, at which time a Feast of the Dead was held (see e.g. Thwaites 1898 10: 275). Assuming that soil fertility and availability of wood, together with the degree of dependence on cultigens, are the deciding factors in village mobility, the geographical characteristics of the Neutral region are important to note. In 1626, Daillon (LeClercq 1881: 269, 270) was impressed by the richness and temperate climate of the Neutral country as was Charlevoix (1766 2: 201) almost one hundred years later. Daillon (LeClercq 1881: 270) notes that the Neutral were able to grow a surplus of corn. In fact, soils which are well suited for growing corn are more abundant in the Neutral region than in Huronia (compare Hoffman *et al.* 1962: 84 and Presant *et al.* 1965: 38, and see also Wicklund and Mathew 1963 for information on soils and climate). Modern records show that the average number of frost free days

Fig. 2 Comparision of q curves for high mortality sites at $r = 0$ (solid line) and $r = -.01$. The mortality quotients are plotted for ages 5 to 20 and illustrate the basic similarity in all curves other than Fairty.



per year is higher. There is no reason to suspect that these differences would have been any less marked in the seventeenth century. The good soils and climate encouraged the heavy hardwood forest cover of the area and game abounded. The Jesuits noted the importance of the hunt to the Neutrals (Thwaites 1898 21: 195-197) and this, as well as the importance of gathered food is confirmed by archaeological studies (Wright 1981: 114, 131-132; Lennox 1981: 340, 360; Fitzgerald 1982: 20- 21, 31-31). Charlevoix recorded the opinion that cultigens were less important in the Neutral than in the Huron diet (1866 2: 152).

This suggestion is corroborated by stable isotope analyses (Katzenberg and Schwarcz, this volume). It may also be supported by studies of dental pathology (Patterson 1982).

Noble (1978: 160) argues that the Neutral stood at an important middle position at the ends of two major trade networks . Fitzgerald (1982: 281 ff.) discusses the archaeological evidence for both local and regional trade by the Neutral during both the prehistoric and historic periods. The geographic position of the Neutral and their neutral status certainly suggest that trade could have been important. The Neutral may have initiated trade in tobacco (Sagard in Wrong 1939: 151) and squirrel pelts (Thwaites 1898 17: 243, n. 8). Trade networks of this sort imply a measure of stability in settlement pattern.

If Neutral villages were not shifted with any regularity, there would be no clear termination for a cemetery. Thus, the Grimsby cemetery may well have been used for a minimum of 20 or 30 years, in contrast to the maximum of 15 years estimated for the historic Huron by the Jesuits (see e.g. Tooker 1964: 42).

Grimsby demography

In making demographic calculations I assume that the total Grimsby sample represents valid palaeodemographic data for the period 1630 to 1650. I assume that the population was in decline and I calculate average age at death ($_5e_0$) for r = -.01 by the Carrier method, using the mean childhood mortality rate of 31 per thousand. Use of the estimated $_5e_0$ outlined in Table 7 gives a birth rate of about 56 per thousand which approaches the normally accepted maximum human birth rate. It indicates that the life table average age at death ($e_0 = 17.8$) is unacceptable here as an estimator of birth rates though the life table crude mortality rate is possible. Since population size is calculated using e_0, population estimates may also be unreliable. However, on the basis of 10 villages, the Jesuits in 1640 estimated that the average Neutral village size was 300 (Thwaites 1898 21: 223). If the Grimsby cemetery source population was one village, we could estimate the size of that village as 353 with 20 deaths a year over a 20 year period. The 10 year estimate would be rather high at 703, but the 30 year estimate of around 237 is not impossible (13 deaths per year).

Huron demography and the Ossossané ossuary

Ossossané apparently represents the period from before 1623 to 1636 when the Huron were beginning to suffer the first impact of European contact. We have some idea of the population of Ossossané in 1623: Sagard mentioned 200 to 300 families (see Trigger 1976: 385 for a discussion of the identity of the 1623 and 1636 villages). Eight or nine villages are said to have contributed their dead to the burial pit in May 1636 (Thwaites 1898 10: 291). Using 15 years as the time limit of the ossuary, the population estimates are 422 for $r=0$ and 352 for $r=-.005$, too low if Sagard's figures were correct. Birth rates calculated from the life table are, for $r=0$, 45 and for $r=-.005$, 48 per thousand per year.

We should not expect Huron birth rates to be high. Famine, disease and social disruption were beginning to take their toll and the men were often away on hunting, trading or war parties. The Jesuits recorded birth spacing of 3 years (Thwaites 1898 8: 127) and it was later specifically noted by the French that Indian birth rates were not high (Charlevoix 1766 2: 201, "the women are far from being fruitful").

It is possible to get some idea of what the French thought of as low birth rates by examining several examples of rural French birth rates from the seventeenth and early eighteenth centuries. Life table birth rates can be calculated for two northern French villages (Mouliherne, see Lebrun 1971: crude birth rate (CBR) 36 per thousand for the eighteenth century; Tourouvre, see Charbonneau 1970: the CBR for 1670-1790 was 40 per thousand with 4.4 as the total fertility rate). From the work of Charbonneau (1975: 125), it is possible to construct a life table for the settlers in New France (1640-1729) by which we can estimate 3.3 as the total fertility rate. Charbonneau noted that the life expectancy in New France was higher than in France (p. 124). This leads to lower life table birth and death rates (around 28 per thousand). The crude birth rate calculated for New France is almost the equivalent of that published for the eighteenth century (30 per thousand) for another small northern French village (Daniel and Henry 1965).

Whether in New France or France itself, the calculated birth rates are lower than those calculated from skeletal series. The French data indicate rates of 30 to 40 per thousand, well below the rate calculated for Ossossané. An examination of 28 North American skeletal series shows that Maurice and Kleinburg (unadjusted data), lacking many infants, have the lowest birth rates (28 for Kleinburg). Other life table birth rates climb to impossible values; for example, among the Arikara of South Dakota where the rates may be above the physiological limit. They are also impossible because, for example, for Leavenworth we know that the population was declining rapidly (Meyer 1977). We cannot rely on the palaeodemographic data to give us birth rate estimates.

Comparison: Ontario Iroquois and the Arikara

I wish to make brief reference to Arikara samples, since these may provide better data than those available from Ontario for the study of mortality during the contact period. The Arikara villages of South Dakota, like the Ontario samples, have not all been studied to their full potential for demography: but the Leavenworth, Larson and Sully sites have been well enough published to allow their use in comparative demographic studies. To permit comparison, standardization is applied (adult age estimated by regression) and also the Carrier adjustment for non-stationary populations.

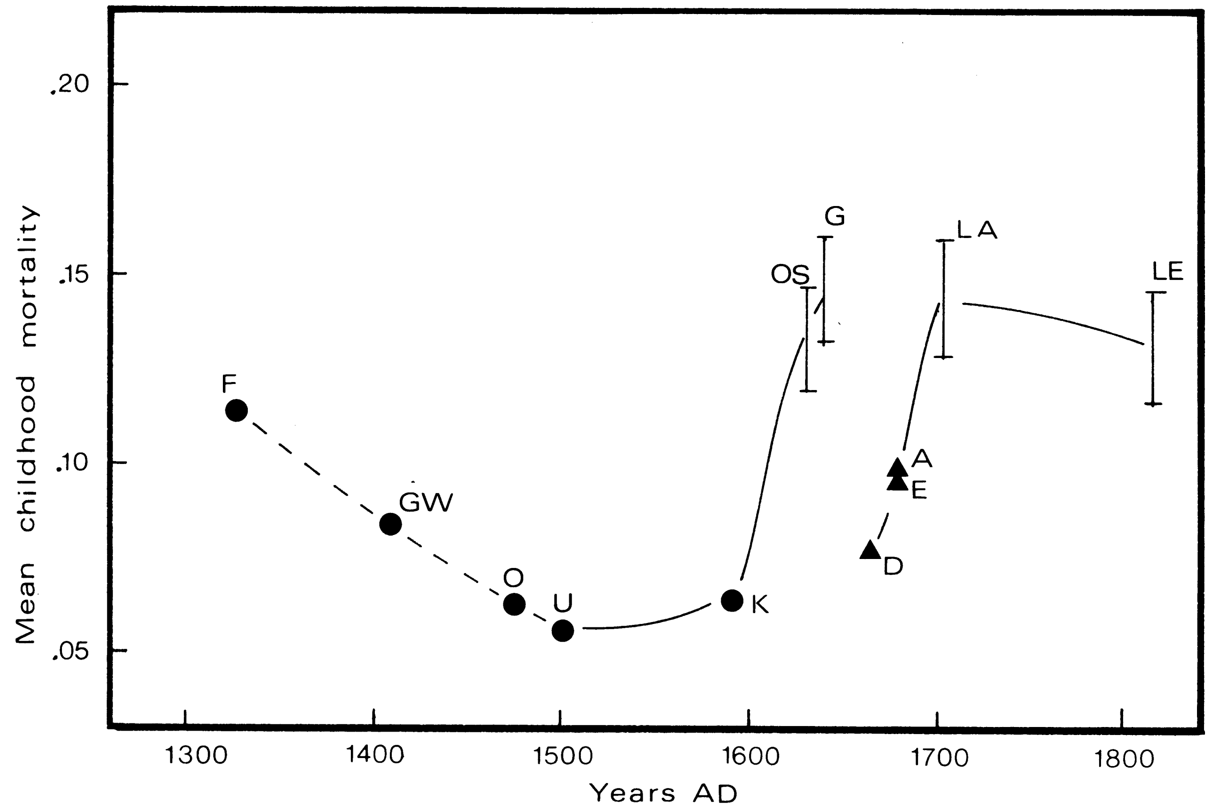
The three components of the Sully site have crude life table mortality rates of 44 to 46 per thousand between 1650 and 1700, before contact was fully established (r = 0). Sully is followed in time by Larson, representing the period 1679-1733 (Jantz and Owsley 1984) during which horses were introduced and trade goods became more numerous. Larson has a crude mortality rate of 83 per thousand ($1/e_0$ adjusted on the assumption of $r = -.01$). That was prior to the period when smallpox is known to have seriously affected the Arikara. Leavenworth, dating to the early nineteenth century, reflects the final impact of European contact, with a death rate of 67 per thousand ($r = -.01$). The trend in mortality for the Arikara is consistent with the recorded decline in population from 2000-3000 in 1826-1836 to 600-700 in 1876 (Meyer 1977). This trend in mortality makes sense in terms of the timing of contact and it suggests that smallpox epidemics may have occurred much earlier than the records suggest.

Arikara mortality rates were apparently much higher than those of the Ontario contact sites. The probable reason for this is that the Arikara sites appear to have full infant representation. This has the effect of markedly lowering ${}_5e_0$, thus increasing the death rate. At $r = -.01$, the ${}_5q_0$ for for Larson is .625 and for Leavenworth .527. Compare this with Ossossané beginning with ${}_5q_0$ adjusted to .311 and altered for $r = -.005$. The Ossossané value calculated under those conditions gives an early childhood mortality rate of .342. This is not a high rate: the equivalents for the French villages are .392 (Mouliherne) and .442 (Tourouvre). Thus we can only expect to see low estimated mortality rates.

Comparison among samples is, then, not possible using the standard method of estimating life expectancy at birth ($1/e_0$). This is partly because of infant under-representation, and partly because adult age distributions may be inaccurate. Here I have tentatively suggested methods of avoiding both problems, but I can claim no more than that the results are less inaccurate than in previous comparative studies. Another possible approach may, however, allow more accurate comparison and thus palaeodemographic analysis of mortality levels. The method is simple and consists of no more than establishing the mean childhood probability of death (i.e. the mean of q_5, q_{10} *and* q_{15}).

In low mortality populations like Uxbridge and Kleinburg, this value is between .05 and .07. Middle range mortality (and this seems to include Glen Williams) gives values of .07 to . 10. Larson, Leavenworth, Grimsby and Ossossané all fall between .110 and .132 (with Grimsby the highest). In Figure 3, the values for the Arikara sites of Larson and Leavenworth and for Grimsby and Ossossané are shown as ranges, each range illustrating the

Fig. 3 Ontario and Arikara mortality trends, estimated on the basis of mean childhood mortality. For Larson and Leavenworth, and for Grisby and Ossossané, a range of mortality based on $r = 0$ (lower) and $r = -.01$ (higher) is shown. Sully A, D and E probably predate direct contact and epidemics. Larson, as well as Grimsby, probably reflects the effects of smallpox epidemics.
Key: F - Fairty; GW - Glen Williams; O - Orchid; U - Uxbridge; K - Kleinburg; M - Maurice; Od - Ossossané; G - Grimsby; A - Sully A; D - Sully D; E - Sully E; La - Larson; Le - Leavenworth.



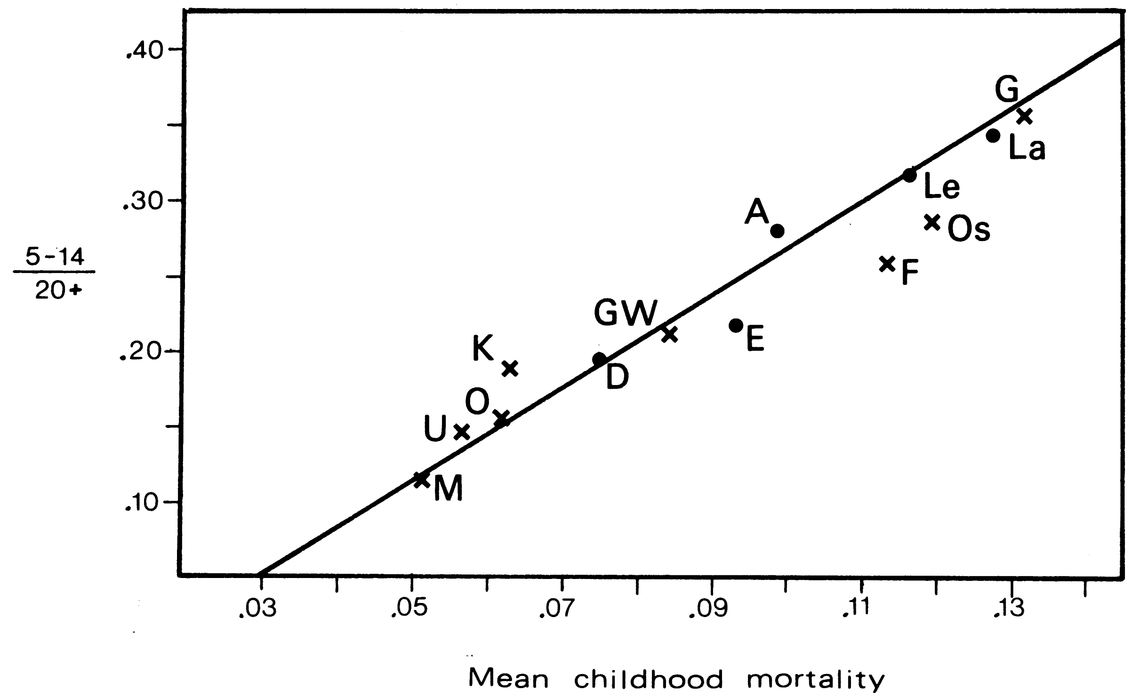


Fig. 4 Regression of juvenile/adult ratio on mean childhood mortality for 35 archaeological sites, both North American and Old World. Key to sites as for Fig. 3. Regression: slope = 3.0749; y intercept = -0.03988; r = .96.

spread between mean childhood mortality calculated for $r = 0$ and $r = -0.01$ when the adult age is set at 25-65. The estimate for populations in decline gives the higher end of the range. The great value of this statistic is that it allows one to compare sites, over space and time, while avoiding the insoluble problem of infant underrepresentation.

Mean childhood mortality is highly correlated with the juvenile:adult ratio suggested by Bocquet-Appel and Masset (1982) since both values are based on the relative frequency of adults and subadults. For 26 North American sites, the correlation (r) is .96, and sites from the Old World fall on or close to the line established for the North American sites. Figure 4 illustrates the distribution of the Ontario and South Dakota sites about the regression line derived from data on 35 North American and other archaeological sites. The data used for this figure are not adjusted for $r = -.01$. The method illustrated in Figure 4 also allows the checking of data. For example, since the Shaver Hill juvenile:adult ratio is .458, while the mean childhood mortality is only .189, the age distribution is so unusual that it should be considered carefully before it is used in a comparative study.

Figures 3 and 4 show that Grimsby mortality is the equivalent of Larson mortality. These two sites evidently illustrate the effects of introduced diseases, a conclusion which could not previously be proved for Larson, but was highly likely for Grimsby given its terminal date of 1650. The people of Ossossané, it seems, had in the 15 years preceeding the spring of 1636, already begun to feel the effects of contact. The only recorded epidemic during that period is that of 1634, and we may infer that it raised mortality levels markedly.

CONCLUSIONS

I suggest then that:

1. Ontario generally provides disappointing material for demography, many sites being unusable (e.g. Tabor Hill).

2. Some sites are potentially useful but need more complete analysis (e.g. Kleinburg).

3. Some sites seem to have marked sampling problems which make deductions drawn from them suspect (e.g. Fairty).

4. All sites have marked infant underrepresentation which invalidates analysis and interpretation from any demographic parameter based on life expectancy at birth (average age at death).

5. Some sites are probably representative of populations in decline so that no statements on mortality rates can be made without an estimation of r.

6. There must be recognition of possible differences between Neutral and Huron burial practices leading (a) to demographic differences in the burial populations, and (b) to the possibility of different age and sex assessment methods

7. There must be some recognition of the possibility of overall sample bias, apart from infant underrepresentation.

8. I propose a standardization of life tables in 5 year age categories (0-4.9 etc.) and, after inclusion of all adults, analysis of childhood q values (q_5, q_{10}, q_{15}), avoiding the problem of infant representation. On the basis of this method I suggest the possibility of **at least** a doubling of childhood mortality between 1600 and 1650 (and thus adult mortality at that level or higher). I suggest that Southern Ontario had very low mortality (in terms of North American archaeological sites) up until 1600. By 1640 Ontario mortality was about the same as that of the Larson site, i.e. the highest of any known archaeological site in North America.

These general characterizations of Ontario mortality must be tempered by a recognition of the shortcomings of our information. No Ontario site provides an ideal sample for demographic research. Grimsby, Fairty, and Ossossané stand almost alone among the 30 or 40 sites studied as a background to this paper. The three Ontario sites cluster in a separate grouping which is most probably founded on irresolvable adult sample bias. Nevertheless, when Huron and Neutral sites are put in a wider context and when special techniques are used in order to circumvent the insoluble problems that face palaeodemographers, we can begin to make sense of Ontario mortality patterns and discern the trends.

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TABLE 1
The Sites

Sites	Source	Period & Date	Total n excavated	Total used for life table	% infants	% >50 yrs
Fairty	Anderson (1961)	AD 1300-1350	n/a	512.0	5.3	0.0
	Melbye (1981)					10.0
	Kapches (1981)					
Garland	Webb (1969)	ca. AD 1525	n/a	198.0	?	?
Glen Williams	Hartney (1978)	AD 1400-1500	309 ?	283.0	2.5	?
Grimsby	Jackes (n.d.)	AD 1620-1650	373	346.0	3.5	2.6
Kleinburg	Pfeiffer (1974)	ca. AD 1600	?	561.0	—	0.0
Maurice	Jerkic (1975)	AD 1640 ?	n/a	132.0	?	?
Milton	Hartney (1978)	AD 1600-1620	109	—	−4.5	?
Orchid	Cybulski (1966)	AD 1500 ?	369	243.0	<1.0	−4.0
	Hartney (1978)					
Ossossané	Katzenberg & White (1979)	AD 1636	n/a	249.0	9.6	9.2
Shaver Hill	Stothers (1971)	ca. AD 1615	n/a	195.0	?	?
Tabor Hill	Churcher & Kenyon (1960)	ca. AD 1250-1300	n/a	213.0	?	?
	Kapches (1981)					
Uxbridge	Pfeiffer (1983)	ca. AD 1500	n/a	456.5	?	6.7

TABLE 2
Summary statistics based on mean values for Mortality Groups; standardized tables with adult age category set at 25-65

Site	% 10-20	e^0	$\frac{5\text{-}14}{20+}$	$\frac{1}{e^0}$	$\frac{0\text{-}5}{0\text{-}20}$	% >25
Group-A						
minimum q_0 .274	15.73	23.6	.307	42.4	53.5	39.5
maximum q_0 .311	14.92	22.5	.307	44.4	57.9	37.5
Group-I						
minimum q_0 .377	9.26	21.6	.306	46.3	67.3	38.6
maximum q_0 .428	8.50	20.0	.306	50.0	71.8	35.2
Arikara q_0 .523	7.09	17.0	.302	58.8	78.5	29.1
Midwest q_0 .330	9.93	23.1	.309	43.3	62.9	41.8
Group-L						
minimum q_0 .215	9.75	29.5	.159	33.9	58.8	57.1
maximum q_0 .277	8.98	27.4	.159	36.5	66.6	52.6

TABLE 3
Cumulative percent of dead by age group

Site	5	10	15	20	25
Kleinburg	12	18	26	28	32
Maurice	10	14	22	28	33
Turner	7	20	23	30	40
Uxbridge	19	25	29	32	45
Pt. of Pines Late	24	28	29	36	46
Glen Williams	20	27	33	38	45
Gibson Klunk	26	30	34	37	41
Pt. of Pines Middle	31	34	35	39	44
Shaver Hill	8	16	30	52	70
Garland	12	24	30	40	60
Grimsby	12	24	32	43	57
Fairty	22	26	36	46	58
Ossossané	22	30	36	47	58
Libben	31	40	47	54	59
Schild LW	29	38	46	54	61
Indian Knoll	32	41	47	51	60
Nanjemoy II	30	36	40	47	52
Dickson (Blakely)	30	35	40	45	53
Nanjemoy I	29	40	45	47	51
Sully	44	51	56	60	65
Leavenworth	46	54	58	63	69
Schild MISS	38	47	54	58	65
Larson	56	64	66	71	75

TABLE 4
Values used in application of Carrier method for non-stationary population estimates

Age		$r=-.01$	$r=+.01$	$r=-.005$	$r=+.005$
0-5	$(1-r)^{2}$	1.02010	0.98010	1.01003	0.99003
5-10	$(1-r)^{7.5}$	1.07748	0.92739	1.03811	0.96310
10-15	$(1-e)^{12.5}$	1.13245	0.88194	1.06433	0.93927
15-20	$(1-r)^{17.5}$	1.19021	0.83872	1.09120	0.91602
20-25	$(1-r)^{22.5}$	1.25092	0.79761	1.11876	0.89335
25-65	$(1-r)^{44.5}$	1.55704	0.63939	1.24850	0.80007

TABLE 5
Tests of differences in age and sex distribution between two phases at Grimsby as defined by Fox and Kenyon (1982)

	Phase			
	IIIA	IIIB		
age under 20	67	62		
males over 20	21	60		
females over 20	26	44	$\chi^2 = 14.44$	P = .0007
age under 20	67	62		
age 20-35	38	62		
age 35+	9	42	$\chi^2 = 18.28$	P = .0001
males 20 - 35	15	39		
females 20 - 25	23	23		
males 35+	6	21		
females 35+	3	21	$\chi^2 = 12.8$	P = .005

TABLE 6
Mean childhood mortality and juvenile/adult ratios for Ontario and Arikara sites

Site	$r = 0$		$r = -.01$ ($r = -.005$)	
	mean childhood mortality	ratio	mean childhood mortality	ratio
Arikara				
Larson	.128	.344	.159	.476
Leavenworth	.117	.321	.145	.439
Sully A	.099	.279	—	—
Sully D	.075	.192	—	—
Sully E	.094	.216	—	—
Ontario				
Fairty	.114	.258	(.126)	(.298)
Glen Williams	.085	.214	—	—
Grimsby	.132	.355	.161	.475
Kleinburg	.064	.188	—	—
Maurice	.052	.115	—	—
Orchid	.063	.153	—	—
Ossossané	.120	.286	(.133)	(.308)
Uxbridge	.057	.147	—	—

TABLE 7
Suggesed "correct" ${}_5e_0$ with the population estimates (P) and life table birth/death rates ($1/e_0$): the derived ${}_5e_0$ is compared with the ${}_1e_0$ originally presented or published.

Site	Ratio	Final Age	Unadjusted ${}_5q_0$	${}_5e_0$	Adjusted ${}_5q_0$	${}_5e_0$	Full Table ${}_1e_0$ (unadj.)	ΣDx (adj.)	P with time = 10	20	30	$\frac{1}{{}_5e_0}$
Ossossané	.286	63.8	.275	23.4	.311	22.4	22.75	281.6	632	318		45
$r = -.005$	.308	***	.246	23.4	(.342)	20.8		253	527	265		48
Grimsby	.355	59.7	.121	26.1	.311	21.0	21.4	476	1001	502	336	48
$r = -.01$	.466	***	.150	23.0	(.368)	17.8		394.6	703	353	237	56
Fairty	.258	65.7	.221	25.6	.311	22.9	24.0*	579	1327	665		44
Glen Williams	.214	69.3	.201	29.9	.277	27.3	——	312.6	854	429		37
Uxbridge	.147	76.4	.191	33.0	.277	29.7	25.0	511	1519	761		34
Kleinburg	.188	71.7	.121	35.9	.277	29.9	25.1**	682	2040	1022		33
Maurice	.115	81.1	.076	42.6	.277	33.9	——	169	574	288		29
Orchid	.153	75.6	.059	38.6	.277	30.2	——	314.6	951	477		33

* The life table here is that of Melbye, 1981 which includes an old age adjustment.

** The life table here is that of Pfeiffer, 1974 with infant adjustment removed; ${}_5e_0$ not ${}_1e_0$.

*** The final age determines Dx' values, it is not possible to derive a final age and then calculate a life table at r = −.01 to accord with a specific ratio.

P = (ΣDx * ${}_5e_0$ / time) + 10% of time

The "correct" ${}_5e_0$ values are derived from the regression of the final age which gives the correct ${}_5e_0$ on the juvenile/adult ratio of Bocquet-Appel and Masset (1982). The relationship is non-linear: $\log y = 8.2 + (-.05264x)$; $r = -.966$; derived from Coale and Demeny West Levels 1, 2, 10 (1966:2-11), pooled sexes and Charbonneau (1970:194;1975:125). The resulting ${}_5e_0/{}_5q_0$ relationship when compared with the United Nations tables (cf. Ascádi and Nemeskéri 1970:47, Fig. 9) gives some idea of the probable infant under representation.

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