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AN ASSESSMENT OF THE APPLICATION OF MODEL STABLE POPULATIONS TO PALEODEMOGRAPHIC DATA

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The Wendat or Huron Indians were made up of five clans and lived in what is now the Georgian Bay region of southern Ontario. More specifically, the Huron country was bounded by Georgian Bay to the west, Lake Simcoe to the east and extensive swamps and lakes to the south. The people referred to themselves as Wendats, Huron being a derogatory term used by the French, meaning unkempt knave (Wrong, 1939). Unfortunately, Huron is the name most commonly given today, so with all due respect to these people it is used here only by convention.

The population which is the subject of this paper is from Ossossané, the principle village of the westernmost tribe of the Huron, the Bear Clan. During the late prehistoric and early historic periods, the Huron practiced a form of secondary reburial where all those who died during a period of approximately ten years were interred in a common grave or ossuary. The ceremony is referred to as the Feast of the Dead and has been described in great detail by both early explorers and missionaries. The Jesuit missionary, Jean de Brebeuf, visited Ossossané in 1636 and witnessed a Feast of the Dead which he reported to his superior in Quebec. Brebeuf's account is contained in Volume 10 of the Jesuit Relations, a 73 volume collection of reports on Jesuit missions in
New France or what is now eastern Ontario, Quebec and the Maritime Provinces (Thwaites, 1896-1901).

Using the information given in the Jesuit Relations on the locations of Huron villages, Frank Ridley (1947) located the village of Ossossané and its associated ossuary. The ossuary was excavated in 1947-1948 by Kenneth Kidd. By comparing the location, size and artifact content of the mass burial with the detailed account of the Huron ceremony written by Brebeuf, Kidd (1953) has convincingly argued that this ossuary is the one associated with the Feast of the Dead ceremony witnessed by Brebeuf on May 13 of 1636.

The skeletal sample from Ossossané represents approximately 700 Bear Clan Huron who died between about 1626 and 1636. The Bear Clan was visited in the winter of 1623-1624 by the Recollet Brother, Gabriel Sagard. Sagard has provided us with excellent descriptions of Huron life, and Trigger (in Tooker, 1964:viii) has noted that "of all the French writers on Huronia, Sagard is the one with whom the modern anthropologist feels most readily on common ground." Following Sagard's visit the Jesuits actively began to establish missions in Huronia. Their reports form the largest body of information on the Huron people, but they are not without bias. In particular, they are shaded with judgmental interpretations of so-called "heathen practices." For example, Brebeuf, in his discussion of sorcerers, states that "they prescribe for one illness a dog feast, for another, that a game of crosse should be played, for another, sleep on such and such a skin, and other stupid and diabolical extravagances." Nevertheless, these historic documents contain a wealth of valuable information and provide a rare opportunity to cross check data derived from the skeletal population with eye witness accounts of the customs and rituals of the Huron.

Of particular interest to the anthropologist is Brebeuf's description of the events surrounding the Feast of the Dead. The mass burial held in 1636 at Ossossané was attended by eight or nine villages, totalling some 2000 people. With few exceptions, all the dead from these villages were brought to the ceremony so that they could be reburied together. Infants under about six months of age and individuals who died by freezing, drowning or violence were excluded from the ossuary (Tooker, 1964).

Brebeuf describes the scene of the ceremony as one of considerable confusion. The skeletal remains were dumped into the ossuary pit and mixed together by five or six men with long poles. Upon excavation of the ossuary, it was found that Brebeuf's description of the random deposition of the bones was accurate. Kidd (1953:363) stated that "the bones lay in extreme miscegenation best exemplified by crania lying inside pelvic cavities and ribs perforating eye sockets."
Given this practice of the commingling of the entire burial sample and the intentional mixing of the bones within the ossuary pit, we confront a situation which Anderson (1964) noted in his Fairty Ossuary report where the focus of analysis is on a population of skeletal elements rather than on a population of individuals. This absence of reconstructable individuals has important implications for determining the total size of the ossuary population as well as for the analysis of the demographic experience of these people.

To determine the minimum number of individuals represented, counts were made of several bones. The highest count was recorded for the right ilium, yielding a total of 681 individuals (Katzenberg and White, 1979). Subadults, here defined as those individuals who were under 18 years of age, are better represented by a count of the right first mandibular molar socket, indicating the presence of 131 individuals.

The subadult mandibles were aged by Sullivan (n.d.) using the crown and root calcification standards of Moorrees, Fanning and Hunt (1963a; 1963b). The mandibular age assessments have been chosen to represent the subadults since dental development is more closely associated with chronological age than other growth events. The adults were aged by evaluating the morphogenesis of the symphyseal face of the os pubis following McKern and Stewart (1957) for males and Gilbert and McKern (1973) for females (Katzenberg and White, 1979). Because adult minimum numbers are based on ilia while age assessment is based on the pubic bone, which is represented in 216 cases, only 28% of the adults could be aged while 92% of the subadults were aged.

The ages which were derived from these methods were then used in the analysis of mortality. Normally, the study of mortality begins with relatively simple measures such as the Crude Death Rate, and proceeds ultimately to the lifetable. However, since differential burial patterns based upon age were practiced and infants are, therefore, drastically underrepresented, the actual number of deaths which occurred in the living population cannot be directly determined. Despite the fact that life table calculation can proceed in cases of infant underenumeration, as demonstrated by Moore, Swedlund and Armelagos (1975), it is felt that this source of error should be corrected for prior to the analysis.

Brothwell (1972) has proposed a method for determining whether a skeletal assemblage approximates a "normal" population in the frequency of infants. A normal distribution appears to lie between the ratios of four subadults to three infants and four subadults.
to one infant. From this, Melbye (1977) has derived a correction factor which lies on the midline of these ratios and can be used to boost up the frequency of infants to at least provide an approximation of the number of missing individuals at this age. Using the correction, in this instance, added 83 infants that would have been observed had it not been for differential burial instead of the 19 that were observed. After adjusting for the missing infants it becomes possible to calculate life tables.

To calculate a life table it must be assumed that the living population had experienced stable conditions for a period of preferably 100 years but 50 is sufficient if there are only minor fluctuations in the underlying vital rates (United Nations, 1967). A stable population is one in which there is a constant sex ratio at birth and there are constant rates of age specific fertility and mortality. A stable population should here be distinguished from a stationary population. In stationary conditions there are not only constant but also equal rates of mortality and fertility. Therefore, a stationary population, unlike a stable one, is in a nongrowth situation (Hawley, 1959).

Normally, in paleodemographic analysis, it can only be assumed that stable conditions occurred and that there were no major demographic disturbances. In this study, with the identification of the ossuary by Kidd, however, it is possible to give the exact date of the inhumation. This enables us to review the historic documents for the years preceding 1636 to determine whether there were any acute episodes of mortality due to disease, famine or warfare.

No major epidemics are reported among the Huron until 1639, at which time smallpox reduced the population by almost two-thirds (Heidenreich, 1971). During the period represented by the ossuary, disease did not significantly affect population numbers. In his relation of 1634, Brebeuf speaks of a contagion which caused sickness among the villagers but without drastic lethal effects. This contagion is not identified, although the later smallpox epidemic was recognized as such (Heidenreich, 1971; Cook, 1973) and, therefore, we feel that variola was not the agent in this particular disease event. One mention of a food shortage is made by Brebeuf, in the relation of 1634, but the members of the Bear Clan villages were able to buy maize from neighboring groups thereby avoiding actual famine. Droughts, such as those of 1628 and 1635, may have affected the food supply (Heidenreich, 1971). However, famine probably did not result since there are no records of any such events. Warfare must also be considered as a possible force of demographic disruption. Prior to 1640, when large scale warfare broke out between the Huron and the Iroquois, conflicts were minor
and short lived (Hunt, 1960). Such a conflict broke out between the Huron and the Seneca in the spring of 1634, but by that summer, peace had been reestablished between the two groups.

From the review of these accounts, we can be somewhat assured that major demographic disturbances did not occur during the years preceding the interment. Therefore, the conditions of stable populations are met for at least part of the requisite time period. We must assume that these same conditions held for at least an additional 40 years. The calculation of life tables is then at least partially justified.

The life table is a device which shows the rates and patterns of disappearance of a cohort (Pressat, 1970). When calculating a life table the raw data are converted to an arbitrary size of 100 or some base of 10 for standardization purposes. The probability of death at each age is calculated which then allows a determination of the proportion of individuals that survive into the next age group. The probability of mortality and the rates of survivorship are, respectively, the $q(x)$ and $l(x)$ functions. Following the calculation of several intermediate columns, the expectation of life, or the $e(x)$ function, is calculated. This is an expression of the expected years remaining to any individual in a particular age class.

The values of $q(x)$, $l(x)$ and $e(x)$, calculated for the Ossossané life table, follow more or less expectable patterns. Of particular interest to us is the $l(x)$ column. This shows that survivorship is relatively poor in infancy. In early childhood the chances of surviving to the next age are enhanced and mortality is even further ameliorated for the years of adolescence and the late teens when the chances of surviving are the highest at any time during the life-span. Beginning in the early adult years there is a steady and progressive attrition of the population until the final age of 60 years is reached.

From the foregoing it now becomes possible to determine which set of model tables, those of Weiss (1973) or Coale and Demeny (1966) best represent the rates observed for the skeletal data and the historic sources. Once a fit is made to the model tables, information on the underlying vital rates which produced that particular stable age distribution is available. We can then evaluate the information derived from the model tables by making reference to the historic sources.

The data were first fit to the Weiss tables. In this study, we chose to fit to the tables using survivorships, or the $l(x)$ function. The survivorship values derived from the calculation of
the Ossossane life table were divided into juvenile and adult components with each component then being separately matched to the model tables. The juvenile l(x) values are best fit to that set of Weiss tables which have a level of 40% survivorship at 15 years. The differences between the observed mortality and survivorship rates and the model rates are relatively small. The total difference is about .07 which is acceptable, particularly given the possible sources of error, such as differential representation of subadult age groups and possible inaccuracies of age reporting. The adult survivorships could not be as readily fit to the model distributions since the date indicated that no one in the population lived beyond 60 years. Nevertheless, it was possible to match the adult survivorship pattern in the Weiss tables. The closest correspondence is achieved for the adults in the tables which have an expectation of life of 20 years at age 15. The difference between the observed and model distributions is .15, which indicates that this at least approximates the appropriate level of mortality. Combining the subadult and adult survivorships then gives the best fit with a 20-40 model table (Figure 1). It is obvious that the survivorship curve in the model table continues for a considerable period beyond the curve for the Ossossane data. This is because the model l(x) function has been fitted by a Gompertz extension at the older age intervals and the empirical data have not been so extended.

The Ossossane data were next matched to the Coale and Demeny tables (Figure 2). Coale and Demeny (1966) recommend that the "West" family tables be used in situations where there is no reliable guide to the regnant pattern of mortality. Nonetheless, the "North" family of tables were selected for this analysis since it was felt that the "West" tables would underestimate subadult survivorship. In addition, the patterns in the "North" tables conform more closely to the observed data than the other three families of tables.

When fitting to the "North" tables only the subadults were matched to the models since there was no correspondence between the adult patterns derived from the skeletal data and the adult patterns in the model tables. Adult mortality in the tables, even at the highest level, is still not as great as that which was observed for the skeletal data. To use the family "North" distributions one must accept Coale's assertion (1972) that, within a single mortality regime, the pattern of mortality and survivorship at one age is related to the pattern at other ages. This means, contrary to Weiss (1973), that with one pattern of subadult mortality there will be only one corresponding pattern of adult mortality. Therefore, for the purposes of argument, the possibility must be entertained that the adult survivorships in the
model are correct and that an underaging bias of adults has caused the observed data to be truncated too early. This point has been expatiated on by Howell (1978) and will be touched upon again.

It was possible to derive a reasonably close fit, using sub-adult survivorship only, between the skeletal data and a model table with a Level 3 mortality. Here the difference between the observed and model survivorships was equal to .06 for the first 20 years of the lifespan. A Level 3 "North" describes a cohort with an expectation of life of 23.7 years at birth, 34.6 years at age 15 and 45% survivorship at 15 years. Next, the empirical data were fit to the appropriate stable population underlying a Level 3 mortality. The closest conformity is achieved at stationary conditions.

With the appropriate levels of mortality determined in both sets of model tables it is possible to examine some of the underlying features and determine which set conforms more closely to the information contained in the Jesuit Relations and the data derived from the skeletal analysis. For this comparison, only those demographic variables are used which would give little chance of age misreporting affecting the results and where there is good confirmation from the documents. These include: Crude Death Rate, Mean Family Size and the proportion of individuals under 15 years.

The Crude Death Rate for the Weiss table is given by the survivorship divided by the Total Person Years lived for the first age group. In the 20-40 table this is 63.9. Crude Death Rate is considerably lower for a stationary Level 3 "North" and here is equal to 42.4. Assuming a round number of 775 deaths for the ossuary, which would be the 681 individuals observed plus the 83 added infants, a rate of 77 people dying per year results. With a total population size of 2,000, given in the Jesuit Relations, the Crude Death Rate is then equal to 38.7. For a nine year interval the Crude Death Rate would be 43.0. Although only an approximation can be given here, the Crude Death rate of the Coale and Demeny tables comes considerably closer to the rate calculated from the skeletal and historic data.

There is little difference between the values given for the Mean Family Size, the number of male and female children, in both sets of tables. A Weiss 20-40 table has a value of 5.00 for this variable while a Level 3 "North" gives 4.74. Both of these fit comfortably within the range of the three to six offspring per couple which the Jesuits observed.
The proportion of individuals under age 15 is quite simply the percent of the population which is less than 15 years and is a rough measure of the age of a population. The Weiss table gives a value of 49.0 for this feature while Coale and Demeny are slightly higher at 55.0. The skeletal data conform more closely to Coale and Demeny than to Weiss with a proportion of 56.7.

On what is admittedly scanty evidence, the Coale and Demeny tables seem to give a better representation of some of the underlying demographic features of the early historic Huron. It is impossible to authoritatively state which tables are more appropriate since in paleodemographic studies the data are not sufficiently precise for this task. Weiss' tables give a better fit for survivorships at all ages than the "North" tables yet the underlying features of the "North" tables conform more closely to the observed situation. Although the question cannot be answered here, we must ask ourselves if the survivorship pattern in the Weiss table is indeed a real one or is it possible that an under-ageing bias has crept in? This latter possibility should not be dismissed too readily. Weiss' tables were derived, in large part, by the use of skeletal populations as source data. Hence, if there has been an under-ageing bias it is not surprising that the skeletal survivorships should conform more closely throughout the lifespan to the Weiss tables than to the Coale and Demeny tables.

Regardless of the final selection of model tables, we do conclude that life for the people at Ossossane was, in Hobbes' words, "nasty, brutish and short." This is indicated initially by the high level of mortality in both model tables which were matched. Further confirmation is given in a recent analysis of periostitis in the Ossossané skeletal remains as well as the remains of two other biologically related yet temporally distinct populations (Sullivan, 1979). When the rates of infection of the Ossossané people are compared to those observed in the two earlier populations it is found that the incidence rises significantly and appears to be related to the amount of contact with Europeans which had occurred. This is attributed to the introduction of new diseases and the disruption of traditional subsistence routines which were associated with the establishment of European economic hegemony.
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FIGURE 1  A comparison of survivorship between Weiss' Model Table 20-40 and the combined subadult and adult skeletal data from Ossossane.
FIGURE 2 A comparison of survivorship between Coale and Demeny "North Level 3" and subadult skeletal data from Ossossane.

- Coale and Demeny "North" Mortality Level 3
- Ossossanaé

Age

l(x) value