Reviving Communities: A Paleodemographic Analyis of Several Sites in the Caribbean from pre-Columbian and Early Colonial Times.

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-by-

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RMA Religion and Society (Caribbean)

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Versie 4.0 (final)

6 augustus 2012

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Acknowledgements

I would like to thank the people of the Caribbean Research Group at Leiden University, specifically Corinne Hofman for allowing me to do this research and help me out whenever it was needed. I would also like to thank Menno Hoogland, Hayley Mickleburgh, Jason Laffoon, Andrea Waters-Rist and Lou-Lou de Veth for their professional help, support and advice as I was writing this thesis. A special thanks is extended to Darlene Weston who showed me the way in paleodemography and even with an ocean in between us was kind enough to keep giving useful comments.

I would also like to thank those other people who know that they mattered. The list of those who supported me through these two years of research and learning is too long to list here, but reading your name in that list is not necessary to know what these people have meant to me in these times. Even so I would like to give the biggest of these thank yous to my parents, Paul en Diane and to Martine Trommels. Of all those who were there for me, they were the ones who above all else were able to give me the courage and strength necessary to engulf myself in my work and yet rescued me before I could drown.

1. Introduction

Archaeology is a social science. Archaeologists attempt to reconstruct everyday life of people by looking at the material remains they left behind. This study does not look at the material remains used by those people, but rather at the material remains of the people themselves.

The bodies of the deceased are interred by their community in a graveyard, which can be found adjacent to or even in the habitation area of the community. The deceased can be seen as still being part of their community and in that sense mirror the make-up of that community. The living members of that community have now long disappeared. They migrated, slowly died out or were annihilated by catastrophic events.

By looking at the demography of a community one can attempt to explain patterns which can be linked to such social events as the rise of agriculture (e.g. Bronson 1975), urbanisation (e.g. Adams 1972) and the development of both social organisation (e.g. Carneiro 1970; Dumond 1965) and hierarchy (e.g. Hassan 1979).

Many of these topics are as of much interest to Caribbean archaeologists as they are to archaeologist anywhere else in the world. Although demography has often been quoted as being instrumental in Caribbean archaeology, the usage of a systematic research into Caribbean paleodemography has been mostly lacking (for an exception see Curet 2005). This research will mark the first large scale usage of paleodemographic research into Caribbean communities.

In order to properly investigate the paleodemography of the Caribbean the main question in this thesis is: what is the diversity in paleodemographic profile of the Caribbean pre-Columbian and early colonial burial assemblages? Rather than assuming that a general profile of all Caribbean archaeological sites can be drawn, it is suspected here that the different sites will yield very different profiles in reflection of the diversity of the Caribbean archaeological landscape.

The main question in this research can only be answered when different subquestions are to be considered. These questions are: what is the paleodemographic profile of each assemblage analyzed? This means that the differences in the profiles of different sites must be analyzed and that an explanation of these differences, being it due to cultural context, biostratigraphy, geography or burial practices must be considered. Furthermore it must be ascertained whether or not the sites and their graveyard assemblages can be divided into different time periods. If this is possible then it must be researched whether or not these different time periods produce different profiles and how these might be explained. It is also the case that Caribbean graveyard assemblages usually consist of very few individuals. Therefore the question must be asked if a distinction between regular and irregular patterns can be made when such few individuals are retrieved. It is also been postulated that Caribbean communities (and even more the individuals within these communities) are highly mobile. It therefore serves merit to investigate if it can be theorized what a migrational population (including such elements as founder populations, colonization and inter-site migration) looks like and if such a population can be identified in the Caribbean through paleodemographic techniques. These paleodemographic techniques themselves are very important as well, as this field of research continues to develop new techniques and methods to tackle the diverse research questions which are inherent to this field of inquiry. Therefore it will be investigated whether or not these new and very specific techniques (e.g. Maximum Likelihood Estimations and Makeham-Gompertz hazard models) can be of any use in Caribbean paleodemography. Lastly it will be investigated if a paleodemographic standard for the Caribbean region can be established based on ethnographic examples from the Tropical Lowland of South America.

All these different research questions serve the objective of trying to identify not only the diversity of the paleodemographic landscape in the Caribbean, but even to establish whether or not paleodemography is a feasible option to investigate pre-Columbian communities in the Caribbean region. In order to do this a strict methodology will be followed in which data acquired by the author is put into a standard model. This model will then serve as the basis on which information provided through literature review will be modelled. In this manner a comparative framework between self-acquired data and data acquired through literature review can be made.

To be able to make this study comprehensible and precise a chapter will first be presented in which the current status of paleodemography is explained. This is done by showing how the field emerged out of more historical oriented population studies and then became a physical anthropological oriented science. The main lines of investigation, criticism and development in this research will be presented as well as the status of paleodemography in the Caribbean area. Considering this a picture will be painted in which the status of Caribbean paleodemography as performed by other authors and this author will be explained.

After the current status of paleodemography is introduced in this fashion, then the theory and methods used in this study will be explained. Whilst doing so the most important aspect, namely the calculation and interpretation of the life table, will be explained. As well as explaining this life table some attention will also be given to such demographic concepts as fertility, mortality and migration. As well as population growth and decline and model life tables. Here the usage of model life tables and the ethnographically derived Warao model life table will also be explained. In order to establish a comparative framework for the Caribbean region in pre-Columbian and Early Colonial times in particular a new standard model will be presented here which might be used to better determine the nature of populations present in this time period and geographical or cultural area (Layrisse, Salas & Heinen 1980). Finally this chapter will outline the sites which will be researched for this study and explain the methodology which will be followed in order to fully answer the research questions of this study.

The next chapter will go into the sites used for this research in more detail. Sites will be presented with information being given on their geographical location, the time span during which they were occupied, earlier research being done at the site, possible interpretations from earlier research and the completeness, preservation and division according to age and sex as well as pathological markers on the skeletons indicative of special conditions of death or injury during the lifetime of these individuals.

With the sites properly presented, the next chapter will deal with the results coming from the analyses of these sites as based on the methodology adhered to in this study. These results will incorporate both visual and written explanation of the results of these analyses. In this way each site will be presented individually in comparison to the standard models used as a reference in this study. By doing so each of these sites will be put into a frame where they later on can be compared to other sites in this study which might have similar profiles.

After the sites have been compared individually to a standard model it will be possible to attempt to group them together into certain categories and in this way compare sites to each other within the region. By doing this an explanation might be offered on the paleodemographic appearance of these communities based on similar characteristics. These comparisons will show that several sites can be grouped together based on their characteristics of either an attritional or catastrophic population, with some having evidence of migration. It will also be shown that most of these sites suffer from preservational and methodological biases which make them almost impossible to compare to any standard model available. Some of these sites however also indicate that the continuous and systematic underestimation of children might indicate a practice where children are not commonly buried in the communal graveyard, but rather are disposed of in an informal fashion.

In short, this research will show that paleodemography is a feasible option in the research into demographical aspects of pre-Columbian Caribbean communities. Although the research encompasses many sites from many regions it serves only as a first step from where future research might lead into more detailed investigations into the demographic aspects of these sites. The methodology used in this study can serve as a framework along which these future researchers might build in order to further enhance not only the picture of these and future sites, but also to enhance the methodology itself so that in time indeed it might be possible to speak about a specific Caribbean Paleodemography.

2. Current Status in Paleodemography

2.1 Introduction

In order to establish the role of paleodemography in the Caribbean it must first be ascertained what exactly the current status of paleodemography is. To do so, the history of this field of research will be explained here, after which the current scope of the field will be established. Finally the role of paleodemography in Caribbean research will be reviewed.

2.2 Before paleodemography

The first investigations of human longevity can be characterized as philosophical (rather than practical) research which already had its roots in Antiquity itself (Ascádi & Nemeskéri 1970: 16). This Antiquity became the research subject in the 19th century when Beloch (1886) and Harkness (1896) investigated human longevity in Ancient Rome. These studies were derived from epitaphs and literary sources and thus were not archaeological in nature. The step towards a more archaeological orientated paleodemography could be taken when guidelines were created on how to properly assign an age to archaeologically retrieved samples. This became possible when Todd (1920, 1921, 1930) published his findings on biological markers of age change in the human pubic bone. This allowed researchers to age individuals that were retrieved from not only an archaeological context, but also from anthropological examples (Ascádi & Nemeskéri 1970: 54).

These first few studies were concentrated more on large scale, general analyses with an emphasis on biometrics and statistics (e.g. MacDonnel 1913, Pearson 1902) then they were grounded solidly in data. The result of this enterprise usually was a long list of the sex and age of individuals, rather than a pursuit of demographic characteristics of a population (Milner *et al.* 2008: 562). In the following years many more studies into the demography of ancient populations were made (for an overview see Ascádi & Nemekéri 1970: 53-57), yet none could be characterized or compared to what is now referred to as paleodemography.

2.3 The beginning of paleodemography

It was not until the studies performed in Greece, on the human life span of Ancient Boeotia that one could speak of paleodemographic research. These studies performed in the late 1940's (Angel 1947) and 1950's (Angel 1954) by J. Lawrence Angel marked the first step onto the road of paleodemography. After this point paleodemographical analyses became a central element in most physical anthropological reports (Chamberlain 2006: 81). At this point the data from the analyzed populations were presented in life tables. These life tables could then be compared to model life tables (e.g. Coale & Demeney 1966, Weiss 1973). This practice allowed data to be compared between sites, which meant that a better cross-comparative framework could be established through which a better understanding could be created of the evolution of human demographics and society from the formerly poorly understood ancient times to modern times (Milner *et al.* 2008: 562-563). Demographic data collected amongst modern hunter-gatherers would be used to aide in the understanding of ancient societies (Hoppa 2001: 11007).

Because from this time onward a standard model could be applied for comparison, this meant that paleodemography could start with statistical comparisons between the data retrieved in the field and the standard models developed by anthropologists. These statistical analyses broadened the field in the sense, that it would now become more and more statistical and mathematical in nature. This new direction allowed for the making of a more solid theoretical backdrop against which to do paleodemographic research. This new and more statistical direction that paleodemography was taking however also meant the beginning of a period of harsh criticism by authors from within the field itself.

2.4 "Farewell to paleodemography(?)"

In a landmark article by Jean-Pierre Bocquet-Appel and Claude Masset, two French researchers from the French National Institute of Prehistory, a bold claim was made. The authors stated that the statistical fluctuations encountered in the new more statistical paleodemography made true research in the field invalid and therefore impossible (Bocquet-Appel & Masset 1982: 332). Although research quickly showed that the statistical were in fact not just random fluctuations, but actually held value and merit for research (Van Gerven & Armelagos 1983) it was quite apparent that the field of paleodemography and more specifically that the statistics associated with this practice, needed reviewing (Buikstra & Konigsberg 1985: 330).

The assessment of the statistical errors and biases brought forward took some time and as of today has not yet been solved. The criticism however, sparked a new interest into different techniques in the assessment of skeletal age and reference sample biases, which in turn has lead to the presentation of many works which attempt to solve these problems (e.g. Hoppa & Vaupel 2002; Koningsberg & Frankenberg 1992, 2002).

These more mathematical or statistical questions have somewhat obscured however, how paleodemography started out; the analysis and interpretation of archaeologically retrieved graveyard populations. Although a thorough investigation of the statistical methods applied in paleodemography is necessary to validate the data and therefore the field, it would seem that very few actual analyses of graveyard populations are still performed. This was however what the majority of paleodemographers focused on for the 15 years after the publication of Bocquet-Appel and Masset's article (Hoppa 2002: 15).

2.5 "The Osteological Paradox"

Another idea which has developed in this field is the one which is called 'The Osteological Paradox'. Based on an article by Wood *et al.* (1992) it pertains to the interesting notion that skeletons retrieved from a graveyard are at all not representative of the living population it is thought to represent. Coming merely 10 years after the first major critique on the field this research sparked another round of fierce debates on the validity of the field.

The problem (as stated by the authors) is threefold, but only two will be outlined here. These two are the problems of *selective mortality* and *hidden heterogeneity* (Wood *et al.* 1992: 344). What these two in essence mean is that the population retrieved from a graveyard is not representative of the population alive. This is because not all persons in a certain age category who are at risk of dying will actually die. The persons retrieved from a graveyard are therefore only a small representation of the actual living age category of which the retrieval is intended. These problems heavily relate to problems in a field adjacent to paleodemography, which is paleopathology. Whilst analyzing skeletal remains pathological lesions on the skeleton are usually noted by the researcher in order to establish the presence (or absence) of diseases in the population. This is problematic, since pathological lesions can be resorbed in the bone, leaving no marks as long as the bone has enough time to heal. When the lesions on the bones are resorbed it means that the disease was present in the population, but the person who suffered from it did not die from it. Diseases might therefore be noted as absent, whilst they are in fact present in a population. Bony lesions as markers of disease also need time to develop. Most people who die from diseases die quickly, so that the bone does not have time to respond and create bony lesions characteristic of the disease they suffered from. This might be the case for instance with rapid developing diseases, which kill people quickly and therefore do not leave a permanent marker on the bone, such as pneumonia or the Black Death.

The debate started by Wood *et al.* was yet another advancement in the field of paleodemography. Although another problem was outlined, the paper started a wide debate which would advance the field. The critiques launched through 'The Osteological Paradox' were necessary, since they investigated some preconceptions that needed some careful consideration (Jackes 1993: 438).

2.6 Current status of paleodemography

Although these critiques were necessary, they would turn the attention of paleodemographers to more methodological issues which meant turning away from the more practical issues. It is however the practical issue of paleodemography (the investigation of graveyard assemblages) that should be the central interest. One should not disregard these problems, but should try to work with or around them whilst analyzing archaeological samples. This is something that is done nowadays mostly in Europe and North America and pertains to very specific populations which get researched again and again with new techniques, which were developed by more methodological oriented paleodemographers.

When paleodemographic studies are performed on graveyard populations these sites usually are of Medieval European origin (e.g. Hawkins 1990, see also Margerison & Knüsel 2002, Waldron 2001, Weston in press). Studies of this nature usually try to investigate large cemetery sites which consist of components of attritional graveyard populations and catastrophic graveyard populations, the former meaning that the population retrieved can be attributed to regular mortality patterns and the latter meaning that the population retrieved most likely was deposited during some form of catastrophic event.[1] In these cases the sites usually consist of common people buried in and/or around a church or cathedral. The catastrophic event represented in these graveyards consists of the epidemic called the 'Black Death' or 'Bubonic Plague'. It is this disease that most of the researchers are interested in. Since paleodemography attempts to retrieve information about past populations from graveyard assemblages it can be argued that looking at a disease such as the Black Death can be very interesting, since it is argued that 30% to 40% of Europe's population died due to the

[1] The exact meaning and nature of these different populations will be further explained in the chapter about the theory and methods of paleodemography.

ill effects of this disease (Platt 1997 in Waldron 2001). This then would have had great effect on the demography, and therefore society, in Medieval Europe.

2.7 "Caribbean Paleodemography"

Aside from research of a more statistical or methodological nature and research into large scale catastrophic Medieval European events other paleodemographic research is performed as well with a regional scope, in the case of this investigation the Caribbean. A first large scale research was performed here by L. Antonio Curet (2005) into the paleodemographic profiles of three sites located on Puerto Rico. Not only does Curet investigate these sites, but also looks into the subject of migration and mobility in the Caribbean (Curet 2005: chapter 3-4), something that has been widely researched in this area (Fitzpatrick & Ross 2010; Lovén 1935; Rainey 1940; Rouse 1986; Wilson 2007). In it Curet uses life tables and compared the sites to each other using standard techniques. He then uses a cross-comparison between these different sites in order to establish the more irregular patterns, whilst at the same time looking for the demographic aspects of migration which were speculated on earlier in the book.

This research was the first of its sort and meant the first steps of paleodemography into the Caribbean archipelago. The work is far from complete however, as Puerto Rico was the only island under investigation and the irregularities and discrepancies within and between profiles retrieved from the three sites on this island showed that although demography has often been misused or poorly understood it is possible to positively use this type of research. Furthermore it showed that the assumption that sites under investigation are stable is most likely not feasible because of the nature of the paleodemographic profiles retrieved from these sites. Punta Candelero is assumed to be a failed colonization attempt as evidenced by low fertility rates and the abandonment of the site after a short amount of time. Tibes also has low fertility rates, but most likely suffers from a sample bias, skewing the results coming from the analysis. Lastly the site of Paso del Indio is one that most likely resembles a stable population.

2.8 The first "Reviving Communities"

Another step was made by the author whilst writing his BA thesis (van Meel 2010). There he researched two sites from the Ceramic Age on the Lesser Antillean island of St. Lucia; Anse Lavoutte and Pointe de Caille (the latter of which is also known as Saltibus Point). The two sites under investigation were located on the northern and southern side of the island and were analyzed using standard techniques and then compared to a standard life table (Coale and Demeney 1983) and to each other.

This research already noted that although the investigation of these sites was a step forward for paleodemography in this region a wider framework was necessary in order to further and better investigate the paleodemography of the Caribbean. Even though these two sites could not be compared to each other because they were affected by differential preservation biases it was possible to conclude that these sites most likely represented unique communities and it was shown that the site of Pointe de Caille could be classified as a stable attritional population and Anse Lavoutte could not be fitted to any model population. Anse Lavoutte's differentiating demographic profile was caused by the overrepresentation of adult individuals and the underrepresentation of the elder individuals and juveniles.

2.9 Conclusion

Since the inception of the field more than half a century ago it has developed from a rudimentary field of inquiry into a separate scientific field. During this time major questions have been posed and answered by the scientist in the field, which has propelled paleodemography significantly from the simple lists of sex and age of individuals it started out with into the field it is now. A majority of studies nowadays is performed in order to answer the questions posed in 1982 and 1992 and are of a statistical or methodological nature. The more practical studies concern Medieval Europe which is not our major field of interest here. The status of Caribbean paleodemography rests now at the point of the individual analysis of sites on one island (Curet 2005, van Meel 2010). The current research will attempt to broaden this field in order to investigate the full variability of sites and the periodisation and mobility between them in the Caribbean.

3. Theory and Methods

3.1 Introduction

Paleodemography can be described in many ways. The definition adhered to here is that paleodemography is the field of inquiry which retrieves past population demographics through the analysis of archaeologically retrieved graveyard populations. This field of research has developed strongly since its inception over half a century ago (i.e. Angel 1947).[2] Through its development many different theories and methodologies have been established. It would be unwise to try and apply all proposed theories and methodologies. Therefore only one methodological must be used, in order to establish a proper standardized dataset, which in turn can be used in a cross-comparative framework.

In this chapter firstly an explanation of the theories which will be adhered to in this research will be presented. The basic assumptions which are central to paleodemography will be explained, as will the calculations and what they lead to, the life table, and how to interpret this life table. Of course no methodology is without its pitfalls or controversies. In order to fully understand the data as it will be presented, all possible biases and problems with the methodology used here will be established, so that were possible, solutions may be opted that can reduce the problems which might arise. Although not all biases or problems might be circumvented, they must all be identified so that it is known to what extend these biases and problems might influence the data. In this section the theory and methodology of calculating the mortality and fertility of a population and population growth or decline rates will also be explained.

Besides the methodology and the life tables they produce, a comparative framework must be created as well. This comparative framework will consist of standard attritional models (Coale & Demeney 1983), standard catastrophic models (Paine 2000) and (mostly theoretical) models concerned with migration (Burmeister 2000, Paine 1997). By establishing this specific comparative framework it is hoped that in the future data can be compared easily to, not only each other, but also a standard for the region.

[2] A more detailed description of the history of paleodemography can be found in the previous chapter.

Secondly the methodology used to analyze the sites for this research will be outlined. This entails that an outline will be given in which the sites which are to be analyzed will be presented. Also an explanation behind the reason to choose specifically these sites will be given. Some of these sites were not researched by the author, but were taken from documentary sources. Since other authors might prefer other methods and/or techniques to gather data or even gather different data from the ones desired in this research, it is stringent that these differing forms of data are adapted in such a way that they will fit into the standardized dataset created for this research.

Another matter of importance is that of periodisation of sites. It is an assumption amongst paleodemographers that individuals recovered and analyzed from graveyards occupied this graveyard continuously through time. This would mean that one graveyard would have to be analyzed as one single population. It is apparent from C14 data performed on skeletal elements from several sites in this research that this is not necessarily so (Hoogland personal communication 2012; Pestle 2010). The deposition in these graveyards can be split into several time-defined periods. To gain a better understanding of demographical developments through time at these sites a periodisation will be made through which each distinct period within the site will be analyzed demographically.

After all sites have been fitted into a standardized dataset they will be compared in order to gain a better inter- and intra-site understanding of them. In order to do so the sites will be matched against a standard for the region and to each other. From this practice the sites with matching or differentiating patterns will be distinguished. By looking at other matching and differentiating characteristics of these sites (geomorphology, location and time period etc.) a better understanding of demographic aspects of this region will be made.

3.2 THEORY

3.2.1 Basic assumptions

Like any other line of research paleodemography has a set of basic assumptions upon which the theory and methodology of the practice are based. The most important of these assumptions had already been used for quite some time by researchers before it was actually named and defined by Nancy Howell (1976). This main assumption is the premise of the *uniformitarian principle* and can best be summarized as such:

> "A uniformitarian position in paleodemography implies that the human animal has not basically changed in its direct biological response to the environment in processes of ovulation, spermatogenesis, length of pregnancy, degree of helplessness of the young and rates of maturation and senility over time." (Howell 1986: 26)

This assumption is not uncommon in archaeology as it is widely assumed that the process seen to day are the same as they were many (thousands of) years ago, as had been first proposed by such men as James Hutton and Charles Lyell in 18^{th} and 19^{th} century Great Britain (Renfrew & Bahn 2005: 274-277) and is still adhered to nowadays. This principle firstly means that the environmental or societal reactions to or for demographic change are as much true now as they were in the past and will be in the future (Hoppa 2002: 10-11). Secondly it means that the biological changes to the skeleton as related to the ageing of an individual are the same in the past as they are now (Hoppa 2002: 11). This *uniformitarian principle* then is considered to be true at a macro level (a society or population) and a micro level (an individual's biological marker of age). There has been criticism to this standpoint (Swedlund & Meindl 1992 in Paine 1997) which states that by adhering to this principle important biological or behavioural differences which could distinguish past societies from our own might be overlooked. It is also argued that past societies are not similar to ours or even the ethnographic data gathered from contemporary hunter-gatherers as they, to certain extend, are influenced by epidemic (European) diseases and modern medicine.

A second set of assumptions rely on the concepts of *stability* and *stationarity* (Curet 2005: 190). A stable population is a population with constant fertility and mortality rates, no net migration and a constant rate of population growth or decline. Stationary populations are a special kind of stable populations (Ascádi & Nemeskéri 1970). This type of population is similar in many ways to the aforementioned stable population except for the fact that the constant growth rate of the population in question is zero and therefore there was no growth or decline of the population. This second set of assumptions is a little contradictory in paleodemography. The growth rate of a population and possible migration, being it immigration or emigration, are usually at the forefront of paleodemography investigations and therefore determining beforehand that the growth rate is zero and that there was no net migration would mean an abandonment of the pursuit of identifying changes in demographic composition over time (Hoppa 2002: 12).

Another basic assumption of paleodemographers states that the graveyard population in question is a direct reflection of the living population it represents. This has been questioned by Wood *et al.* (1992), who stated that the graveyard population is not representative of the entire population, but rather only of those individuals who were at a higher risk of dying. This would mean that the graveyard population being researched is 'weaker' or more 'frail' than the living population it should be representing[3]. Although this particular theory in essence is true and as of so far has not yet been countered or mended by other researchers, it must be noted that the graveyard population in question might not completely represent the living population, but still is heavily related to this living population and therefore can be seen as a representative of it. Furthermore this problem does not mean that the graveyard populations can be compared to each other. Even if they were a flawed representation of the living population this does not mean that the graveyard populations can not be compared amongst each other, since the 'flaw' then is equally true for all.

A final assumption made here is that the graveyard population had to be deposited by the living population over a continuous and uninterrupted amount of time. A graveyard population is not a representation of one specific moment in time, but rather the accumulation of the dying population over the time that the graveyard was in use. If the graveyard was at times not used by the population, then this would mean that the graveyard population is an incomplete representation of the living population. It must also be assumed that all individuals were buried in the graveyard and that some groups were not excluded from the graveyard for one reason or another. This for example is the case in Christian burial grounds where unbaptized children and stillborns are not buried in the consecrated ground of the cemetery (Duday 2009: 58). This means that this particular group of individuals might not be excavated whilst excavating the burial ground and therefore a large portion of the deaths in a population might be obscured by differentiating burial practices.

3.2.2 Calculating the life table

After a graveyard has been completely excavated it must be investigated by a physical anthropologist, who will investigate the skeletons whilst in the process noting the condition of several skeletal elements. The physical anthropologist should note the completeness, preservation, sex, age-at-death and pathological conditions of the skeleton. All of these should be noted, because they might at a later time help in the interpretation of the data. After this dataset has been compiled it can be used in creating a life table.

[3] For a further explanation of this theory, the concept of frailty and mathematical and statistical calculations that underlie these conclusions see Wood *et al.* 1992.

A life table can be characterized as a representation of age-specific mortality rates for a population (Chamberlain 2006: 27). The calculation of these life tables used to be long and tedious work. With the advancement of automated computer spreadsheets the time and effort needed to compile these life tables has considerably shortened. Although these automated spreadsheets can serve to ease the work it is necessary to fully outline the calculations necessary to compile the life table, since by doing so the underlying principles and calculations used in these automated spreadsheets can be understood. To create a better understanding of the life table and its calculations an example life table taken from the Hereford Cathedral Close Cemetery site in Herford, UK (Weston in press: Figure 24) will be used here. Although this life table is quite dissimilar of the ones used in this study it can serve as a basic example of a life table from which the life tables used later in this study are derived.

(x)	**(D_x)**	**(d_x)**	**(l_x)**	**(q_x)**	**(L_x)**	**(T_x)**	**(e_x)**
0	23.05	1.94	100.00	0.02	0.9903	32.5330	32.53
1	70.09	5.91	98.06	0.06	3.8041	31.5428	32.17
5	92.17	7.77	92.15	0.08	4.4130	27.7387	30.10
10	81.69	6.89	84.38	0.08	4.0466	23.3257	27.65
15	59.00	4.97	77.49	0.06	3.7500	19.2791	24.88
20	104.50	8.81	72.51	0.12	3.4054	15.5291	21.42
25	116.75	9.84	63.70	0.15	2.9390	12.1237	19.03
30	116.75	9.84	53.86	0.18	2.4468	9.1848	17.05
35	107.25	9.04	44.01	0.21	1.9746	6.7380	15.31
40	107.25	9.04	34.97	0.26	1.5224	4.7634	13.62
45+	307.50	25.93	25.93	1.00	3.2409	3.2409	12.50
Total	1186						

Table 1: Life table for complete Hereford skeletal sample (adapted from Weston in press: Figure 24).

Chamberlain (2006: 28-31) will serve here for the explanation of the different categories in the life table seen above and the calculations necessary to produce them. As may be seen in Table 1 the life table consists of a table with along the top eight distinct categories, all of which will be explained below.

The first category is named *(x)* and stands for the age category or interval (these two terms can be used interchangeably and this will done throughout this text). The number in this column denotes the age an individual has at the beginning of that particular age category. The age categories here are split up into 5-year age intervals with the exception of the first two categories *(0)* and *(1)*, of which the length of the age interval is 1 and 4 years respectively, and the last age interval *(45+)*, because archeologically retrieved individuals usually cannot be aged precisely after 45 years of age. For this life table a maximum age is assumed of 70 years. Since an actual age cannot be determined one must be assumed and 70 years is the best reflection of archaeological populations (Weston personal communication 2010). Life tables can be calculated for populations using different age intervals, the most complete of which would be a different life table for each sex and age categories of 1 year. This is however not possible to achieve in archaeology and paleodemography and therefore age intervals are being used which are deemed appropriate by the paleodemographer. Using age intervals instead of actual ages for a life table is what is referred to as using an abridged life table (Curet 2005: 195).

The second category is the number of people dying *(D_x)* in the corresponding age category *(x)*. The number depicted in the table is not a whole or rounded number. This has to do with the fact that archaeological individuals cannot be aged precisely and therefore are divided into age categories. If a person is assigned to an age category which overlaps the ones depicted here in the life table, then this would mean that the individual is divided proportionally over these age categories. In this manner it is possible that 'partial' individuals are assigned to an age category, giving us the incomplete individuals found in this column. At the bottom of the column one can also find the total number individuals found in the burial assemblage, which in this case are 1186 individuals.

The third category is the proportion of people dying, or mortality rate, *(d_x)* in the corresponding age category *(x)*. This number is found by taking the number in the column *(D_x)* and dividing it with the total number of individuals. For example: *(d_{10})* is found by dividing the value of *(D_{10})*, which is 81.89 with the total of the population 1186, giving us the value of 6.89.

The fourth category is the survivorship rate of the population. It may best be defined as the percentage of people from the original birth cohort still alive at the beginning of that age category. Because all members of the population are still alive at birth (in this case ignoring stillborns or death at birth of newborns) it can be assumed that 100% of the population is still alive at the beginning of the age category. This means that the value for *(l_0)* is 100.00 and for the following categories will slowly decline as a larger and larger part of the original birth population dies. The remaining values for this column can be calculated with the formula $(l_x) = (l_{(x-1)}) - (d_{(x-1)})$. In the final row of the column the number for *(l_x)* must be the same as the number in the last row of the column *(d_x)*. This is logical since the percentage of people dying in the final age category must be the same as the percentage of people who are still alive at the beginning of that age category.

The fifth category represents the probability of death (q_x) in that specific age category (x). This means that a person in the category (q_{10}) has a chance of o.o8, or 8%, of dying in that particular age category. The value for the probability of death can be found through the calculation $(q_x) = (d_x) / (l_x)$. With this in mind it is clear that the final category (q_{45+}) should be 1.00, since every person in this age category will die and therefore the entire age category has a 100% chance of dying.

The sixth category denotes the average years per person lived (L_x) in that age category (x). Any random person in the category (L_5) therefore lives an average of 4.4130 years, or around 4 years and 5 months. The values for this column can be calculated using the following equation: $(L_x) = 0.5 * [(l_x) + (l(_{x+1}))] * (x)$. This means that the average proportion of survivors at the beginning and end of each age interval (x) is multiplied by the length of that age interval (x). The values in this column are used to calculate the values of the seventh column. This seventh column is the cumulative number of average years a person still has to live (T_x) in that particular age interval (x). It is calculated by summing from the bottom up all values found in the column (L_x). The sum of the average years a person in the age category (T_{10}) still has to live is found by adding up the values for (T_{15}) and (L_{10}), thus giving 19.2791 + 4.0466 = 23.3257.

The eight and last category calculated for the life table is the average life expectancy in years a person still has (e_x) at the beginning of age category (x). The value is calculated by taking the sum of the average number of years a person still has to live and dividing it by the survivorship rate for the corresponding age category, described mathematically as: $(e_x) = (T_x) / (l_x)$. This means that a person (e_{10}) still has 27.65 years to live, which means that he might reach the age of 37.65, since the value for (e_{10}), 27.65 years, has to be added to the age that person already has, 10 years.

The values needed to calculate the life tables are dependent on each other and the way the life table is portrayed here is not the only way they can be found in literary sources. Since the values for (d_x), (l_x) and (q_x) are directly related to each other a life table can be calculated using any of these three, or the category of (D_x) which is used here, as a starting point.

3.2.3 Interpreting the life table

The many different categories which might be depicted in a life table can all lend themselves for interpretation. Only three categories however, are routinely used for this. These are the categories of the mortality rates (d_x), the survivorship rates (l_x) and the average life expectancy *(e_x)*. All three of these are best used when making a comparison to a model life table, since it is expected that the calculated life table conforms to a certain model. For this reason more explanation on the different model life tables and how to compare the calculated life table against the different model life tables which are available will be found in the section “Model life tables” further on in this thesis.

3.2.4 Biases and pitfalls

As with any theory and method there are certain biases that must be taken into account when looking at a skeletal collection. This is no different for paleodemography. It is also the case that some biases and pitfalls mentioned here might contradict or supplement the basic assumptions which have been mentioned earlier. Most of these problems can be subdivided into four main categories (Curet 2005; Milner *et al.* 2000; Paine & Harpending 1998).

Cultural or mortuary biases. In many societies certain people do not have the same rights as others and these cultural practices extend into mortuary practices. Most of these cultural practices are common in hierarchical societies and cause the underernumeration of sub-adults (Milner *et al.* 2008: 563; Parker Pearson 2008: 103; Saunders 2008: 118-119) and females (Hassan 1981: 96; Paine & Harpending 1998: 232).

Taphonomical processes. It has been recognized that taphonomical processes might cause a differential preservation of bones. This once again usually affects sub-adults, causing an underernumeration of infants, children and juveniles in the archaeological record (Chamberlain 2006: 89; Johnston & Zimmerman 1989; Stodder 2008: 83). This can mostly be attributed to the fact the bones of sub-adults have not yet fully calcified, which means they are more liable to be destroyed by taphonomical processes. The lessened likelihood of preservation may also be the case for older adults, since they have more brittle bones, which might be equally likely to be destroyed by taphonomical processes (Stodder 2008: 83).

Archaeological processes. A third factor, which is closely related to taphonomical processes mentioned above, has to do with the recovery of the bones by archaeologists. The problem here lies in the fact that the bones of the sub-adults and elderly, which (as mentioned before) are more brittle and thus are less likely to be recovered, will be overlooked by archaeologists, causing them to be underrepresented (Walker *et al.* 1988). The bones of small children are also less likely to be recognized in the field, as they may be overlooked or mistaken for animal bones (Chamberlain 2006: 89). Another problem in archaeological recovery lies in the fact that the majority of graveyards encountered are 'stumbled upon' rather than actually sought for by archaeologists (Curet 2005: 193)[4].

The very last problem arises during the analysis of the skeleton and perhaps is the most substantial problem of the four listed here. It pertains to the estimation of age of the individual. It has been found that older individuals (those over the age of 40) are generally categorized as younger individuals (Curet 2005: 194; Lovejoy *et al.* 1985). This misclassification leads to a bigger issue in the problem of age estimation, which is the problem of age mimicry. Age mimicry is defined here as 'the phenomenon of the age distribution of the target population being influenced by the age distribution of the reference population in such a way that the former seems to be mimicking the latter in age distribution'. This problem was first identified by Bocquet-Appel and Masset (1982) and has received much attention since (e.g. Boldsen *et al.* 2002; Konigsberg and Frankenberg 1992, 2002; Van Gerven & Armelagos 1983), because the main focus of paleodemography has always lain on the fact of how to estimate the age of an individual (Milner *et al.* 2008: 561).

For the most extensive explanation of the problem of age estimation and many of its solutions there is referred here to the edited volume by Hoppa and Vaupel (2002). Most of the methods which can be turned to in order to solve this problem rely on Bayes' Theorem[5]. Using this theory a specific age is not found, but a probability curve across all ages which indicated which age is the most probable for the sample at hand. To attain this probability curve the probability of an individual having a biological characteristic given they are a certain age must be calculated. One must then first know the prior probability of someone having that age. It can be imagined that if a certain known age distribution is chosen for the probability that this age distribution leaves its mark on the retrieved age. It has therefore been suggested that a uniform prior across all age categories can be used, a so-called 'uninformative prior' (Bocquet-Appel and Masset 1982; Konigsberg and Frankenberg 1992: 239). The problem here lies with the fact that most 'uninformative prior' models have an uneven distribution of individuals (Chamberlain 2006: 114) which causes the need to discard a part of this dataset (Konigsberg and Frankenberg 1992: 239). Another option which can be used here is standardized models taken from literary sources (e.g. Coale and Demeney 1966, 1983; Weiss

[4] This is certainly the case in the Caribbean, which is why it is emphasized here by Curet. Skeletal material is often recovered as an 'extra' with the excavation, rather than that the goal of the excavation is to retrieve a complete burial assemblage. See also Sandford *et al.* 2002: 210-211.

[5] $Pr(a|c)=Pr(c|a)*Pr(a)prior/\int[Pr(c|a)*Pr(a)prior]$. For an elaborate explanation see Chamberlain 2006: 112-114 and Hoppa and Vaupel 2002: 5.

1973) which can provide different models for different types of populations. Once again the problem here lies in the fact that a model would be used after which the target population would partly model itself. In order to truly achieve an independent age estimate one must be able to calculate a prior probability of age which does not reference to any other sample but to the one of which one are tries to estimate the age. This would seem impossible because one would like to know the age distribution of the target sample and yet at the same time this distribution must already be known to calculate it. The prior probability of age must therefore be replaced with a calculation which helps to estimate the desired age distribution.

This can be achieved through different methods, such as the Maximum Likelihood Estimation (Konigsberg and Frankenberg 1992), hazard models (Gage 1988), latent-trait approach (Holman *et al.* 2002), transition analysis (Boldsen *et al.* 2002) and contingency tables (Konigsberg & Frankenberg 2002). These methods listed here are not all of the possible methods which might be used, but do represent a wide range of the possibilities in the correction of age mimicry. All these methods (as might be expected) have their own advantages and disadvantages. One stands out from the rest however, which is the Maximum Likelihood Estimation (MLE). This method has been widely discussed and used in literature so that the plethora of different study examples allow for wide comparisons. The usage of these different techniques is heavily simplified by the advance of different computer programs which allow scripts to calculate the values for the entire age distribution[6]. What must be kept in mind however with these computer programs is that, although scripts are widely and freely available, these programs require training to use.

Although all these techniques are more effective than using just life tables they are not always easy to use, since for comparative purposes they are hard to attain. Doing these calculations is only possible if one possesses all the relevant information. This means if one wants to study the age distribution or recalculate distributions made by earlier research, one would need a full skeletal report in which all the scoring of traits, assigned ages and used ageing techniques are available. This is hardly available for most researchers as the reports written by researchers on skeletal assemblies usually (for brevities sake) only contain the most basic of information. The life table or age-at-death distribution as taken from the literature must therefore be taken for granted unless one wishes to attain the full report, something that most researchers most likely will not share.

[6] An example of a program which is used widely by paleodemographers is R (http://www.r-project.org/).

3.2.5 Mortality and fertility

Age-specific mortality rates are not identifiable from data derived from skeletons alone (Milner *et al.* 2008: 582). This can be attributed to the fact that mortality refers to the number of people dying as a percentage of the living population (Ascádi & Nemeskéri 1970: 24; Chamberlain 2006: 25). Through excavating a graveyard it can be established (with a reasonable amount of certainty) how large the population was that was buried at that site. One cannot establish however, how large the living population was at the site, which is a necessity if one wants to know the percentage of those who died as opposed to those who lived. The paleodemographic information from a graveyard site is therefore not enough to calculate the mortality rates and information gained through paleodemographic analysis must therefore be integrated with data from settlement archaeology (Milner *et al.* 2008: 582; Paine 1997: 12).

There are other means of calculating or approximating the mortality for a given population. It can be assumed that in a stationary population the mortality rates are stable and therefore can be calculated with the formula $1/e_0$ (Ascádi & Nemeskéri 1970: 25). The category in the life table of the probability of death (q_x) is somewhat similar to the mortality rates, although the former is calculated with the survivorship rates of the original birth cohort, rather then the latter, which is calculated through the mid-interval survivor to deceased ratio (Ascádi & Nemeskéri 1970: 26).

It can be said that the mortality rate of a population is hard to ascertain in this current investigation, because of the lack of data and the inaccuracy of the methods used in archaeological and paleodemographic research in the Caribbean (Curet 2005: 198). It has been noted however, that in all likelihood the mortality rates of horticulturalists and hunter-gatherers are very similar to the general human mortality curve and therefore one can speak of a general human mortality rate (Wood *et al.* 2002: 137).

Fertility is that which is referred to with respect to the actual number of children born per individual, whereas fecundity is the ability to produce these children. In a stable population the fertility rate will be the same as the mortality rate (Chamberlain 2006: 35). The possible reproductive span is limited by the onset of the capability of conceiving offspring and by menopause or death (for women this span is usually between 15 and 49 years of age [Chamberlain 2006: 35]). Other constricting factors are fetal death, the span between live births and length of the pregnancy (Hassan 1981: 126). In a stable population the fertility rate can be calculated with the formula $1/e_0$ (Chamberlain 2006: 35). When dealing with a non-stationary population however, different methods to derive the fertility rates for a population can be employed.

The three methods outlined here can all be calculated by the ratio of children against adults. The first method calculates the ratio of those over 30 years of age against those over 5 years of age, or D30+/D5+ (Buisktra *et al.* 1986). By excluding the individuals below 5 years of age the problem of the underernumeration of younger individuals is partly circumvented. Another method as suggested by Milner *et al.* (1989) is the usage of the ratio D45+/D5-. The problem herein lies that the two categories of individuals used are the ones most frequently affected by underernumeration and misclassification, making it less suitable for archaeological populations which are easily effected by these problems. The final method takes a ratio of D20+/D5+ (Konigsberg *et al.* 1989) which is more suitable than the D30+/D5+ ratio, since it takes in account all adults, circumventing the possible problem of adult misclassification (Curet 2005: 198). Another possible ratio which might be used is D5-14/D20+ (Bocquet-Appel & Masset 1982). This is not an effective method however, as it becomes increasingly erratic for sample sizes below a 100 individuals (Paine & Harpending 1996: 153), which in the case of the Caribbean is a common size for graveyard assemblages.

Mortality and fertility are two major components in any population. These two elements are often seen as pivotal markers for societal changes, such as the onset of agriculture, which is marked by an increased infant mortality rate and at the same time higher fertility rates (Hassan 1979: 148). It is also considered to be true that sedentary populations in general can sustain higher fertility rates (Chamberlain 2006: 64). It has been pointed out (Sattenspiel & Harpending 1983) that age-at-death distributions in a skeletal assembly are more affected by changes in fertility rates, than they are by equal changes in mortality rates. These rates, together with migration, form the basis for population growth and decline.

3.2.6 Population growth and decline

As mentioned earlier, it is assumed that populations under investigation were stable and stationary and therefore did not exhibit any growth or decline in population size (Curet 2005: 190). This of course is an idealised construction for the purpose of trying to establish certain values from skeletal data, since it can be argued that no population has stable fertility and mortality rates and no net migration over long periods of time (Chamberlain 2006: 26). In prehistoric times a struggle of sorts might have existed with both high mortality and fertility rates, where the amount of newborns was merely enough to replace those dying, causing a very slow population growth (Dumond 1975). It has been suggested (Harpending 1997: 93; Hassan 1981: 143) that in these prehistoric times there were long periods of very slow population growth, which were interrupted by sudden rapid growths, which might have been constrained by cultural practices. The *starburst* model holds a similar premise of slow long term population growth, albeit being of a different nature. With this theory it is postulated that there were explosive growth numbers in prehistoric populations, which after a while would be wiped out by a cultural or natural disaster, so that another population with a rapid population growth could take their place (Harpending 1997: 93). This would mean that one would find a population with a large growth rate, but non with a slow growth rate, since the population was wiped out before the low growth rate could fossilize in the archaeological record of the skeletal assembly (Harpending 1973: 93). This means that a form of crisis mortality causes low long-term growth rates, something that has been referred to as boom-and-burst models (Chamberlain 2006: 69). A long term very slow population growth might thus be expected, but with short term population booms.

Population growth or decline can be modelled mathematically through the usage of the formula $r = b - d\ (-/+\ m)$. This means that the annual growth rate can be modelled by taking the birth rates minus the death rates to the result of which the inward or outward migration is either added or subtracted respectively (Curet 2005: 196). The birth and death rates are referred to as intrinsic factors, while the rate of net migration is referred to as an extrinsic factor (Chamberlain 2006: 19-20). Growth rates can either be exponential or logistic in nature. Exponential growth however, would imply that there is no ultimate limit to the population size. This is highly unlikely due to the limited carrying capacity of a catchment area around a site (Chamberlain 2006: 21-22; Curet 2005: 155). A population thus has a ceiling, or maximum population, above which it cannot sustain itself. Growth of such a population is then best modelled by using a logistic expression, which resembles an S-curve (Chamberlain 2006: 22). Since one would still need to attain certain numbers which are unattainable by paleodemography to use a logistic growth pattern, it is necessary to use a formula which can be easily modelled over time. This is done by taking a natural logarithmic formula, which allows us to model population growth between two known estimates at two points in time. This can be done with the formula $r = [\ln (N_t / N_0)\ ] / t$ (Curet 2005: 196; Vradenburg *et al.* 1997: 153). Here the growth r can be modelled between a starting population number N_0 and another population number N_t after the elapsed time t.

There are also other ways to calculate population growth. This can be done by taking information from model life tables and data from the life tables under investigation. If for example one knows the fertility (or juvenility) index of a population and the life expectancy at birth (e_0) the population growth can be modelled as well (after Chamberlain 2006: Figure 4.2). This however, requires the use of model life tables.

3.2.7 Model life tables

As pointed out earlier, when researching demographic variations from archaeological populations it can be hard to retrieve all values necessary to say something meaningful about a population. Even if able to do so, those numbers in themselves do not tell much. In order to be able to use paleodemographic data to its fullest model life tables must be used. These model life tables can be used to fill in the blanks in our dataset and serve as a comparative backbone for comparing different sites to each other.

There are many different model life tables available (e.g. Coale & Demeney 1966, 1983; United Nations 1983; Weiss 1973). Here there will be adhered to the most widely used of these model life tables which are the ones compiled by the Office of Population Research at Princeton University (Coale & Demeney 1983). These life tables are based on European census reports and (according to the authors) can be divided into four different categories, according to where these populations are most likely encountered in Europe. These categories are "North", "East", "South" and "West". The "West" model life table can best be used for non-industrial underdeveloped countries (Coale & Demeney 1983: 25). If one were to extrapolate these numbers they can also be applied to historical and prehistoric populations (Chamberlain 2006: 32), which is how they are used here. The regional model life tables are divided into different levels, each of which is categorized by the average life expectancy at birth, starting at level 1 (e_0 = 20) and leading up to level 25 (e_0 = 80). These numbers are based on females in that category, since the values for the regional model life table are calculated separately for males and females. Furthermore the age categories used for these regional model life tables are separated into 5-year age intervals and lead from 0 years to 100 years. Because one wants to use these life tables in a paleodemographical setting, the male and female life tables must be combined, the age intervals adjusted and the life table must be ended at 70 years of age. This procedure is performed for the West level 5 model life table (e_0 = 30) as this is the most common level used in paleodemography.

The regional model life table explained above is referred to as an attritional population. This means that this population had a 'regular' mortality pattern, which is associated with a stable prehistoric population, not suffering from any irregular events. The mortality curve of such a population will usually be u-shaped. This can be explained by the high mortality rates for sub-adults, a lower mortality rate for adolescents and young adults and slowly rising mortality rates for older and senescent individuals. There are however, a series of events which could alter this life table.

3.2.8 Catastrophic life tables

A catastrophic mortality profile can be defined as a short-term event, which affects a population with limited (or no) regard for age and sex differences (Paine 2000: 182). These mortality rates can be natural (natural disasters, epidemics etc.) or man-made (warfare, raiding etc.) in origin. The mortality profile found in a catastrophic population will closely resemble the living population at risk (Chamberlain 2006: 7). This means that the values for such a catastrophic population can be constructed from data in the Regional Model Life Tables (Coale & Demeney 1983). Instead of taking the number of deaths however, the standard formulas used in constructing a life table are applied to the living population. The result of which is a sloping profile with high numbers of sub-adults, lower numbers of adults and very low numbers for the elderly, thus mimicking a living population.

There are several variations possible in a catastrophic mortality profile. It has been shown (Chamberlain 2006: 69-74) that natural disasters such as floods and earthquakes cause different mortality profiles then catastrophic mortality profiles resulting from famine. This can be attributed to such elements as protectionism; mothers protecting their children during natural disasters, causing a slightly lower death rate amongst sub-adults than might be expected and agility, since young men are able to leave crumbling buildings faster in the event of an earthquake than others. Needless to say, other contextual information from a graveyard will most likely indicate catastrophic events (destroyed house structures etc.).

Another possible catastrophic mortality profile which might be different from a standard catastrophic mortality profile is one resulting from conflict (Chamberlain 2006: 77-80). Here it is likely that the number of young males retrieved is higher than one would expect in a catastrophic mortality profile. This can of course be attributed to the fact that the warfaring troops usually consists of young adult men. Civilian deaths however, are also not unlikely and can therefore be found in such a profile. Here the distinction can be made that the persons who fell victim to conflict most likely have pathological trauma on skeletal elements, which can help in distinguishing this particular profile.

These deviations from the expected pattern are only mildly visible and can only truly be distinguished in large graveyard populations, where such a distinction can easily be made. When such large graveyard populations are not available it is necessary to retrieve as much information possible from contextual sources, so that an easy distinction might be made. The catastrophic mortality profile can be easily distinguished however, from the attritional mortality profile and the migration profile, the latter of which will be discussed below.

3.2.9 Migration life tables

Migration was a poorly understood and researched subject in archaeology (Anthony 1990: 895; Burmeister 2000: 539)[7]. The same holds true for paleodemography, as it derives its data from archaeological sources. To complicate matters there are different forms of migration which all have different causes and effects and potentially can be difficult to identify in paleodemography. The main line of difference can be found in the vital demographics of a population. When migration takes place both a donor and recipient population can be distinguished (Chamberlain 2006: 38). Since these populations have the potential of being different in population structure and mortality and fertility rates it is highly likely that a migration between them could have significant influence on the population structure of both the donor and recipient population (Chamberlain 2006: 38). There are different forms of migration, both long range and short range. Also there is the possibility of seasonal migration, itinerant workers and a special form of migration; colonisation. Colonisation is a migratory move from a donor population into an unoccupied region, at which point this new population at times is referred to as the founding population. Since there is no recipient population, the donor population's growth rates and possible diffusion into the new territory must be taken into account (Chamberlain 2006: 40-41). Mortality and migration can be hard to distinguish as they both are irreversible and have long-term effects, although its effects on fertility are unclear (Dumond 1997: 185).

It is generally theorised that the population who takes part in a migratory move consists of younger males in the ages between 20 and 30 (Burmeister 2000: 543) or around the age of marriage and new household formation (Paine 1997: 195), although the two of these usually overlap. The effects on a recipient population of such an influx of young men can have different effects. Paine (1997) theorizes that such a migrant population will not be retrievable through a graveyard population in the demographic groups that usually migrate.

[7] Although recent advances in such fields of study as stable isotope analysis have considerably helped in the development of a more sound research into migration (Katzenberg 2008: 430-431; Laffoon & de Vos 2011)

Rather he suggests that the immigration of many young men would increase fertility rates in the donor population and thus create a disproportionate amount of infants in the recipient population. The problem herein lies that this is unlikely, since then the migratory population would have to consist of not only young men, but also young women. With only men migrating this does not allow for the opportunity for more children as the recipient population's women in the same age class do not suddenly raise their possible fertility or fecundity. If the donor population therefore takes with them their own women, then there is a heightened chance of infants to be recovered in the graveyard assemblage. If there however, are no females accompanying the males, then there most likely will only be a heightened amount of young males to be found in the graveyard assemblage.

Another interesting form of migration which might be listed here is post-mortem migration. There is a distinct possibility that deceased individuals could've been moved from the community where they lived to the community where they were buried (Hofman, personal communication 2012; Keegan 2009). The only way this has a possibility of being traced is through secondary burials (Duday 2011: 89). It might be expected therefore, that the individuals interred in a secondary burial could have been moved after death and therefore also could have been moved from one community to another. These secondary burials could also have been caused by individuals being moved within the same community, or for some reason or another being reburied in the same community. Research into these forms of mobility can be performed through isotope analysis. Since the scope of this research is limited however, the notion will be entertained but due to several constraints this will not be researched further in depth

3.2.10 The Warao model life table

So far a series of model life tables has been established which might be beneficial to the paleodemographical research in the Caribbean. In order to further strengthen the case of Caribbean paleodemography a possible new attritional and catastrophic model life table based on ethnographic sources will be presented here.

Analogies between the mainland of South America and the Caribbean are not uncommon (e.g. Siegel 2010) and small-scale horticulturalists from the Tropical Lowlands (especially the Orinoco and Amazon streamland) serve as a common reference for both the origin region of Caribbean culture and as a living reference for the extinct Caribbean populations. For this purpose a model life table was constructed based on a society currently inhabiting this region of analogies. Data was derived from a publication on Warao demography (Layrisse, Salas & Heinen 1980: 66), which was then adjusted so that it could serve as a comparative life table for our purposes here. Since the data was collected over a period of 5 generations (Layrisse, Salas & Heinen 1980: 60), this means it can serve as an analogy to a graveyard assemblage, which is made through generations over a long period of time rather than representing one moment in time. A K-S two-sample test was performed on the West Level 5 model life tables and Warao model life tables to determine if they were significantly different. Since the outcome showed that ($P \geq 0.01$)[8] this then means that the life tables are significantly different. Although this does not mean that the tables could be used interchangeably, there will be adhered to the Warao life tables here, since these are grounded more solidly in ethnography and can therefore be used more easily in this case of Caribbean paleodemography. The life tables for the Warao attritional and Warao catastrophic life tables can be found below in Tables 2 and 3.

x	**Dx**	**dx**	**lx**	**qx**	**Lx**	**Tx**	**ex**
0-4	126,00	0,468	1,000	0,468	3,829	18,181	18,181
5-9	25,00	0,093	0,532	0,175	2,426	14,352	26,998
10-14	15,00	0,056	0,439	0,127	2,054	11,927	27,189
15-17	5,50	0,020	0,383	0,053	1,118	9,873	25,784
18-25	17,50	0,065	0,362	0,179	2,309	8,755	24,154
26-35	21,00	0,078	0,297	0,263	2,584	6,445	21,672
36-45	16,50	0,061	0,219	0,280	1,887	3,862	17,606
46+	42,50	0,158	0,158	1,000	1,975	1,975	12,500
Total:	269,00						

Table 2: Warao attritional life table.

x	**Dx**	**dx**	**lx**	**qx**	**Lx**	**Tx**	**ex**
0-4	264,00	0,194	1,000	0,194	4,515	20,402	20,402
5-9	245,00	0,180	0,806	0,224	3,579	15,888	19,714
10-14	173,00	0,127	0,626	0,203	2,811	12,308	19,670
15-17	72,00	0,053	0,499	0,106	1,416	9,498	19,052
18-25	173,50	0,128	0,446	0,286	2,673	8,082	18,137
26-35	173,00	0,127	0,318	0,400	2,544	5,409	17,009
36-45	111,00	0,082	0,191	0,428	1,500	2,865	15,014
46+	148,50	0,109	0,109	1,000	1,365	1,365	12,500
Total:	1360,00						

Table 3: Warao catastrophic life table.

[8] For the attritional life table the observed D is 0.130 and the critical D 1% value is 0.099. For the catastrophic life table the observed D is 0.185 and the critical D 1% value is 0.125.

The main difference between these Warao life tables and the West level 5 life tables lies in how they are attained. The Warao life tables are derived from ethnographic data describing population groups of the same small group of people living in a small area over a short period of time. The West level 5 life tables are derived from historic and archival sources in Western Europe which are averaged over a large geographical area and over a large period of time. The Warao life tables are therefore more culturally specific than are the West level 5 tables and are more suitable to serve as a comparative population since they are based on smaller groups of people, as is the case in the Caribbean.

3.3 METHODS

3.3.1 The sites

In order to properly try and reconstruct the plethora of different paleodemographic profiles which existed in the Caribbean in pre-Columbian and early Colonial times it is necessary that a proper sample of sites is selected for analysis. The sites in this sample must confirm to certain guidelines in order to serve in a paleodemographic framework which will be established here. Firstly the site must be from the pre-Columbian or early Colonial time period. The Archaic age was disregarded for the reason that the communities living in the Caribbean during this time period were most likely mobile hunter-gatherers, a group which is distinctly different from the horticulturalists and agriculturalists investigated here. Secondly the site had to have a graveyard population. Thirdly this graveyard assembly has to consist of a minimal number of individuals. A problem associated with this is that when considering very small numbers of individuals it is very likely that statistics become almost impossible to perform, since due to the small number of individuals, numbers and calculations start to fluctuate wildly. An exception to this guideline is made when it can be assumed *a priori* that the site was special in one way or another. In this investigation, this is only the case with the site of Kelbey's Ridge on Saba, which is assumed to be a colonizing population (Hofman, personal communication 2012). Fourthly the site must have a skeletal report available, in which persons are aged, sexed assessed for pathology, completeness and preservation. Only when this is done is it possible to fully analyze the site from these documentary sources. All the sites to which these criteria are applicable can be found in Table 4.

Site	Dating	MNI	Source
El Chorro de Maita, Cuba	AD 1400-1600	133	Weston, personal communication
El Atajadizo, Dominican Republic	Ostionoid & Chicoid phases	51	Luna Calderon 1976
El Soco, Dominican Republic	Ostionoid & Chicoid phases	98	Coppa *et al.* 1995
Juan Dolio, Dominican Republic	AD 1400-1600	102	Coppa *et al.* 1995
Punta Macao, Domincan Republic	AD 800-1500	40-50	Tavarez Maria & Luna Calderon 2007
Anse a la Gourde, Guadaloupe	AD 400-1400	+/- 100	Weston/Hoogland personal Communication
Maisabel, Puerto Rico	Hacienda Grande-Ostionoid	34	Weston, personal communication
Punta Candalero, Puerto Rico	AD 400-600	85	Crespo Torres 2000/ Pestle 2010
Paso del Indio, Puerto Rico	Elenan Ostionoid	152	Crespo Torres 2000/ Pestle 2010
Tibes, Puerto Rico	Ceramic, no age on burials	126	Crespo Torres 2010/ Pestle 2010
Kelbey's Ridge, Saba	AD 1350-1450	11	Hoogland & Hofman 1999
Anse Lavoutte, St. Lucia	AD 400-1400	+/- 50	Weston, personal communication
Pointe de Caille, St. Lucia	AD 300-1000	58	Fabrizii-Reuer and Reuer 2005
Tutu, St. Thomas	AD 450-1535	42	Righter 2002

Table 4: List of researched sites. Sites are ordered according to alphabetical order of country and name of the site. Also listed are dating, Minimum Number of Individuals (MNI) and source of the data.

As can be seen from Table 4, there are many different researchers who worked on many different sites. In order to create a comparative dataset the data must be standardized in one single coherent manner. To do this a methodology will be followed that was used in the research of two of the above sites[9].

Populations will be assessed as a whole on their completeness and preservation and the balance of males and females will be assessed as well. After that the individuals will be categorized in a Bradford ageing system. A system with broad categories is preferred, since using a technique with wide age categories instead of exact ages allows for less misclassification (Bocquet-Appel & Masset 1982: 324). The Bradford ageing system consists of the following classes: Infants (0-4 years), Children (5-9 years), Juveniles (10-14 years), Adolescents (15-17 years), Young adults (18-25 years), Young middle adults (26-35 years), Old middle adults (36-45) and Mature adults (46+ years). Skeletons which were adult but could not be assigned to a specific age category were classified as 18+. This last group is

[9] In 2010 the author assisted in the osteological analysis of the sites of Anse Lavoutte and El Chorro de Maita, under the supervision of Dr. Darlene Weston and for familarities sake the techniques used in that investigation will be used here as well.

slightly problematic as they cannot be assigned to a specific age category. In order to amend for this problem one can choose to either distribute those individuals proportionally over the adult age classes or to distribute them evenly over all adult age classes. It is chosen here to distribute the individuals evenly over all adult age classes, since distributing them proportionally would in a sense exaggerate them. The model life tables used for attritional, catastrophic and migration populations will also be adapted to fit the Bradford ageing system. By using this one single framework one can properly analyze and compare the many different sites in this research.

In order to properly analyze each assemblage other calculations must also be adjusted. The juvenility index must be amended so that they will be calculated by using a D5-17/D18+ ratio and comparing across the sites with a χ^2-test[10]. The same test will be used to calculate the relation between the number of males and females in the population.

3.3.2 Periodisation of sites

As mentioned earlier, some of the sites used here can be subdivided in different periods as to when the graveyard population was deposited. This means that instead of dealing with one single population, the site consists of many sequential deposits. By splitting up these sites into different time periods elements of population growth, changing functions for sites and differentiating populations in one site through time can be investigated. In order to properly apply this periodisation to a site it is necessary to have a dating sequence available for this site. A proper dating sequence should consist of C14 dating performed on skeletal elements of the graveyard. These C14 dates are available for the following sites: Anse a la Gourde, Kelbey's Ridge, Anse Lavoutte (Hoogland, personal communication 2012), Punto Candelero, Paso del Indio and Tibes (Pestle 2010: Appendix D). When it is made clear through C14 dating that different periods of deposition were present for these sites life tables will be constructed for each different distinguishable period. These life tables will each be analyzed separately so that the different periods can be explained to the fullest extend.

3.3.3 Analysis of the life tables

After the sites have been fitted to the standardized framework, periodisized where possible and their life tables have been calculated, they can be properly analysed. This will be done by comparing each to two standard models for the region. The first being the Warao attritional

[10] The Chi-square test is used to determine if there is a significant association between two variables in a contingency table (Fletcher & Lock 2005: 129).

profile and the second being the Warao catastrophic profile. By performing a K-S two sample test[11] between the site in question and either of these two profiles it can be determined whether or not they are comparable. When the site in question is comparable to any of the two standard profiles it can be determined to which it matches best.

When all sites have been matched to a standard they can be matched with each other. In this manner it can be determined what sites are similar paleodemographically speaking and what sites are not. By then looking at either matching or distinguishing characteristics from each site it can be determined what might have caused these patterns. Elements which will be taken into consideration during this process are such matters as geomorphology, time period, geographical setting, type of site, size of site, differentiating burial practices and archaeological recovery techniques used. By looking at all of these elements it can be attempted to explain how exactly these patterns came to be.

Each site will, in this manner, be treated like a case study. By understanding exactly what causes the demographic profiles encountered, these profiles can be used to explain social processes happening in that community. In essence one can move from the hard data of the paleodemographic profiles back to the communities themselves to, in this manner, better understand these communities.

3.3.4 Concluding remarks

The theory of paleodemography and the methodology of how the data will be retrieved from sites have been outlined in this chapter. The many basic assumptions, calculations, pitfalls and solutions which are central to paleodemography have been explained so that the methodology used here can be properly understood. By doing so it is hoped that the methodology outlined here can be used in future research into paleodemography in this region. Furthermore this methodology serves as the basis on which the analysis of the sites will be performed in this study.

[11] This Kolmogoroff-Smirnoff two sample test is used to determine whether or not two assemblages are in fact comparable to each other (Fletcher & Lock 2005: 111)

4. Sites

4.1 Introduction

The Caribbean region stretches in a rough arc from the Orinoco Delta in Venezuela to the Yucatan Peninsula of Mexico. Situated between 10°0'N latitude and 25°0'N latitude on the edge of the Caribbean and Atlantic tectonic plates, some of these islands consist geologically out of volcanic sediments and others out of limestone[12] representing climates ranging from Tropical to Subtropical. The islands vary widely in size, with the Greater Antilles (Cuba, Jamaica, Hispaniola and Puerto Rico) totaling 194,000 km² in size and the Lesser Antilles (those islands stretching the Eastern border of the Caribbean region from Puerto Rico to Venezuela) compromise a total of 12,000 km². The earliest movement of people into this chain of islands happened at around 4,000 BC. Since then many waves of people and their cultures have moved into this region, most well known of them being the arrival of Columbus in AD 1492, an encounter which triggered a series of events leading to the eventual extinction of most of the original inhabitants and their culture. It is these Amerindians, their people and their settlements which are the subject of the current investigation.

In the previous chapter a list was provided introducing all the sites which will be investigated for this research. In this chapter a more detailed overview will be provided in which each site will be reviewed. A history of the investigations at the site will be provided as will the major conclusions that were drawn by previous researches. Where possible[13], information on elements important to this research will be highlighted.

Sites will be presented in alphabetical order by country and site name respectively. For each site an overview will be provided of some preliminary osteoarchaeological observations and the general characteristics of the graveyard population. This includes completeness and preservation of the skeletons, methods used in the physical anthropological analysis and division of the sexes. Any abnormalities or inconsistencies with expected patterns will be

[12] The notable exception being the island of Antigua, which consists of both and Guadeloupe which in fact is two islands (one volcanic and the other limestone) connected to each other.

[13] It is conceivable that not all previous researches focused on matters that are important to this research. If important information is not available from literary or personal sources, then it will be noted as such in the main body of this text.

commented on in this section as well. The presentation and comparison of life tables and demographic profiles will be presented on in the next chapter.

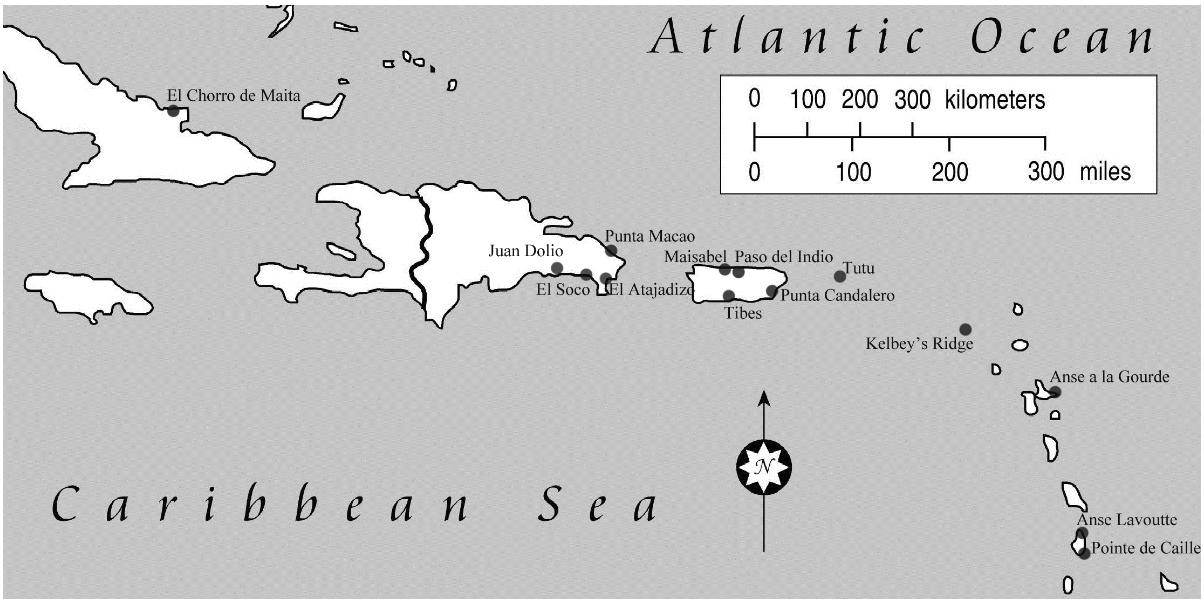


Figure 1: Map of the Caribbean depicting sites mentioned in the text.

4.2 CUBA: EL CHORRO DE MAITA

El Chorro de Maita is located 4 km from the coast in the present day province of Holguin (Valcárcel Rojas *et al.* 2011: 226) in north-western Cuba. The site was surveyed by Rouse (1942) and belongs to the agricultural phase (Guarch Delmonte 1990). The graveyard was excavated in 1986 and 1987 by the Departamento de Arqueologia in Holguin (Guarch Delmonte 1996; Valcárcel Rojas & Rodriguez Arce 2003: 508). A full physical anthropological assessment of the graveyard population was performed at the Departemento de Arquelogia in Holguin in 2010 by a team from Leiden University, The Netherlands, under the supervision of Dr. Darlene Weston (Weston, in prep). Radiocarbon dating has placed the date of usage of the graveyard between Cal AD 1020 and Cal AD 1670 (Valcarel Rojas 2002: 142). This rather wide dating indicates that the site was most likely occupied during the contact period. It is this contact element that is of particular interest here, as it has been shown that there were European burials present at the site (Valcarel Rojas *et al.* 2011). Keeping this in mind, it could be expected that the site contains a migrational population, a catastrophic mortality profile (due to the introduction of European diseases to the native population in the Caribbean), a conflict mortality profile or a combination of these elements.

The most recent research by Valcarel Rojas *et al.* (2011) points in the direction of a probable catastrophic mortality caused by an epidemic during the Contact Period, which is made evident by the mortality profile showing a high number of infant deaths which remains steady through adulthood (Valcarel Rojas *et al.* 2011: 231-232). It has also been shown through isotopic research that there were a number of non-local individuals present at the site (Valcarel Rojas *et al.* 2011: 238-241), which could be indicative for a form of migration at the site.

4.3 DOMINCAN REPUBLIC: EL ATAJADIZO

The site of El Atajadizo is located on the south-eastern coast of the Domincan Republic, approximately 3 km from the sea (Luna Calderon 1976: 295; Veloz Maggiolo *et al.* 1976: 283). A team from the Museo del Hombre Domincano excavated the site in 1975, unearthing a settlement and graveyard, which were associated with Ostionoid and Chicoid pottery dating to about 700-800 BP (Rothschild *et al.* 2000: 936). A total of 51 individuals were recovered from the graveyard and analyzed by Fernando Luna Calderon from the Museo del Honbre Dominicano, who states that 6 out of 51 burials were secondary in nature (Luna Calderon 1976: 295) and that 4 out of 51 skeletons show signs of violent trauma (Luna Calderon 1976. 298-299). Two individuals also showed signs of serious infection (Luna Calderon 1976. 296, 298), something that was confirmed in a later investigation (Rothshild *et al.* 2000: 937).

4.4 DOMINCAN REPUBLIC: EL SOCO

The site of El Soco consists of a graveyard which can be split into two categories (Phase 1 and Phase 2) numbering a total of 158 individuals (Coppa *et al.* 1995: 154) dating to approximately AD 800 (Rothschild *et al.* 2000: 936). These individuals were classified by age according to Nemeskéri *et al.* (1960) for the post-cranium and Lovejoy (1985) for dental attrition. Sex was assigned according to Ascádi & Nemeskéri (1970). For the site of El Soco an abridged life table was constructed by Coppa *et al.* (1995). This life table is a comingling of the two phases described earlier and shows a distinct pattern with an underenumeration of children (Coppa *et al.* 1995: 154-155; Figure 2). Individuals from El Soco were also investigated for treponemal disease showing that 8 individuals out of the sample of 106 individuals were infected (Rothschild *et al*. 2000: 937).

Age group x		Dx	dx	lx	qx	Lx	Tx	ex
0	0	7.50	4.75	100.00	47.47	97.63	2703.50	27.04
1	2	11.0	6.96	95.25	73.09	182.91	2605.87	27.36
3	4	5.23	3.31	88.29	37.52	172.39	2422.96	27.44
5	6	2.70	1.71	84.98	20.11	168.48	2250.57	26.48
7	9	3.37	2.13	83.27	25.59	246.11	2082.09	25.00
10	12	1.20	0.76	81.14	9.36	242.15	1835.97	22.63
13	15	3.57	2.26	80.38	28.09	238.78	1593.82	19.83
16	19	11.53	7.30	78.12	93.45	298.47	1355.04	17.35
20	24	19.26	12.19	70.82	172.14	319.57	1056.57	14.92
25	29	17.05	10.79	58.63	184.10	266.39	737.00	12.57
30	34	23.09	14.62	47.84	305.60	201.39	470.61	9.84
35	39	20.41	12.92	33.22	388.88	131.87	269.22	8.11
40	44	14.49	9.17	20.30	451.63	76.41	137.36	6.77
45	49	9.24	5.84	11.13	524.88	39.81	60.95	5.47
50	+	8.36	5.29	5.29	1000.00	21.13	21.13	4.00
Totale		158.00	100.00			2703.50		

Figure 2: Abridged life table for the El Soco population (after Coppa *et al.* 1995: Table 2)

4.5 DOMINCAN REPUBLIC: JUAN DOLIO

The site of Juan Dolio is located in the south-eastern Dominican Republic and can be dated to approximately AD 1400 (Rothschild *et al.* 2000: 936). A total of 108 individuals were recovered from the site and aged according to Nemeskéri *et al.* (1960) for the post-cranium and Lovejoy (1985) for dental attrition. Sex was assigned according to Ascádi & Nemeskéri (1970). An abridged life table was constructed for the Juan Dolio population, showing a large underenumeration of neonates and infants (Coppa *et al.* 1995: 154-155; Figure 3). From the Juan Dolio population 67 individuals were investigated for treponemal disease, indicating that 3 individuals suffered from the disease (Rothschild *et al.* 2000: 937).

Age group x		Dx	dx	lx	qx	Lx	Tx	ex
1	2	2.83	2.62	100.00	26.23	197.61	2627.92	26.28
3	4	3.95	3.66	97.38	37.56	191.23	2430.31	24.96
5	6	4.02	3.72	93.72	39.68	183.62	2239.08	23.89
7	9	4.17	3.86	90.00	42.87	264.52	2055.46	22.84
10	12	3.72	3.44	86.14	39.95	252.66	1790.94	20.79
13	15	4.07	3.77	82.70	45.53	243.04	1538.28	18.60
16	19	10.41	9.64	78.94	122.08	296.05	1295.24	16.41
20	24	17.22	15.94	69.30	230.06	303.62	999.19	14.42
25	29	15.48	14.34	53.36	268.67	231.29	695.57	13.04
30	34	12.04	11.15	39.02	285.82	165.08	464.27	11.90
35	39	8.65	8.01	27.87	287.52	118.27	299.19	10.74
40	44	7.04	6.52	19.86	328.41	81.50	180.92	9.11
45	49	5.61	5.20	13.33	389.71	53.78	99.41	7.46
50	+	8.79	8.14	8.14	1000.00	45.63	45.63	5.61
Totale		108.00	100.00			2627.92		

Figure 3: Abridged life table for the Juan Dolio population (after Coppa *et al.* 1995: Table 1)

4.6 DOMINCAN REPUBLIC: PUNTO MACAO

The site of Punto Macao is located in the far eastern tip of the Domincan Republic in the county of Salváleon de Higuey and was excavated in 2004 (Tavarez Maria & Luna Calderon 2007: 692). The field methodology used was rigorous and strict (Tavarez Maria & Luna Calderon 2007: 693) and it can therefore be assumed that biases caused by fieldwork methodology can be excluded.

4.7 GUADELOUPE: ANSE À LA GOURDE

The site of Anse à la Gourde was excavated in a joint effort by a team from Leiden University, The Netherlands under the supervision of Corinne Hofman and Menno Hoogland and DRAC (Direction Régionale des Affaires Culturelles), Guadeloupe, FWI under the supervision of André Delpuech from 1995 to 2000. The site is located on the limestone formed Grande-Terre on the north-eastern tip of the island (Bright 2003: 8). The site yielded approximately a 100 individuals (Weston/Hoogland, personal communication 2011), who can be arranged over at least three periods of deposition at the site, ranging from 450 Cal AD to 800 Cal AD and 1000 Cal AD to 1350 Cal AD.

4.8 PUERTO RICO: MAISABEL

The site of Maisabel is located on the northern coast of Puerto Rico, roughly 30 km west of San Juan, where it was excavated by the Centro de Investigaciones Indigenas de Puerto Rico under the supervision of Peter Siegel. Ceramic association has determined that the site was occupied almost continuously from 200 BC to AD 1200 (Siegel 2005: 89). A C14-dating procedure combined with cultural diagnostics for associated artefacts among 22 of the individuals recovered from the site (Siegel 1996: Table 1) determined that 3 individuals originated from the Hacienda Grande period (100 BC – AD 400), 8 from the Cuevas period (AD 400 – AD 600), 4 from the Saladoid to Ostionoid transition phase, 4 from the Montseratte period (AD 600 – AD 900) and 9 from the Santa Elena period (AD 900 – AD 1200). There is no apparent grouping according to time periods in these burials and it is estimated furthermore (based on the overall size of the site and the number of individuals recovered per square meter from the excavated are) that there may be as many as 2500 individuals present in total (Siegel 1996: 323). As so far however, only 34 individuals have been recovered (Budinoff 1987; Weston, personal communication 2011). The 28 adults from this sample were divided evenly among the sexes, whilst the remaining 6 individuals were all classified as sub-adults. Two of the males also suffered from trauma, one had a stingray spine in his chest and the other had his right upper arm severed (Budinoff 1986).

4.9 PUERTO RICO: PUNTA CANDALERO

The site of Punta Candelero is the first of three sites in Puerto Rico (the others being Paso del Indio and Tibes) which was researched by L. Antonio Curet (2005). Osteological analyses of the skeletons retrieved from these sites were all performed by the same researcher (Crespo Torres 1994, 1998, 2000) allowing for a proper comparison between the three sites.[14]

The site is located in the east of Puerto Rico approximately 300 meters from the sea. Although the sites contains elements from both the La Hueca and Cuevas style-periods, the burials encountered here are all attributed to the Cuevas period (AD 400 – 600 [Rodriguez 1991; Curet 2005: 199-200]). This chronology is corroborated by the C14-dates which were based on the bones of the skeletons themselves, giving an approximate age between 483 Cal AD and 1097 Cal AD (Pestle 2010). Instead it was argued that the skewed population

[14] The majority of information about the sites, the osteological and paleodemographical analyses will be inferred by information from these sources.

demographics were indeed the correct ones for Punta Candelero and reflected the once living population, which was of a colonizing nature (Curet 2005: 201-202).

4.10 PUERTO RICO: PASO DEL INDIO

The Paso del Indio site is located in the north-central part of Puerto Rico approximately 6,6 km from the coastline and was occupied from Archaic (2850 BC) to Chican-Ostionoid times (AD 900 – AD 1500) based on stylistic data (Curet 2005: 208-209; Walker 2005: 55) and confirmed by C14-dating performed on the bones of the individuals in the graveyard (Pestle 2010). The site was excavated in the early 1990's as part of a rescue effort (Walker 2005: 56-57), yielding a total of 138 individuals which could all be assigned to a single population coming from the Elenan-Ostionoid component of the site (Walker 2005: 69).

In the original paleodemographical analysis it was concluded that Paso del Indio was a regular site with an underenumeration of older adults resulting from a methodological bias and a moderate fertility rate which could also be attributed to the underenumeration of older adults (Curet 2005: 210-212).

4.11 PUERTO RICO: TIBES

This site is located on the south-central part of Puerto Rico, approximately 10 km from the south coast (Curet 2005: 203; Siegel 1996: 326) and was occupied from Saladoid to Elenan Ostionoid times (Curet 2005: 203). During the sites occupation there were two distinct clusters of graveyard deposits; one underneath the plazas of the site in Saladoid times and the other in refuse middens surrounding those same plazas (Curet & Oliver 1998: 225). C14-dating performed on skeletal elements from those graveyards show dates ranging from 497 Cal AD to 1027 Cal AD (Pestle 2010). Although a total of 126 individuals were present, only 95 of those have been taken into consideration when analyzing the site, since these individuals could be indentified as the ones coming from the same Saladoid population underneath the main plaza.

In the original paleodemographic analysis it was concluded that this sample most likely was not representative of the original population, as there is a substantial underenumeration of Sub-Adults and Elderly, as well as a proportional larger amount of females than males. All of this could most likely be attributed to the poor status of preservation of the individuals (Curet 2005: 208)

4.12 SABA: KELBEY'S RIDGE

Kelbey's Ridge is located 300 meters from the sea on a small ridge on the north-eastern side of the island of Saba in the northern Lesser Antilles (Hoogland & Hofman 1993: 163; Hoogland & Hofman 1999: 100). The site has been identified as an extension of the Greater Antillean Tainan culture into the Lesser Antilles (Hoogland & Hofman 1993: 177; Hoogland & Hofman 1999: 107). The site was surveyed in 1988 by a team from Leiden University, The Netherlands, under the supervision of Dr. Corinne Hofman and Dr. Menno Hoogland (Hoogland & Hofman 1993: 163). Dating performed with an AMS procedure on the bones of individuals located at the site yielded dates ranging between AD 1100 and AD 1550 (Hoogland & Hofman 1993: 168).

The site has originally been interpreted as a settling (Hoogland & Hofman 1999: 1105-107) or refugee (Hoogland & Hofman 1993: 177-178) population, or an outpost for (seasonal) exploitation of the fishing grounds on the Saba Bank (Hofman & Hoogland 2011: 29-30).

4.13 ST. LUCIA: ANSE LAVOUTTE

The Anse Lavoutte site is located on the northern part of St. Lucia and was first excavated in 1968 by Ripley and Adelaide Bullen of the University of Florida, who found many small figurines and ceramics dating to what they called the Suazey period (AD 800 - AD 1500 [Bullen & Bullen 1969]). In the mid-1980's Dr. Hedwig Friesinger excavated three burials at the site (Fabrizii-Reuer & Reuer 2005). Most recently the site has been excavated by a team from Leiden University in The Netherlands, under the direction of Prof. Dr. Corinne Hofman and Dr. Menno Hoogland (Hofman & Hoogland 2009). Ceramic dating from the site resulted in mostly Suazan Troumassoid with some early Saladoid and Troumassan Troumassoid dating the site from around AD 1000 onward (Hofman & Hoogland 2009: 9), which was corroborated by C14 dates taken from human bones at the site (Hoogland, personal communication 2010).

In the original paleodemographic analysis it was concluded that the site of Anse Lavoutte is completely different, not resembling a stable attritional population or a catastrophic one and that the mortality rates of this population were so erratic the only conclusion that could be drawn was that an incomplete population was excavated, resulting into erratic numbers and therefore an erratic population profile (van Meel 2010: 58). This most likely resulted from the fact that the heavy erosion at the site washed away a substantial number of bones, especially the fragile bones of the sub-adults, who are underrepresented in this sample.

4.14 ST. LUCIA: POINTE DE CAILLE

In 1983 a 5-year campaign was started by Prof. H. Friesinger of the University of Vienna at the Pointe de Caille site, which sometimes is also referred to as Saltibus Point. The site of Pointe de Caille measures approximately 300 x 400 meters and is located on the south-eastern part of Saint Lucia on a small peninsula in the Atlantic Ocean, which has been eroding away some of the graveyard. Thermoluminescence and C14-dating dated the site to around AD 800 (Friesinger *et al.* 1986: 6). The site was visited again in May of 2002 by a mixed team from Leiden University and the Florida Museum of Natural History. They conducted fieldwork including some shovel tests and surveys. A lot of ceramics were recovered, but no more graves could be located (Keegan *et al.* 2002: 10, 12-15)

For the fieldwork conducted in 1984 there was an anthropological team consisting of Egon Reuer and Susanne Fabrizii-Reuer who made a full physical anthropological report (Fabrizii-Reuer & Reuer 2005). This report contains a description of all the individuals in, a demographical analysis, metrics and biological data for the population. The large amount of data present provided a good framework to make a paleodemographic analysis. A total of 58 individuals were recovered. It must be noted that the skeletons remained in St. Lucia (Fabrizii-Reuer & Reuer 2005: 1), where they were restored and preserved, which allowed for a re-evaluation of the original analysis during the 2010 fieldwork season of Leiden University by Darlene Weston. During this reassessment it became apparent that several individuals had been assigned a wrong age. In an attempt to attain the proper ages the individuals were reassessed, but only 35 out of 58 individuals could be re-analyzed because of time constraints. Out of these 35 individuals 13 were found to be misclassified. This means that the current analysis consists of individuals re-analyzed by the Leiden team and individuals analyzed by the Austrian of which there is a distinct possibility that they have been misclassified. Since not the entire population could be re-analyzed a synthesis will be presented here consisting of two (partial) analyses of the same population.

In the original paleodemographic analysis based on this data it was concluded that the site of Pointe de Caille resembled a stable attritional population, although it differs from the model population on certain points, the resemblances are greater than the differences (van Meel 2010: 58).

4.15 ST. THOMAS: TUTU

The Tutu site is located on the eastern end of the U.S. Virgin Island of St. Thomas within 2 km of the coast. Two periods of occupation have been suggested for Tutu, ranging from 65 Cal AD to 900 Cal AD and from 1150 Cal AD to 1500 Cal AD (Righter 2002: 1, 9). Collagen samples from 29 human collagen samples were AMS dated (Righter 2002: 55) with dates ranging from AD 555 to AD 1675 (Righter 2002: Figure 1.27c & Table 1.4). A total of 42 burials were identified at the site. Burial pits were excavated carefully and all soils from these burial pits were carefully screened through several meshes (Righter 2002: 32-34; Sandford *et al.* 2002: 212) excluding the possible overlooking of small or very fragile remains.

The Tutu population was also investigated for signs of pathologies. This resulted in the discovery of widespread treponemal disease, inflammatory disease, metabolic disease, osteoarthritis, some neoplasms and one individual with an actively healing fracture (Sanford *et al.* 2002: 215-216, 222-227). Since the population can be clearly separated into two distinct periods, the Tutu site is useful in the search for temporal changes within a site.

4.16 Concluding remarks

All the sites relevant to this investigation have been reviewed here in order to create proper background knowledge on them. A framework in which previous investigations, history, location and dating of the site as well as any possible techniques used in the physical anthropological analysis are provided makes sure that these sites are grounded more firmly in a theoretical and methodological background. It has shown that the graveyards from many sites have not been completely analyzed. This means that when these sites are analyzed further through the means of life table analyses it is highly likely that they will not produce proper results, since the original information will be too fragmented to properly analyze. The sites of El Chorro de Maita, El Atajadizo, Punta Macao, Anse à la Gourde, Maisabel, Punta Candalero, Paso del Indio, Tibes, Kelbey's Ridge, Anse Lavoutte, Pointe de Caille and Tutu (combined) were analyzed against the Warao standard population with a χ^2-test to determine if there was a significant association between male and female sex distributions. Only these sites could be analyzed as the other sites did not yield enough information to include them in this particular analysis. This showed that a significant association between these sites could be made based on male and female sex distributions[15].

[15] The critical values for 1% and 0.1% are 6.63 and 10.8 respectively.

Site	ECdM	EA	ES	AalG	Mais	PC
χ^2	722,28	693,69	689,82	722,97	696,92	717,81
Site	PdI	T	KR	AL	PdC	T
χ^2	703,75	703,13	682,21	694,01	698,52	696,64

Table 5: χ^2 values for the sites of El Chorro de Maita, El Atajadizo, El Soco, Anse à la Gourde, Maisabel, Punta Macao, Paso del Indio, Tibes, Kelbey's Ridge, Anse Lavoutte, Pointe de Caille and Tutu (combined).

Further analyses and comparisons must show whether or not these discrepancies are the cause of natural or cultural factors. It is conceivable that the values found here are an actual representation of the living communities at those times, who buried their dead in such a manner that the proportions in which they are retrieved nowadays is a good reflection of their burial practices. The only way to properly ascertain whether or not this is the case is to study these assemblages through the method of life table analysis and compare them to standard values, which is the subject of the next chapter.

5. Results

5.1 Introduction

The previous chapter outlined the composition of the skeletal assemblages under investigation and gave background information on the sites where these skeletal assemblages were retrieved. In order to be able to properly compare these sites to each other the preservation, completeness and division between males and females and Adults and Sub-Adults will be depicted where that information is available. Life tables were calculated using the methodology outlined in chapter 3. The life table for each site is presented and they are compared to the ethnographically derived Warao attritional and catastrophic life table based on their respective mortality values. The values retrieved will be explained through the nature of the skeletal assemblages and the sites they were retrieved from. Where possible these sites will be analyzed based on their different temporal components. The sites will be presented in the order as they are seen in table 4 of chapter 2.

5.2 CUBA: EL CHORRO DE MAITA

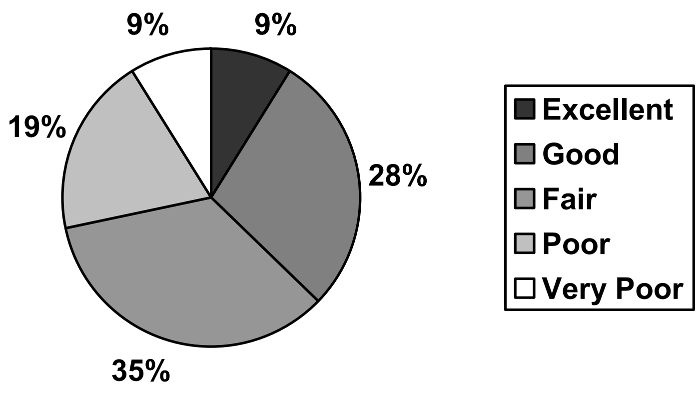


Figure 4: Distribution of individuals according to preservation. N=132

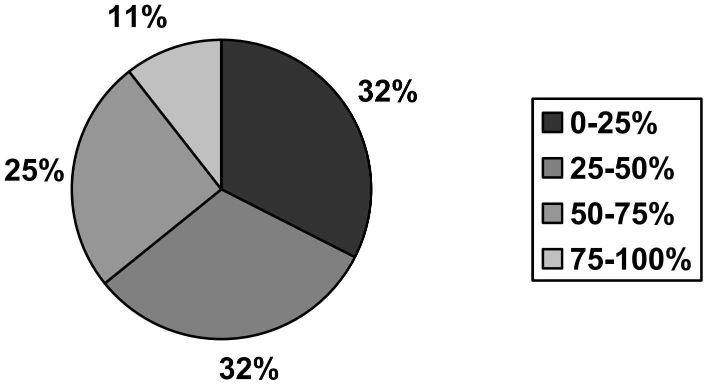


Figure 5: Distribution of individuals according to completeness. N=131

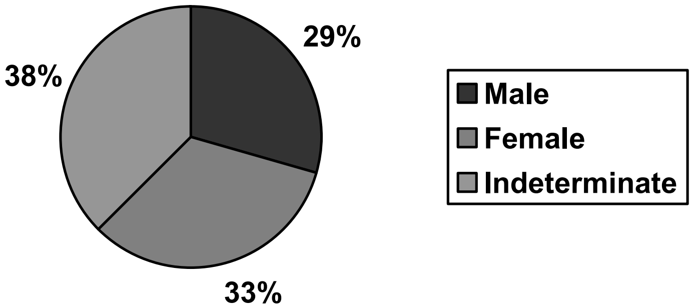


Figure 6: Distribution of individuals according to sex. N=133

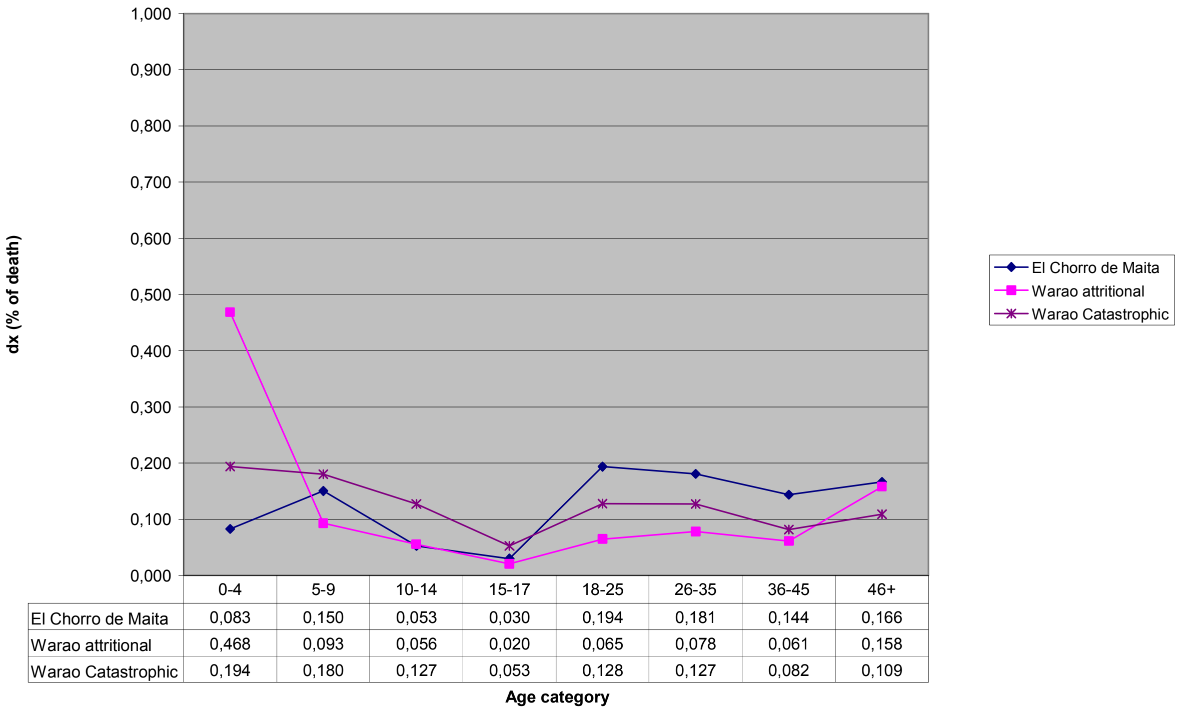
Figures 4, 5 and 6 indicate that there is a roughly even division in sex amongst the individuals from El Chorro de Maita. The preservation of the individuals can in general be classified as fair. The reason that there is one individual less in the classification according to preservation and two less in the classification according to completeness is caused by the fact that two individuals retrieved from the graveyard were not housed at the Departemento de Arquelogia in Holguin but at the museum dedicated to the site of El Chorro de Maita. The two skeletons could therefore not be investigated personally, but rather were evaluated on basis of photographic material. This means that these two individuals, out of a total of 133, could not be completely examined.

Individuals were aged according to the morphology of the pubic symphysis (Katz and Suchey 1986; Todd 1921a, 1921b), auricular surface (Lovejoy *et al.* 1985), and sternal rib ends (Işcan & Loth 1986a, 1986b) as well as the degree of cranial suture closure (Meindl &

Lovejoy 1985) and dental attrition (Brothwell 1981; Lovejoy 1985)[16]. Age of Non-Adults was determined according to dental development (Smith 1991), long bone length (Sundick 1978; Ubelaker 1989), and the degree of epiphyseal fusion (Scheurer and Black 2000). Since it is not possible to determine the exact chronological age of an individual based on morphological changes to the skeleton and teeth, adult and juvenile skeletons were assigned to standard age groups. Sex was determined on the morphology of the skull (Ascadi and Nemeskeri 1970; Buikstra and Ubelaker 1994) and pelvis (Buikstra and Ubelaker 1994; Phenice 1969). Biological sex was not assigned to the juvenile individuals due to a lack of secondary sex characteristics found in the skull and pelvis (Scheuer and Black 2000).

x	Dx	dx	lx	qx	Lx	Tx	ex
0-4	11,00	0,083	1,000	0,083	4,793	27,375	27,375
5-9	20,00	0,150	0,917	0,164	4,211	22,582	24,618
10-14	7,00	0,053	0,767	0,069	3,703	18,371	23,955
15-17	4,00	0,030	0,714	0,042	2,098	14,668	20,536
18-25	25,75	0,194	0,684	0,283	4,112	12,570	18,372
26-35	24,05	0,181	0,491	0,369	4,002	8,459	17,241
36-45	19,10	0,144	0,310	0,464	2,380	4,457	14,387
46+	22,10	0,166	0,166	1,000	2,077	2,077	12,500
Total:	133,00						

Table 6: Abridged life table for the population of El Chorro de Maíta.



	0-4	5-9	10-14	15-17	18-25	26-35	36-45	46+
El Chorro de Maita	0,083	0,150	0,053	0,030	0,194	0,181	0,144	0,166
Warao attritional	0,468	0,093	0,056	0,020	0,065	0,078	0,061	0,158
Warao Catastrophic	0,194	0,180	0,127	0,053	0,128	0,127	0,082	0,109

Figure 7: Comparison of % of dead (dx) for the population of El Chorro de Maíta, Warao attritional standard model and Warao catastrophic standard model.

[16] Earlier investigations in the Caribbean have shown that dental attrition is particularly unreliable in the estimation of age. This is caused by the fact that teeth wore at an advanced rate because those teeth were used as tools (Mickleburgh 2007).

When looking at the El Chorro de Maita skeletal sample (Table 5 and Figure 7) two conclusions can be drawn. Firstly the number of non-adults present is lower than is to be expected based on the Warao life table. This can be explained however, by taking in mind the second conclusion whilst looking at this underenumeration of non-adults. The mortality profile of El Chorro de Maita clearly shows a resemblance to the catastrophic Warao mortality rates[17]. This indicates that the population at El Chorro de Maita might have suffered from a catastrophic event at the time of the deposition of the individuals at the graveyard of the site. This can not be substantiated properly however, since the statistics show that El Chorro de Maita is significantly different from the Warao catastrophic standard model.

The dating of the site would seem to suggest that the site can be placed in the Early Contact Period. The transmittance of diseases during this time period (Wilson 2007: 158-159) can be seen as the cause of a catastrophic mortality amongst the indigenous population. The presence of non-indigenous people interred at this graveyard (Laffoon & de Vos 2011) would also explain the low number of non-adults in the graveyard, since these non-adults usually are not taken along when exploring or settling new areas. Within the overall low number of non-adults there is by comparison a large number of Infants (5-9 years old). This peculiar pattern cannot be explained at this time.

5.3 DOMINICAN REPUBLIC: EL ATAJADIZO

Since there so far only has been a preliminary field report, which contains little information it is hard to make any clear conclusions about this population. This report provided only information on 42 individuals from the site, some of which could not be assessed in the field. Out of these 42 individuals only 13 could be assigned to a sex category and 16 to an age category (although out of 16 individuals 9 could be assigned no further than adult or sub-adult). Even so, there is a very uneven sex distribution (Figure 5) and an underenumeration of sub-adults (Figure 6).

[17] K-S two-sample tests showed that D=0.238 whilst ($P \leq 0,01 = 0.148$), which means the two samples are significantly different.

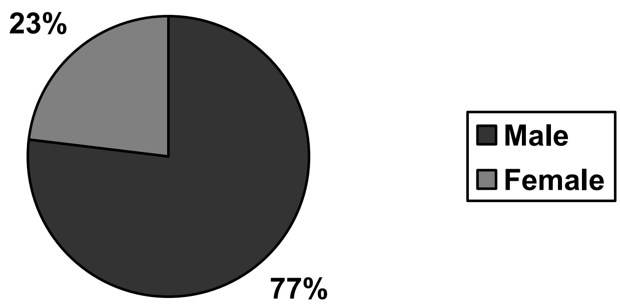


Figure 8: Distribution of individuals according to sex. N=13

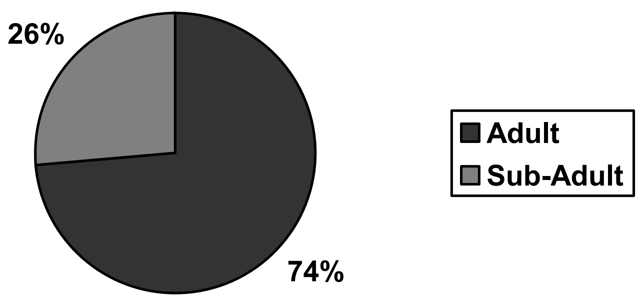
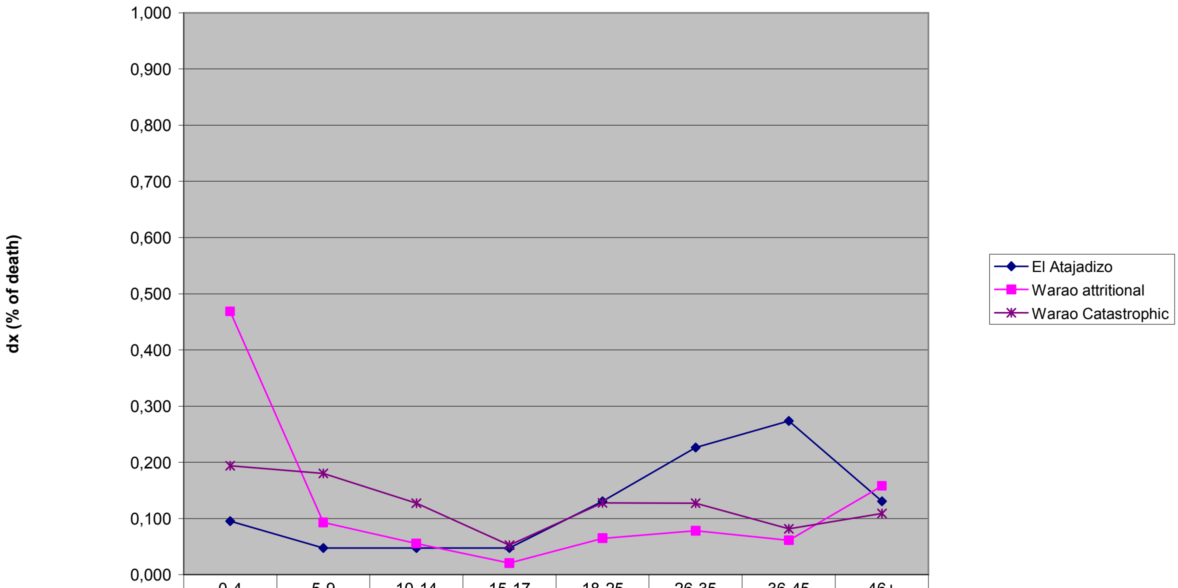


Figure 9: Distribution of individuals according to Adult /Sub-Adult division. N=19

x	Dx	dx	lx	qx	Lx	Tx	ex
0-4	2,00	0,095	1,000	0,095	4,762	30,060	30,060
5-9	1,00	0,048	0,905	0,053	4,405	25,298	27,961
10-14	1,00	0,048	0,857	0,056	4,167	20,893	24,375
15-17	1,00	0,048	0,810	0,059	2,357	16,726	20,662
18-25	2,75	0,131	0,762	0,172	4,875	14,369	18,859
26-35	4,75	0,226	0,631	0,358	5,179	9,494	15,047
36-45	5,75	0,274	0,405	0,676	2,679	4,315	10,662
46+	2,75	0,131	0,131	1,000	1,637	1,637	12,500
Total:	21,00						

Table 7: Abridged life table for the population of El Atajadizo.



	0-4	5-9	10-14	15-17	18-25	26-35	36-45	46+
El Atajadizo	0,095	0,048	0,048	0,048	0,131	0,226	0,274	0,131
Warao attritional	0,468	0,093	0,056	0,020	0,065	0,078	0,061	0,158
Warao Catastrophic	0,194	0,180	0,127	0,053	0,128	0,127	0,082	0,109

Age category

Figure 10: Comparison of % of dead (dx) for the population of El Atajadizo, Warao attritional standard model and Warao catastrophic standard model.

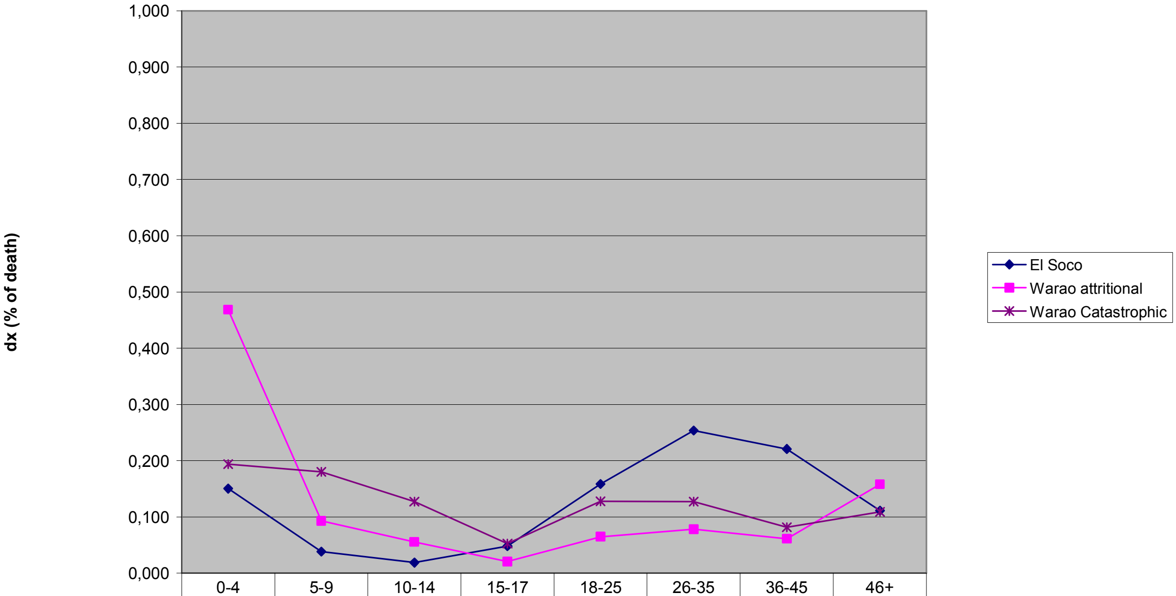
The site of El Atajadizo has a mortality profile unlike any other[18], with an underenumeration of non-adults and an overrepresentation of those individuals in the age category 36-45. This specific profile is most likely caused by the incomplete analysis of the site. A total of 51 individuals were recovered from the site, but only 21 individuals could be aged and sexed, most of them no further than adult or non-adult (Luna Calderon 1976: 295). This incomplete analysis then is most likely the cause for the erroneous results.

5.4 DOMINICAN REPUBLIC: EL SOCO

x	Dx	dx	lx	qx	Lx	Tx	ex
0-4	23,73	0,150	1,000	0,150	4,625	27,955	27,955
5-9	6,07	0,038	0,850	0,045	4,153	23,331	27,454
10-14	2,99	0,019	0,811	0,023	4,010	19,178	23,636
15-17	7,55	0,048	0,792	0,060	2,306	15,168	19,140
18-25	25,02	0,158	0,745	0,213	4,659	12,862	17,272
26-35	40,14	0,254	0,586	0,433	4,593	8,204	13,992
36-45	34,90	0,221	0,332	0,665	2,218	3,611	10,867
46+	17,60	0,111	0,111	1,000	1,392	1,392	12,500
Total:	158,00						

Table 8: Abridged life table for the population of El Soco.

[18] K-S two-sample tests showed that D=0.427 for (P≤0,01=0.369) and D= 0.316 (P≤0,01=0.358) for the attritional and catastrophic life tables respectively. This means that the El Atajadizo population is significantly different from the attritional population, but not from the catastrophic population.



	0-4	5-9	10-14	15-17	18-25	26-35	36-45	46+
El Soco	0,150	0,038	0,019	0,048	0,158	0,254	0,221	0,111
Warao attritional	0,468	0,093	0,056	0,020	0,065	0,078	0,061	0,158
Warao Catastrophic	0,194	0,180	0,127	0,053	0,128	0,127	0,082	0,109

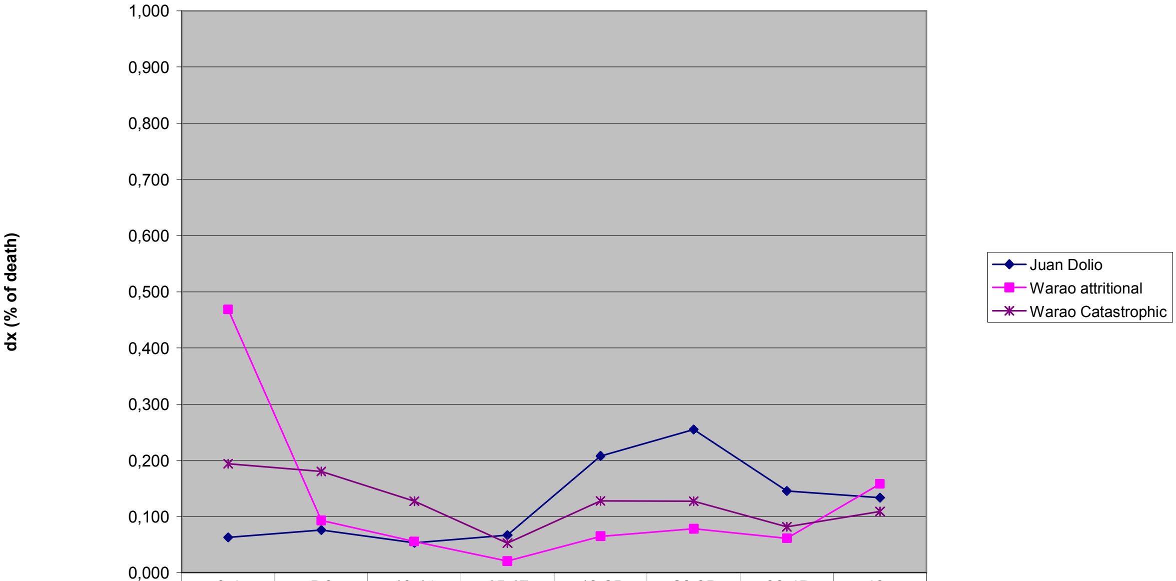
Figure 11: Comparison of % of dead (dx) for the population of El Soco, Warao attritional standard model and Warao catastrophic standard model.

None of the profiles depicted above can be easily compared to the standard models. The main reason here probably lies in the fact that according to the authors there are two distinct populations present at El Soco (Coppa *et al.* 1995: 154), something they have not taken into account when looking at the population whilst constructing the abridged life table. The profiles depicted here are derived from that data and therefore the comingling of these two, probably distinct, populations.

5.5 DOMINICAN REPUBLIC: JUAN DOLIO

x	Dx	dx	lx	qx	Lx	Tx	ex
0-4	6,78	0,063	1,000	0,063	4,843	28,084	28,084
5-9	8,19	0,076	0,937	0,081	4,497	23,241	24,798
10-14	5,76	0,053	0,861	0,062	4,174	18,745	21,761
15-17	7,23	0,067	0,808	0,083	2,324	14,571	18,032
18-25	22,43	0,208	0,741	0,280	4,461	12,247	16,526
26-35	27,52	0,255	0,533	0,478	4,060	7,787	14,597
36-45	15,69	0,145	0,279	0,521	2,060	3,726	13,375
46+	14,40	0,133	0,133	1,000	1,667	1,667	12,500
Total:	108,00						

Table 9: Abridged life table for the population of Juan Dolio.



	0-4	5-9	10-14	15-17	18-25	26-35	36-45	46+
Juan Dolio	0,063	0,076	0,053	0,067	0,208	0,255	0,145	0,133
Warao attritional	0,468	0,093	0,056	0,020	0,065	0,078	0,061	0,158
Warao Catastrophic	0,194	0,180	0,127	0,053	0,128	0,127	0,082	0,109

Age category

Figure 12: Comparison of % of dead (dx) for the population of Juan Dolio, Warao attritional standard model and Warao catastrophic standard model.

This site again shows a mortality profile which cannot be positively attributed to any of the two standard models[19]. The underenumeration of children seems to be the factor which can explain most of this, as this underenumeration will then affect all following age categories. If one were to look only at the adult categories it is quite clear that Juan Dolio resembles most the catastrophic mortality rates. It can therefore be said that the population at Juan Dolio suffered from a catastrophic event during the usage of the graveyard.

5.6 DOMINCAN REPUBLIC: PUNTA MACAO

Sexing was based on the femoral head diameter (Bass 1995: 35) and ageing was done on basis of cranial suture closure (Meindl & Lovejoy 1985) and dental attrition (Brothwell 1981: Meindl & Lovejoy 1985). As of so far only 26 individuals have been analyzed, showing a marked imbalance between the sexes (Figure 13) and a slightly lower number of Sub-Adult individuals than expected (Figure 14).

[19] K-S two-sample tests showed that D=0.425 for (P≤0,01=0.185) and D= 0.309 (P≤0,01=0.163) for the attritional and catastrophic life tables respectively. This means that the site of Juan Dolio is significantly different from both the attritional and catastrophic populations.

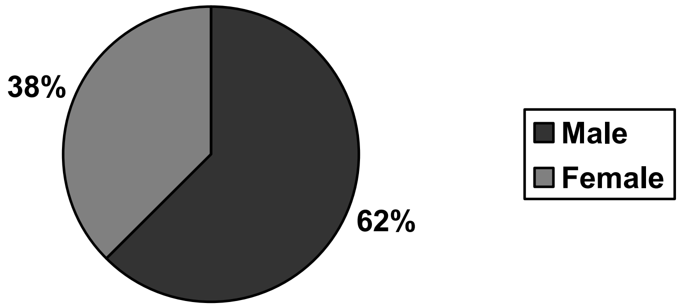


Figure 13: Distribution of individuals according to sex. N=16

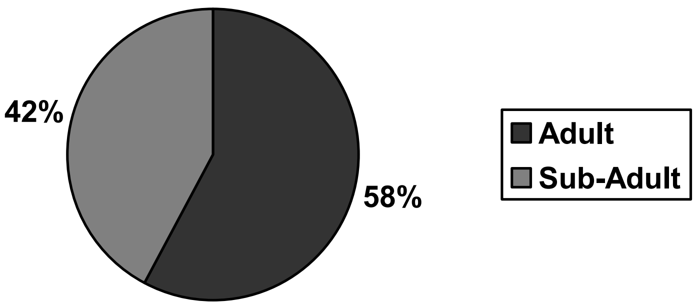


Figure 14: Distribution of individuals according to Adult/Sub-Adult division. N=26The site of Punta Macao yielded to little information on the skeletons in order to construct a proper abridged life table. For this reason no conclusions can be drawn about the demographic make-up of this particular site.

5.7 GUADELOUPE: ANSE À LA GOURDE

Overall preservation and completeness of skeletons retrieved from Anse à la Gourde was fair, as evidenced by Figures 15 and 16.

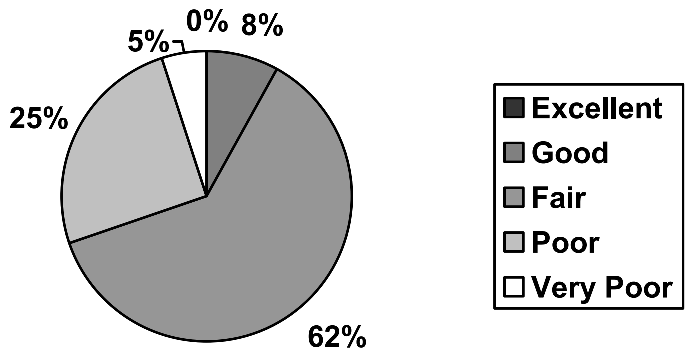


Figure 15: Distribution of individuals according to preservation. N=99

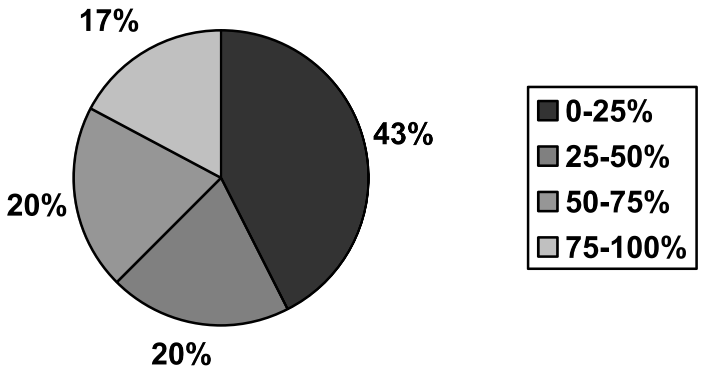
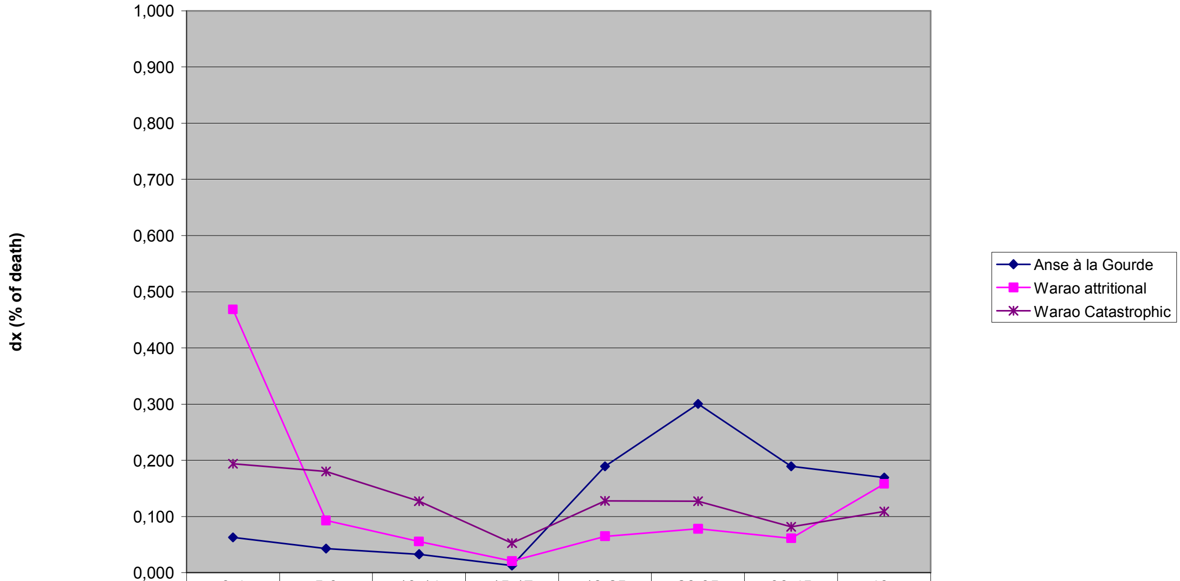


Figure 16: Distribution of individuals according to completeness. N=99

x	Dx	dx	lx	qx	Lx	Tx	ex
0-4	6,25	0,063	1,000	0,063	4,842	31,490	31,490
5-9	4,25	0,043	0,937	0,046	4,577	26,648	28,443
10-14	3,25	0,033	0,894	0,037	4,388	22,071	24,689
15-17	1,25	0,013	0,861	0,015	2,564	17,683	20,535
18-25	18,75	0,189	0,848	0,223	5,277	15,119	17,818
26-35	29,75	0,301	0,659	0,456	5,088	9,842	14,933
36-45	18,75	0,189	0,359	0,528	2,639	4,754	13,257
46+	16,75	0,169	0,169	1,000	2,115	2,115	12,500
Total:	99,00						

Table 10: Abridged life table for the population of Anse à la Gourde.



	0-4	5-9	10-14	15-17	18-25	26-35	36-45	46+
Anse à la Gourde	0,063	0,043	0,033	0,013	0,189	0,301	0,189	0,169
Warao attritional	0,468	0,093	0,056	0,020	0,065	0,078	0,061	0,158
Warao Catastrophic	0,194	0,180	0,127	0,053	0,128	0,127	0,082	0,109

Age category

Figure 17: Comparison of % of dead (dx) for the population of Anse à la Gourde, Warao attritional standard model and Warao catastrophic standard model.

As mentioned before, the site of Anse à la Gourde is most likely made up of two temporal components. Since not all individuals could be assigned to one of these two periods it is impossible to make a distinction based on these two respective time periods. Only 9 individuals out of the total of 99 analyzed individuals could be analyzed by C14-dating techniques.. The overall composite profile of the site seems to indicate an underenumeration of non-adults, while the other age categories have a closer resemblance to the catastrophic mortality profile[20]. Since this is a composite however, no real conclusions can be drawn.

[20] K-S two-sample tests showed that D=0.488 for (P≤0,01=0.191) and D= 0.404 (P≤0,01=0.170) for the attritional and catastrophic life tables respectively. This means that the site of Anse à la Gourde is significantly different from both the attritional and catastrophic populations.

5.8 PUERTO RICO: MAISABEL

x	Dx	dx	lx	qx	Lx	Tx	ex
0-4	7,00	0,200	1,000	0,200	4,500	34,000	34,000
5-9	1,00	0,029	0,800	0,036	3,929	29,500	36,875
10-14	0,00	0,000	0,771	0,000	3,857	25,571	33,148
15-17	0,00	0,000	0,771	0,000	2,314	21,714	28,148
18-25	5,00	0,143	0,771	0,185	4,900	19,400	25,148
26-35	5,00	0,143	0,629	0,227	5,571	14,500	23,068
36-45	4,00	0,114	0,486	0,235	4,286	8,929	18,382
46+	13,00	0,371	0,371	1,000	4,643	4,643	12,500
Total:	35,00						

Table 11: Abridged life table for the population of Maisabel.

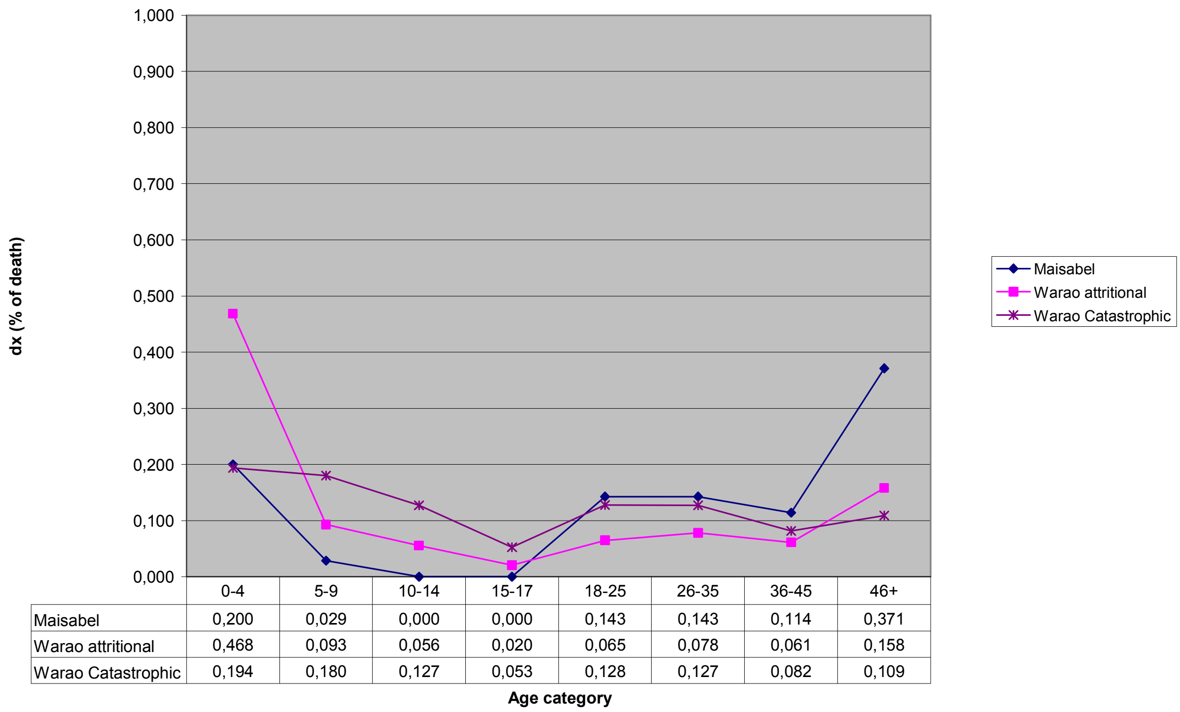


Figure 18: Comparison of % of dead (dx) for the population of Maisabel, Warao attritional standard model and Warao catastrophic standard model.

The site of Maisabel, once again, seems to suffer from an underenumeraton of the non-adult category. The individuals recovered could be assigned to different periods, based mostly on ceramics. The division of periods cannot however, be upheld for this analysis. This is because there are no clear breaks in occupation and therefore usage of the graveyard. This means it can be assumed here that the population retrieved from Maisabel, albeit spanning a long time period, is the result from a continuous occupation. This population is therefore treated as one single and continuous population. Although there is an underenumeration of non-adults the remaining age categories resemble most closely the attritional standard values[21]. Statistics show however, that the site of Maisabel is significantly different from both the model attritional and catastrophic populations. This means that Maisabel cannot be said to resemble any of these standard models.

5.9 PUERTO RICO: PUNTA CANDALERO

A total of 85 individuals were recovered from the site, the distribution of which according to sex and adult-sub-adult division can be found in Figures 19 and 20. The incomplete number can be attributed to the number of individuals assigned to an indeterminate age and/or sex category.

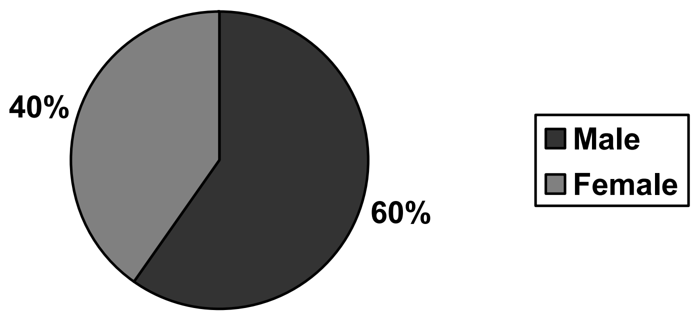


Figure 19: Distribution of individuals according to sex. N=67

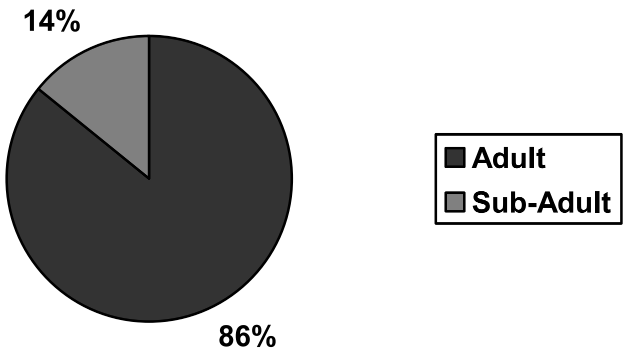


Figure 20: Distribution of individuals according to Adult/Sub-Adult division. N=78

[21] K-S two-sample tests showed that D=0.409 for (P≤0,01=0.292) and D= 0.325 (P≤0,01=0.279) for the attritional and catastrophic life tables respectively. This means that the site of Maisabel is significantly different from both the attritional and catastrophic populations.

What can be noticed from the above figures is that the ratios between males and females and adults and sub-adults are out of balance. In the original paleodemographic research inconsistencies caused by differential preservation or possible biases in analysis methods were rejected as they would not affect the data in such an extreme manner Curet 2005: 200-201).

x	Dx	dx	lx	qx	Lx	Tx	ex
0-4	6,00	0,071	1,000	0,071	4,824	35,250	35,250
5-9	5,00	0,059	0,929	0,063	4,500	30,426	32,737
10-14	0,00	0,000	0,871	0,000	4,353	25,926	29,780
15-17	0,75	0,009	0,871	0,010	2,599	21,574	24,780
18-25	9,25	0,109	0,862	0,126	5,651	18,975	22,019
26-35	23,00	0,271	0,753	0,359	6,176	13,324	17,695
36-45	18,00	0,212	0,482	0,439	3,765	7,147	14,817
46+	23,00	0,271	0,271	1,000	3,382	3,382	12,500
Total:	85,00						

Table 12: Abridged life table for the population of Punta Candalero.

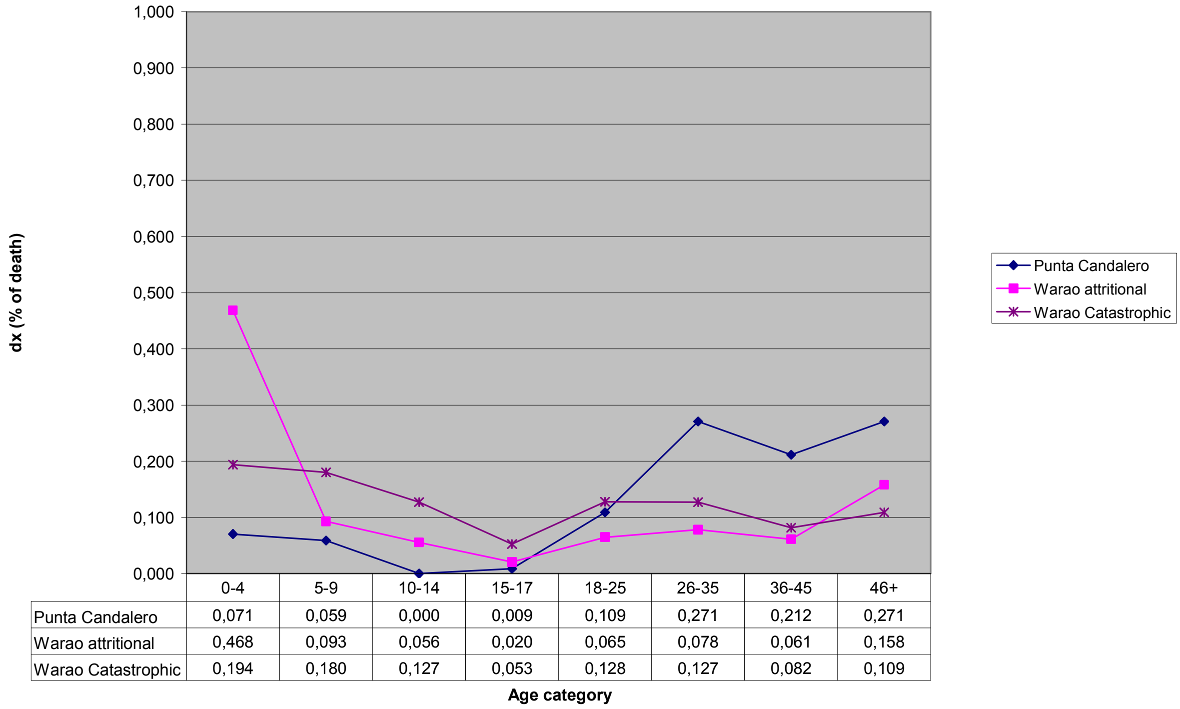


Figure 21: Comparison of % of dead (dx) for the population of Punta Candalero, Warao attritional standard model and Warao catastrophic standard model.

The mortality profile taken from Punta Candalero is quite distinctive with a large and small underenumeration of non-adults and young adults respectively and a large overenumeration of older adults. Since this site was analyzed completely it cannot be categorized that the results are wrong because of an incomplete analysis. It must therefore be said that the population depicted here is a representation of the once living population. Since there is a larger number of males than females and they are almost all from the older adult age categories it can be stated that this mortality profile is most likely caused by a failed colonization attempt[22]. A group of younger males colonized and later moved people from their original habitation area to this newly colonized area. They however failed to properly establish a new generation at this site, as evidenced by the low number of non-adults, and therefore could not uphold this site, most likely causing them to relocate to their original area after a couple of years, which also explains the short time represented in the remainder of the site's chronology.

5.10 PUERTO RICO: PASO DEL INDIO

The distribution of these individuals according to sex and Adult/Sub-Adult division can be found in Figures 22 and 23. The total number of individuals in Figure 15 can explained by the number of sub-adult (72) and the individuals to bad preserved to be assigned a sex (4)[23].

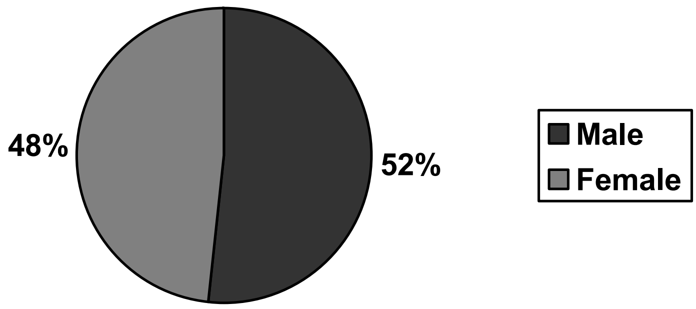


Figure 22: Distribution of individuals according to sex. N=62

[22] K-S two-sample tests showed that D=0.500 for (P≤0,01=0.202) and D= 0.435 (P≤0,01=0.182) for the attritional and catastrophic life tables respectively. This means that the site of Punta Candalero is significantly different from both the attritional and catastrophic populations.

[23] Although Crespo Torres (2000) reports a total of 149 individuals, there are only 129 individuals in Curet's (2005) analysis and 138 in the report by Walker (2005). Since Walker reports more completely, that number will be adhered to here.

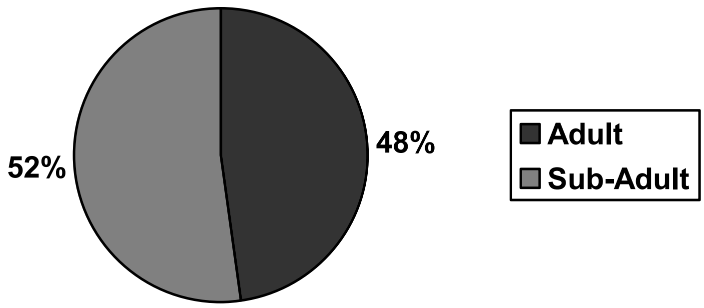


Figure 23: Distribution of individuals according to Adult/Sub-Adult division. N=138

x	Dx	dx	lx	qx	Lx	Tx	ex
0-4	41,00	0,318	1,000	0,318	4,205	20,163	20,163
5-9	20,00	0,155	0,682	0,227	3,023	15,957	23,392
10-14	5,00	0,039	0,527	0,074	2,539	12,934	24,537
15-17	1,50	0,012	0,488	0,024	1,448	10,395	21,286
18-25	7,50	0,058	0,477	0,122	3,134	8,948	18,768
26-35	20,00	0,155	0,419	0,370	3,411	5,814	13,889
36-45	26,00	0,202	0,264	0,765	1,628	2,403	9,118
46+	8,00	0,062	0,062	1,000	0,775	0,775	12,500
Total:	129,00						

Table 13: Abridged life table for the population of Paso del Indio.

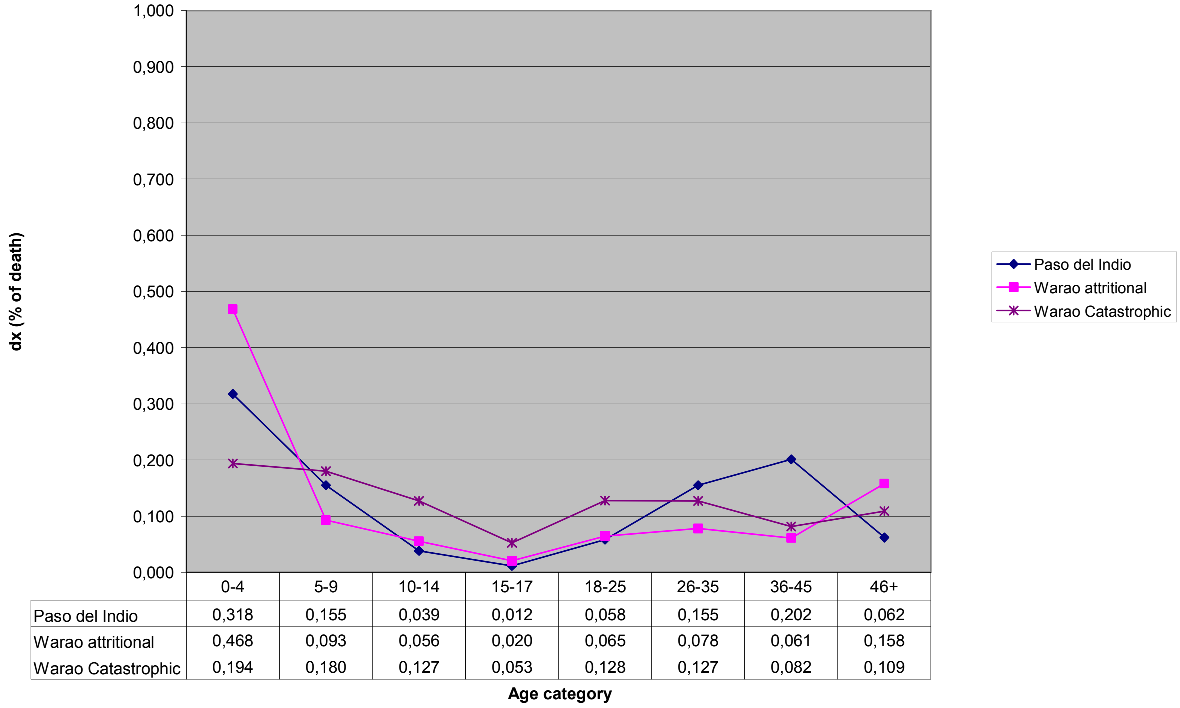


Figure 24: Comparison of % of dead (dx) for the population of Paso del Indio, Warao attritional standard model and Warao catastrophic standard model.

The site of Paso del Indio, in contrast to other sites, does not have an underenumeration of non-adults, but rather an overenumeration of older adults. This particular pattern cannot be matched to an attritional or a catastrophic standard model[24]. The site also does not match any expected pattern of migration. Since the site was completely excavated and there are no inconsistencies in the distribution of males and females it must be assumed that the profile presented here is not a correct representation of the living population but rather is the result from a bias. Most likely the bias here is the one noted earlier in which there is an overenumerution of older adults. A different conclusion from the original research is drawn here and it is stated that the population at Paso Del Indio is not a direct representation of the living population, but rather one that is biased.

5.11 PUERTO RICO: TIBES

Almost all of these individuals were in a poor state of preservation and had a low completeness which greatly affected the analysis (Curet 2005: 204). This also explains the low total numbers in Figures 17 and 18 below, depicting the distributions according to sex and Adult/Sub-Adult divisions.

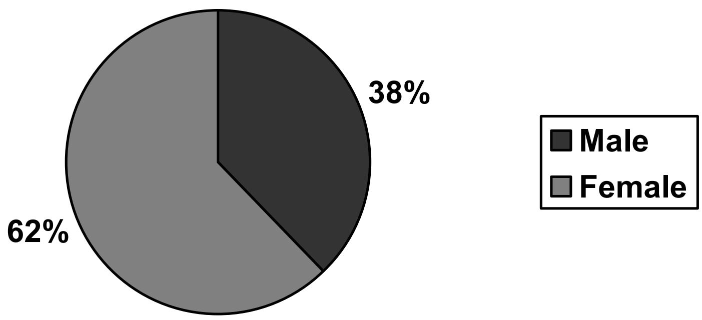


Figure 25: Distribution of individuals according to sex. N=37

[24] K-S two-sample tests showed that D=0.150 for ($P \leq 0{,}01=0.174$) and D= 0.124 ($P \leq 0{,}01=0.150$) for the attritional and catastrophic life tables respectively. This means that the site of Paso del Indio is not significantly different from both the attritional and catastrophic populations.

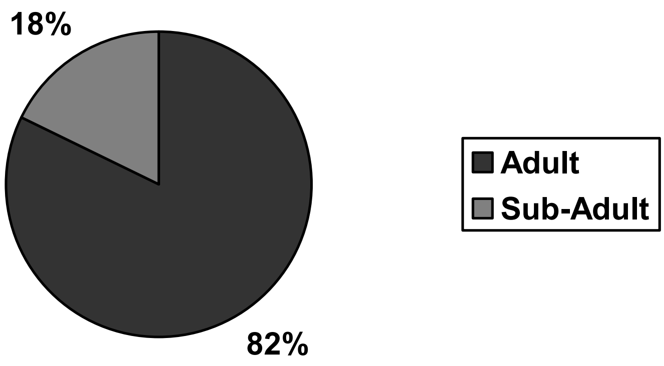
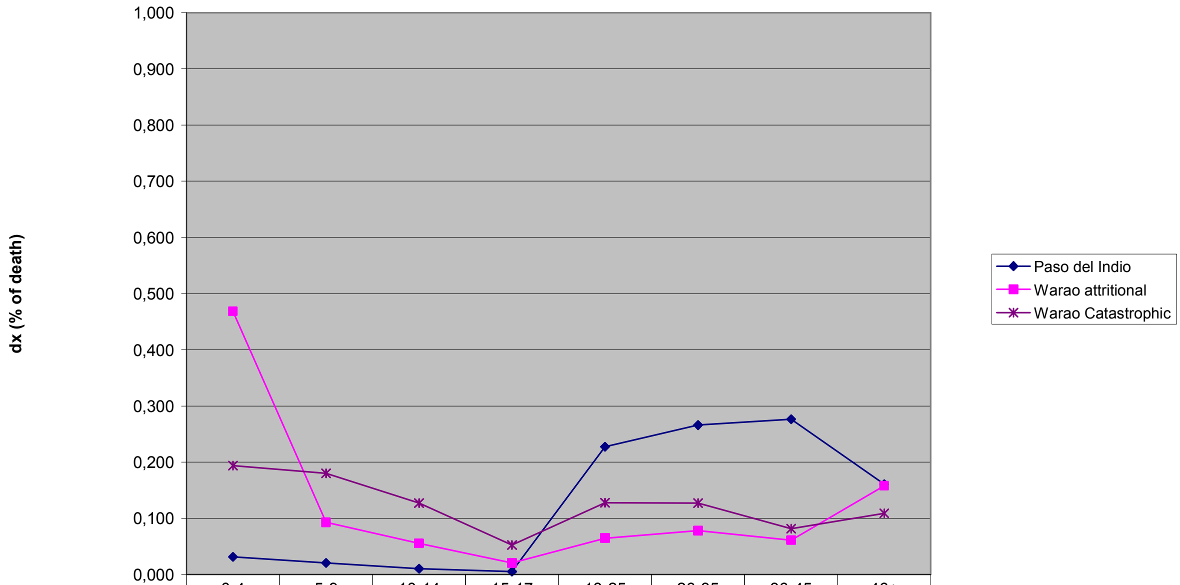


Figure 26: Distribution of individuals according to Adult/Sub-Adult division. N=45

x	Dx	dx	lx	qx	Lx	Tx	ex
0-4	3,00	0,032	1,000	0,032	4,921	33,653	33,653
5-9	2,00	0,021	0,968	0,022	4,789	28,732	29,669
10-14	1,00	0,011	0,947	0,011	4,711	23,943	25,273
15-17	0,52	0,005	0,937	0,006	2,802	19,232	20,529
18-25	21,64	0,228	0,931	0,245	5,722	16,430	17,640
26-35	25,28	0,266	0,704	0,378	5,705	10,707	15,218
36-45	26,28	0,277	0,437	0,632	2,992	5,002	11,434
46+	15,28	0,161	0,161	1,000	2,011	2,011	12,500
Total:	95,00						

Table 14: Abridged life table for the population of Tibes.



	0-4	5-9	10-14	15-17	18-25	26-35	36-45	46+
Paso del Indio	0,032	0,021	0,011	0,005	0,228	0,266	0,277	0,161
Warao attritional	0,468	0,093	0,056	0,020	0,065	0,078	0,061	0,158
Warao Catastrophic	0,194	0,180	0,127	0,053	0,128	0,127	0,082	0,109

Age category

Figure 27: Comparison of % of dead (dx) for the population of Tibes, Warao attritional standard model and Warao catstrophic standard model.

Tibes has a distinct profile (not matching with any of the standard models[25]) in which there is an extreme underenumeration of non-adults and an overenumeration of all adult age categories. The numbers are so extreme however, that a methodological bias can hardly be the explanation. A preservational bias is more likely the explanation as the majority of the individuals recovered from this site had a very low completeness and preservation. The site therefore, as was also concluded in the original analysis, cannot be seen as a representation of the living population.

5.12 SABA: KELBEY'S RIDGE

A total of 10 individuals were buried at the site (Hoogland & Hofman 1999: 104-105), of which the distribution into sex and Adult/Sub-Adult can be found in Figures 28 and 29.

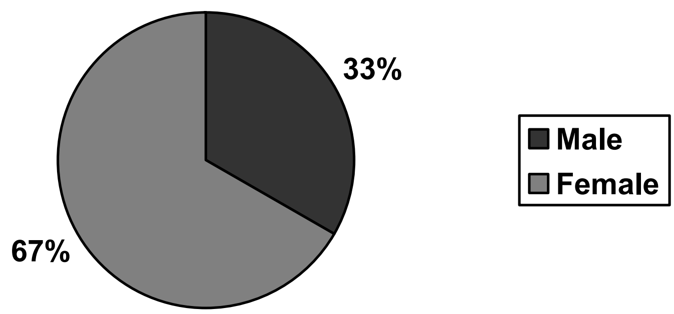


Figure 28: Distribution of individuals according to sex. N=3

[25] K-S two-sample tests showed that D=0.569 for (P≤0,01=0.194) and D= 0.485 (P≤0,01=0.173) for the attritional and catastrophic life tables respectively. This means that the site of Tibes is significantly different from both the attritional and catastrophic populations.

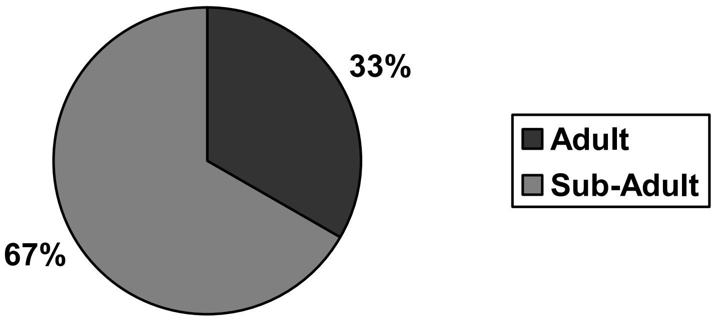
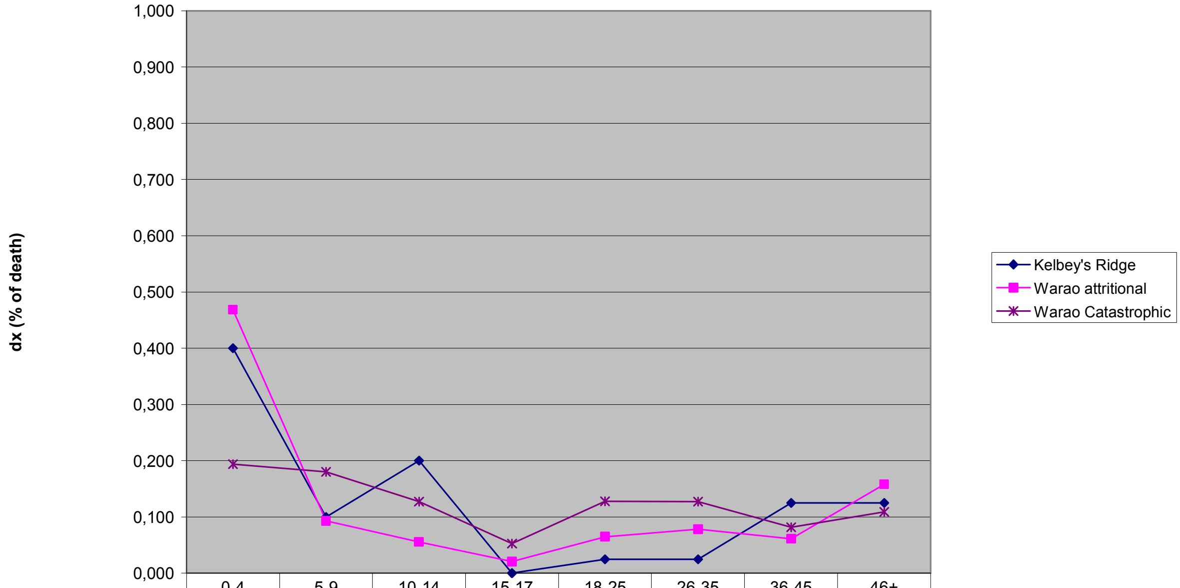


Figure 29: Distribution of individuals according to Adult/Sub-Adult division. N=9

x	Dx	dx	lx	qx	Lx	Tx	ex
0-4	4,00	0,400	1,000	0,400	4,000	17,725	17,725
5-9	1,00	0,100	0,600	0,167	2,750	13,725	22,875
10-14	2,00	0,200	0,500	0,400	2,000	10,975	21,950
15-17	0,00	0,000	0,300	0,000	0,900	8,975	29,917
18-25	0,25	0,025	0,300	0,083	2,013	8,075	26,917
26-35	0,25	0,025	0,275	0,091	2,625	6,063	22,045
36-45	1,25	0,125	0,250	0,500	1,875	3,438	13,750
46+	1,25	0,125	0,125	1,000	1,563	1,563	12,500
Total:	10,00						

Table 15: Abridged life table for the population of Kelbey's Ridge.



	0-4	5-9	10-14	15-17	18-25	26-35	36-45	46+
Kelbey's Ridge	0,400	0,100	0,200	0,000	0,025	0,025	0,125	0,125
Warao attritional	0,468	0,093	0,056	0,020	0,065	0,078	0,061	0,158
Warao Catastrophic	0,194	0,180	0,127	0,053	0,128	0,127	0,082	0,109

Figure 30: Comparison of % of dead (dx) for the population of Kelbey's Ridge, Warao attritional standard model and Warao catastrophic standard model.

The site of Kelbey's Ridge most closely resembles an attritional population[26]. There are a slight overenumeration of the youngest and two oldest age categories. This can be explained by the small nature of the site. The site was occupied for approximately 50 years while only 10 individuals were deposited here. This then most likely means that the site had a special function causing this particular profile. It is a possibility that the site served as a seasonal outpost where families resided only for a short period of time, burying their dead somewhere else entirely. The few individuals interred here then most likely are a random rather then a systematic representation of the population inhabiting this settlement on a periodic basis.

5.13 ST. LUCIA: ANSE LAVOUTTE

A total number of 45 burials, containing 53 individuals were excavated. These skeletons recovered from the site were analyzed in January 2010 under the supervision of Dr. Darlene Weston of then Barge's Anthropologica/LUMC, Leiden University and Lou-Lou de Veth and the author, both students at the Faculty of Archaeology of Leiden University. The

[26] K-S two-sample tests showed that D=0.083 for (P≤0,01=0.525) and D= 0.206 (P≤0,01=0.517) for the attritional and catastrophic life tables respectively. This means that the site of Kelbey's Ridge is not significantly different from the attritional and catastrophic populations.

large category of indeterminates in this sample can be ascribed to the low level of completeness (Figure 31) and poor preservation (Figure 32).

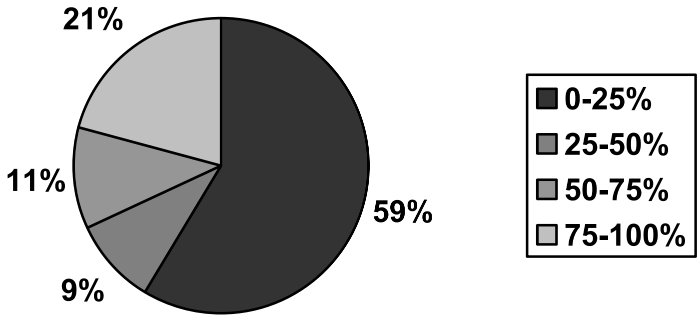


Figure 31: Distribution of individuals according to completeness. N=53

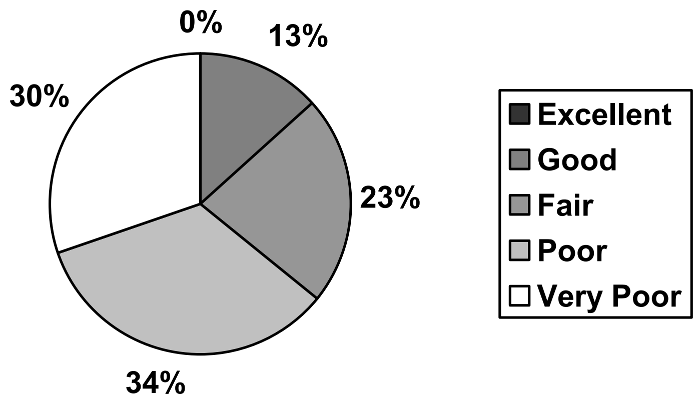


Figure 32: Distribution of individuals according to preservation. N=53

The preferred sexing method used during the analysis of the skeletons was the morphology of the pelvis (Ascádi & Nemeskéri 1970: 79). The cranial morphology was also taken into consideration when sexing the skeletons (Ascádi & Nemeskéri 1970: 76).

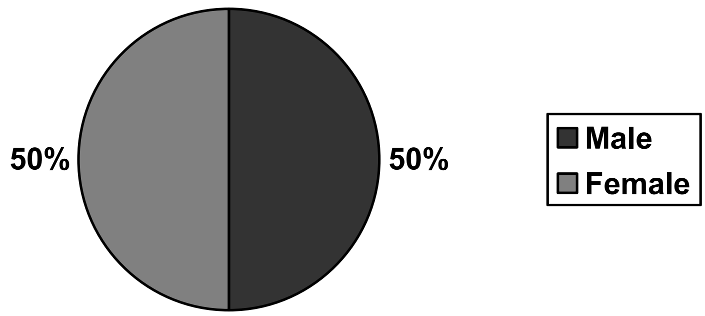


Figure 33: Distribution of individuals according to sex. N=28

For the age determination of the skeletons several techniques were used. Skeletons were aged using the pubic symphysis (Katz & Suchey 1968; Todd 1921a, 1921b), the auricular surface (Lovejoy *et al.* 1985), sternal rib ends (İşcan & Loth 1986a, 1986b), ectocranial suture closure (Meindl & Lovejoy 1985) and dental attrition (Brothwell 1981). The ratio of non-adults versus adults is depicted in Figure 34.

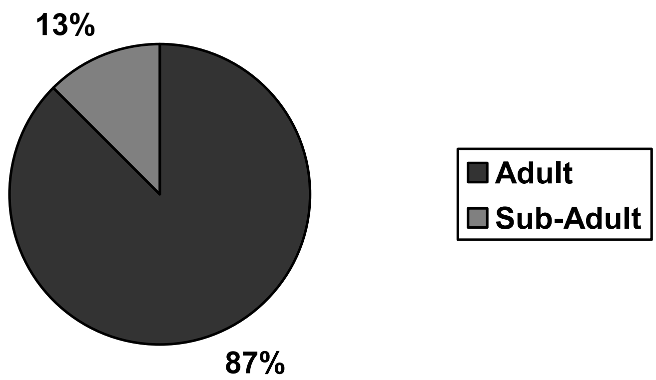
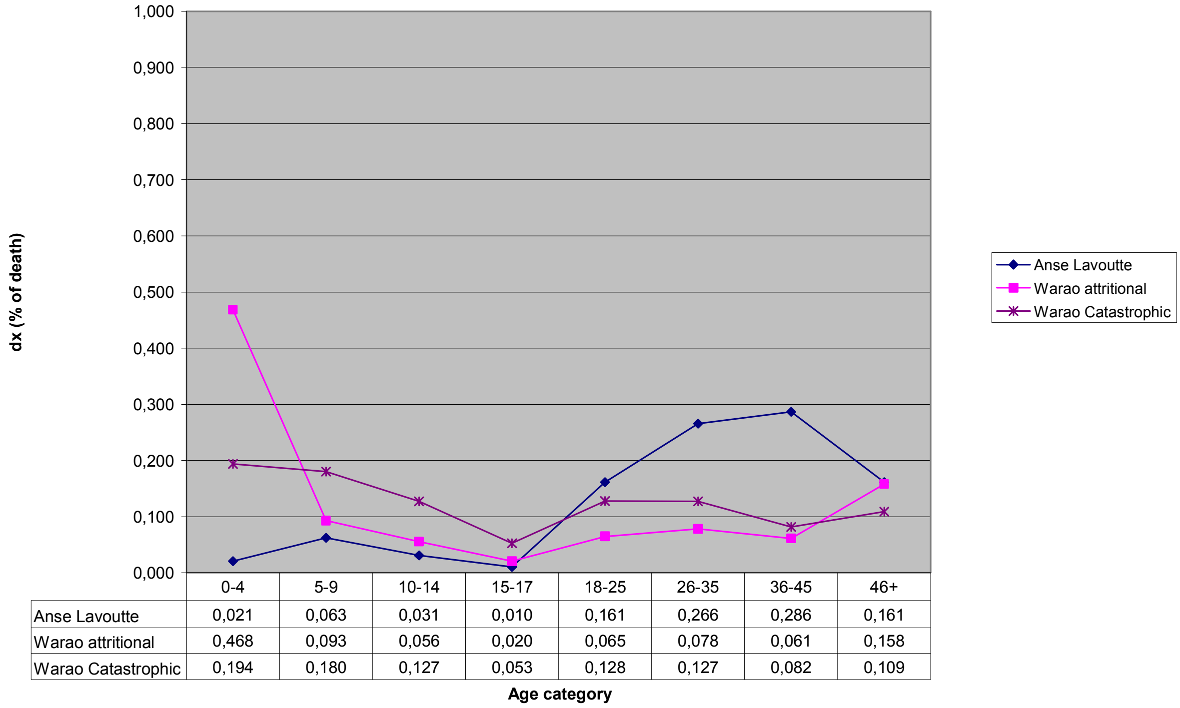


Figure 34: Distribution of individuals according to Adult/Sub-Adult division. N=48

x	Dx	dx	lx	qx	Lx	Tx	ex
0-4	1,00	0,021	1,000	0,021	4,948	33,266	33,266
5-9	3,00	0,063	0,979	0,064	4,740	28,318	28,920
10-14	1,50	0,031	0,917	0,034	4,505	23,578	25,722
15-17	0,50	0,010	0,885	0,012	2,641	19,073	21,541
18-25	7,75	0,161	0,875	0,185	5,560	16,432	18,780
26-35	12,75	0,266	0,714	0,372	5,807	10,872	15,237
36-45	13,75	0,286	0,448	0,640	3,047	5,065	11,308
46+	7,75	0,161	0,161	1,000	2,018	2,018	12,500
Total:	48,00						

Table 16: Abridged life table for the population of Anse Lavoutte.



	0-4	5-9	10-14	15-17	18-25	26-35	36-45	46+
Anse Lavoutte	0,021	0,063	0,031	0,010	0,161	0,266	0,286	0,161
Warao attritional	0,468	0,093	0,056	0,020	0,065	0,078	0,061	0,158
Warao Catastrophic	0,194	0,180	0,127	0,053	0,128	0,127	0,082	0,109

Figure 35: Comparison of % of dead (dx) for the population of Anse Lavoutte, Warao attritional standard model and Warao catastrophic standard model.

The site of Anse Lavoutte has an underenumeration of non-adults, which in turn affects the remaining age categories. This can be explained by the fact that this site suffered from severe natural and cultural erosion, resulting in a low completeness and very poor preservation of skeletons. This preservational bias then most likely is the cause for the erroneous mortality profile. The population depicted here then is not a representation of the living population[27].

[27] K-S two-sample tests showed that D=0.513 for ($P \leq 0,01=0.255$) and D= 0.429 ($P \leq 0,01=0.239$) for the attritional and catastrophic life tables respectively. This means that the site of Anse Lavoutte is significantly different from the attritional and catastrophic populations.

5.14 ST. LUCIA: POINTE DE CAILLE

The overall preservation and completeness of the skeletons is fair. Fabrizii-Reuer and Reuer originally gave a rough estimation of the completeness and preservation combined: about 1/3 was very well-preserved, another 1/3 was well-preserved and the last 1/3 was badly preserved. The authors attributed the state of preservation to both the erosion of the site and the graveyard by the ocean, but also to the soil in which the bodies were buried. The poor preservation means it is necessary to take into account the fact that errors might occur in the analysis due to this poor preservation.

The consequent analysis by the Leiden team used ageing methods according to the morphology of the pelvis (Ascádi & Nemeskéri 1970: 79) and the cranium (Ascádi & Nemeskéri 1970: 76). Ageing was done according to the pubic symphysis (Katz & Suchey 1968; Todd 1921a, 1921b), the auricular surface (Lovejoy *et al.* 1985), sternal rib ends (İşcan & Loth 1986a, 1986b), ectocranial suture closure (Meindl & Lovejoy 1985) and dental attrition (Brothwell 1981). The result of these analyses can be found in Figures 25 & 26. The low number of total individuals can be attributed to the number of indeterminates and Sub-Adults in the collection.

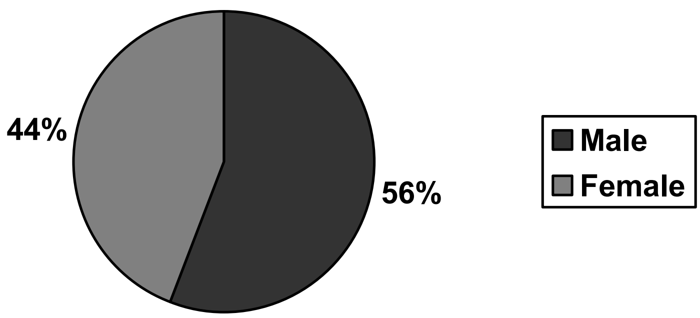


Figure 36: Distribution of individuals according to sex. N=34

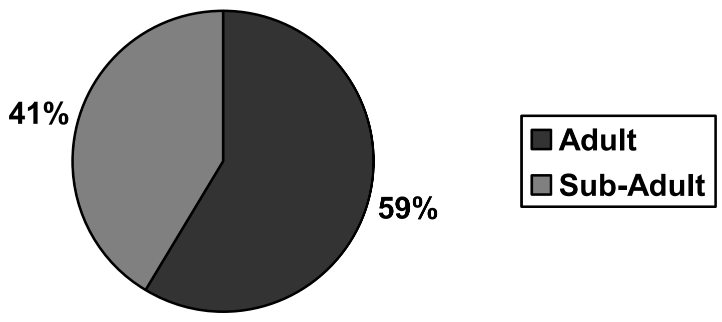


Figure 37: Distribution of individuals according to Adult/Sub-Adult division. N=48

x	Dx	dx	lx	qx	Lx	Tx	ex
0-4	13,76	0,237	1,000	0,237	4,407	26,960	26,960
5-9	8,24	0,142	0,763	0,186	3,459	22,553	29,568
10-14	0,00	0,000	0,621	0,000	3,103	19,095	30,764
15-17	1,00	0,017	0,621	0,028	1,836	15,991	25,764
18-25	4,53	0,078	0,603	0,129	3,951	14,155	23,457
26-35	7,03	0,121	0,525	0,231	4,647	10,204	19,424
36-45	11,72	0,202	0,404	0,500	3,031	5,557	13,750
46+	11,72	0,202	0,202	1,000	2,526	2,526	12,500
Total:	58,00						

Table 17: Abridged life table for the population of Pointe de Caille.

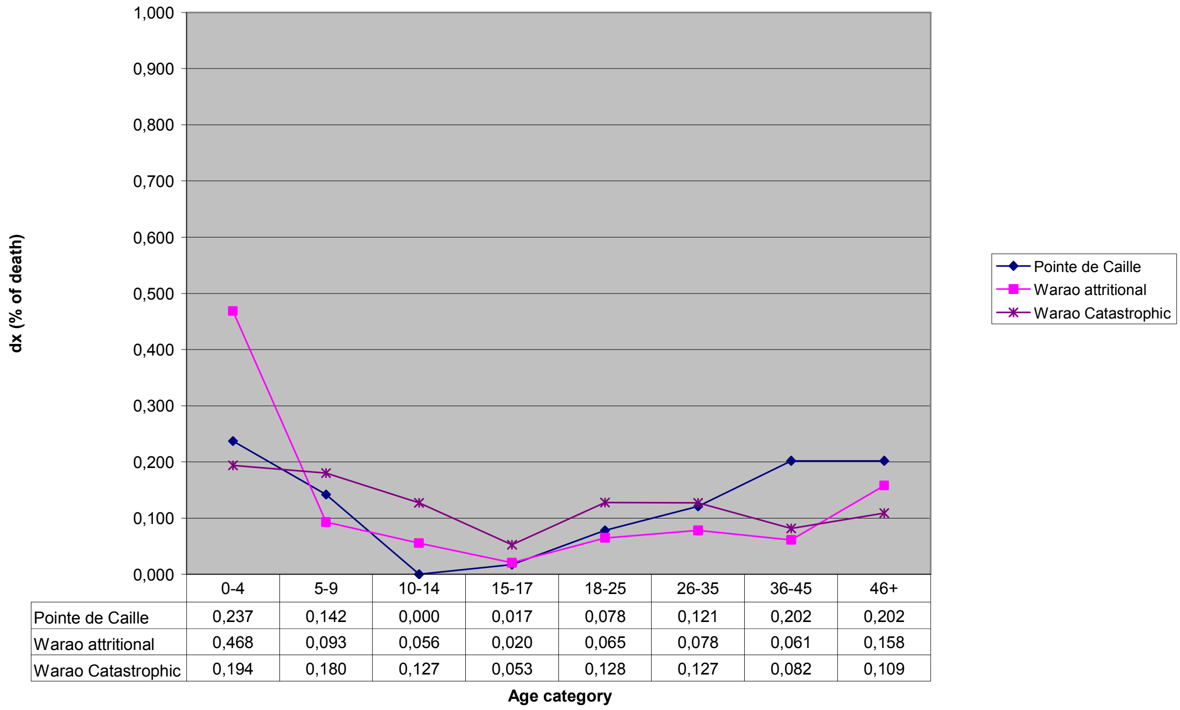


Figure 38: Comparison of % of dead (dx) for the population of Pointe de Caille, Warao attritional standard model and Warao catastrophic standard model.

The site of Pointe de Caille closely resembles the Warao attritional[28] population. There is an underenumeration of children, which might be explained by the presererveration, as some skeletons were preserved badly, which could mean that some might have been destroyed. Even taking this underenumeration of non-adults in consideration however, does not take away from the fact that the Pointe de Caille population resembles an attritional population. The statistics show however, that the attritional model and Pointe de Caille are significantly different and they therefore cannot be compared.

5.15 ST. THOMAS: TUTU

Individuals were assigned an age based on methods for the ventral arc, subpubic concavity, medial aspect of the pubis, subpubic angle, preauricular sulcus, relative length of the pubis and the sciatic notch (Bass 1987; Buikstra & Ubelaker 1994; Phenice 1969; Ubelaker 1989; White 1991). Methods for sexing on the skull were also employed (Bass 1987; Buikstra & Ubelaker 1994; Krogman & İşcan 1986; Ubelaker 1989). The distribution of individuals according to sex can be found in Figure 39.

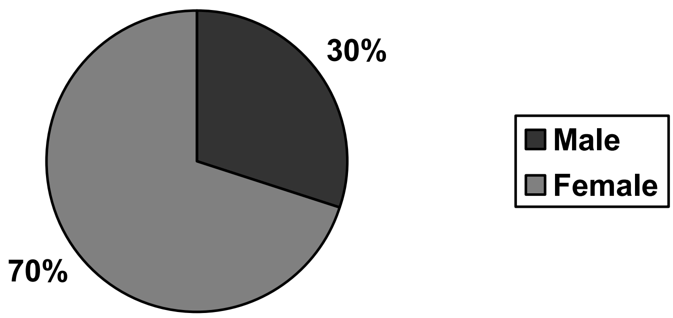


Figure 39: Distribution of individuals according to sex. N=20

Individuals were aged according to morphological changes in the pubic symphysis (Brooks & Suchey 1990) the auricular surfaces (Lovejoy *et al.* 1985) and cranial suture closure (Meindl & Lovejoy 1985). The distribution of individuals according to Adult/Sub-Adult division can be found in Figure 40.

[28] K-S two-sample tests showed that D=0.242 for (P≤0,01=0.236) and D= 0.214 (P≤0,01=0.219) for the attritional and catastrophic life tables respectively. This means that the site of Pointe de Caille is significantly different from the attritional population, but not from the catastrophic population.

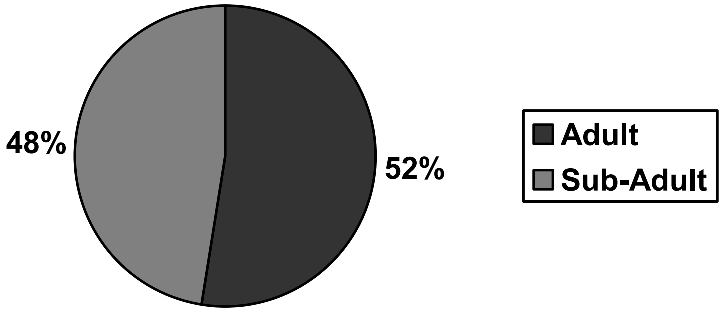


Figure 40: Distribution of individuals according to Adult/Sub-Adult division. N=42

x	Dx	dx	lx	qx	Lx	Tx	ex
0-4	1,50	0,056	1,000	0,056	4,861	38,593	38,593
5-9	3,50	0,130	0,944	0,137	4,398	33,731	35,716
10-14	0,00	0,000	0,815	0,000	4,074	29,333	36,000
15-17	1,00	0,037	0,815	0,045	2,389	25,259	31,000
18-25	2,00	0,074	0,778	0,095	5,185	22,870	29,405
26-35	0,00	0,000	0,704	0,000	7,037	17,685	25,132
36-45	8,00	0,296	0,704	0,421	5,556	10,648	15,132
46+	11,00	0,407	0,407	1,000	5,093	5,093	12,500
Total:	27,00						

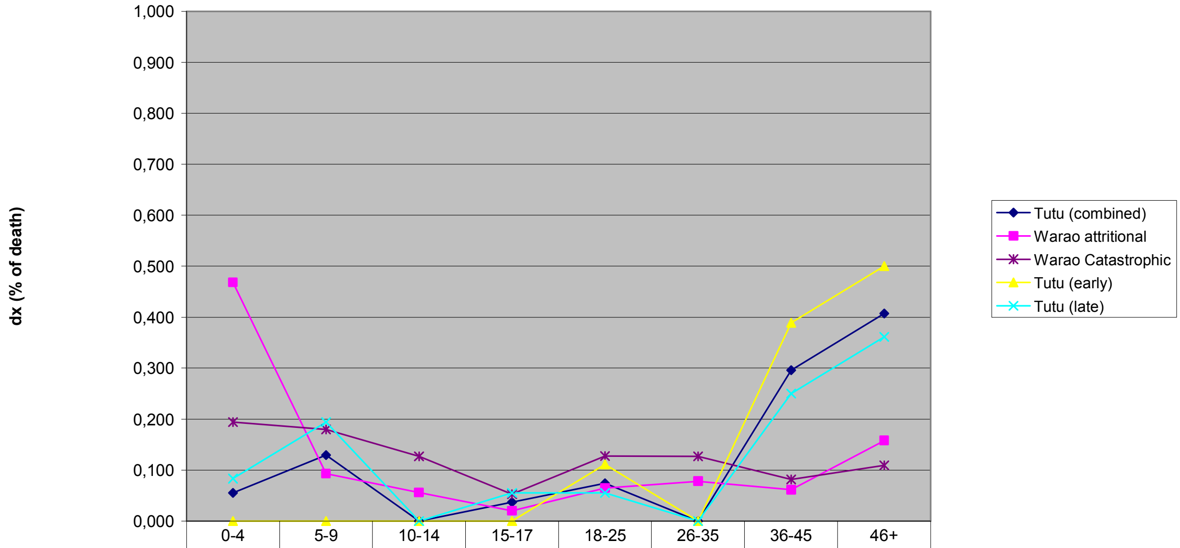
Table 18: Abridged life table for the population of Tutu (combined).

x	Dx	dx	lx	qx	Lx	Tx	ex
0-4	0,00	0,000	1,000	0,000	5,000	46,694	46,694
5-9	0,00	0,000	1,000	0,000	5,000	41,694	41,694
10-14	0,00	0,000	1,000	0,000	5,000	36,694	36,694
15-17	0,00	0,000	1,000	0,000	3,000	31,694	31,694
18-25	1,00	0,111	1,000	0,111	6,611	28,694	28,694
26-35	0,00	0,000	0,889	0,000	8,889	22,083	24,844
36-45	3,50	0,389	0,889	0,438	6,944	13,194	14,844
46+	4,50	0,500	0,500	1,000	6,250	6,250	12,500
Total:	9,00						

Table 19: Abridged life table for the population of Tutu (early).

x	Dx	dx	lx	qx	Lx	Tx	ex
0-4	1,50	0,083	1,000	0,083	4,792	34,542	34,542
5-9	3,50	0,194	0,917	0,212	4,097	29,750	32,455
10-14	0,00	0,000	0,722	0,000	3,611	25,653	35,519
15-17	1,00	0,056	0,722	0,077	2,083	22,042	30,519
18-25	1,00	0,056	0,667	0,083	4,472	19,958	29,938
26-35	0,00	0,000	0,611	0,000	6,111	15,486	25,341
36-45	4,50	0,250	0,611	0,409	4,861	9,375	15,341
46+	6,50	0,361	0,361	1,000	4,514	4,514	12,500
Total:	18,00						

Table 20: Abridged life table for the population of Tutu (late).



	0-4	5-9	10-14	15-17	18-25	26-35	36-45	46+
Tutu (combined)	0,056	0,130	0,000	0,037	0,074	0,000	0,296	0,407
Warao attritional	0,468	0,093	0,056	0,020	0,065	0,078	0,061	0,158
Warao Catastrophic	0,194	0,180	0,127	0,053	0,128	0,127	0,082	0,109
Tutu (early)	0,000	0,000	0,000	0,000	0,111	0,000	0,389	0,500
Tutu (late)	0,083	0,194	0,000	0,056	0,056	0,000	0,250	0,361

Age category

Figure 41: Comparison of % of dead (dx) for the population of Tutu (complete), Tutu (early), Tutu (late), Warao attritional standard model and Warao catastrophic standard model.

Based on dating the site of Tutu could be subdivided into two periods, an early and a late component. The paleodemographic analyses have been performed accordingly, giving an early and a late component. The two resulting profiles are different amongst each other (Figure 41), but both of them cannot be matched positively to any of the standard models, although statistics show that the Tutu (late) component is significantly different from the standard catastrophic population.

There is not only an underenumeration of the non-adult categories, something that might be expected, but also of some of the adult categories. This profile then cannot be explained by any proposed paleodemographic model and it must therefore be assumed that the two components are not representative of the living population at Tutu[29][30]. Moreover, there is no pattern which can be found that might be seen as a development of sorts in the Tutu sample when looking at the early and late components.

5.17 Juvenility Indices

The juvenility index was calculated for the sites of El Chorro de Maita, El Atajadizo, El Soco, Juan Dolio, Anse à la Gourde, Maisabel, Punta Candalero, Paso del Indio, Tibes, Kelbey's Ridge, Anse Lavoutte, Pointe de Caille and all Tutu components, comparing them amongst each other, the results of which are shown in Table 20[31].

Site	El Chorro de Maita	El Atajadizo	El Soco	Juan Dolio	Anse à la Gourde	Maisabel	Punta Candalero	Paso del Indio
5-14/18+	0,341	0,188	0,141	0,265	0,104	0,037	0,078	0,430
Site	Tibes	Kelbey's Ridge	Anse Lavoutte	Pointe de Caille	Tutu (combined)	Tutu (early)	Tutu (late)	
5-14/18+	0,040	1,000	0,119	0,264	0,214	0,000	0,375	

Table 21: Juvenility Indices of the sites in this research based on the distribution of individuals amongst the 5-15 and 18+ age categories. Punta Macao is not included because of a lack of data.

High numbers here tend to indicate a high fertility, whereas low numbers indicate a low fertility. The two extremes in this table are Kelbey's Ridge and the early Tutu component which have a perfect distribution between Adults and Sub-Adults and no Sub-Adults respectively. The general underrepresentation of Sub-Adult individuals in the Caribbean sample is influencing this statistic as well since the juvenility indices of the Warao attritional and catastrophic life table are 0,467 and 0,809 respectively. Only the Paso del Indio sample gets close to the expected values, whereas the other populations tend to fall below the expected values. Possible reasons for the Sub-Adult underrepresentation will be discussed in the following chapter.

[29] K-S two-sample tests showed that D=0.670 for (P≤0,01=0.552) and D= 0.698 (P≤0,01=0.545) for the attritional and catastrophic life tables respectively of the Tutu Early component. This means that the Tutu Early component is significantly different from both the attritional and catastrophic populations.

[30] K-S two-sample tests showed that D=0.392 for (P≤0,01=0.397) and D= 0.420 (P≤0,01=0.387) for the attritional and catastrophic life tables respectively of the Tutu Late component. This means that the Tutu Late component is not significantly different from the attritional population, but is significantly different from the catastrophic population.

[31] χ^2-tests showed that there is a significant association between the Adults and Sub-Adult age distribution, with the χ^2 for the Caribbean populations being 52.21 and the values for (P≤0,01) being 34.5.

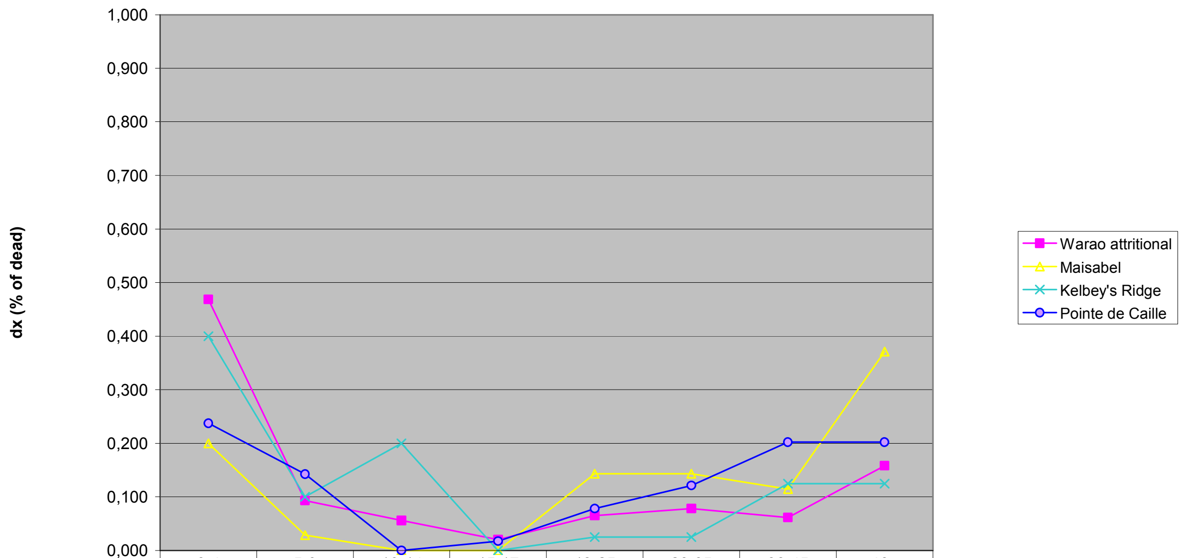
6. Discussion

6.1 Introduction

The previous chapter outlined each single site. As mentioned before however, one must be able to compare these sites not only to one standard, but also to each other in order to gain a better pan-regional perspective of the demography of the Caribbean. In order to gain this perspective the sites mentioned in the previous chapters will be compared here. The sites in question will be compared to each other based on their initial comparison to the two standard models and the conclusions drawn in the previous chapter about those comparisons. Firstly the sites which were attributed to an attritional profile will be reviewed, followed by those attributed to a catastrophic profile. Lastly all other profiles, including those attributed to incomplete samples, preservational and methodological biases and failed colonization attempts will be reviewed.

6.2 Attritional profiles

It was concluded earlier that the sites of Maisabel, Kelbey's Ridge and Pointe de Caille could most likely be attributed to an attritional profile. In order to see if any of these sites can be compared not only to each other but also to the standard attritional model a Kolmogoroff-Smirnoff two sample test was performed between each site and the standard model and all the sites amongst themselves. The results of this test showed that the sites are in fact not comparable to the standard model and each other. This means that these sites cannot be compared to each other from a statistical standpoint. They will be treated together here however, based on their overall similarity to these profiles. Figure 44 depicts these sites and the Warao attritional standard model.



	0-4	5-9	10-14	15-17	18-25	26-35	36-45	46+
Warao attritional	0,468	0,093	0,056	0,020	0,065	0,078	0,061	0,158
Maisabel	0,200	0,029	0,000	0,000	0,143	0,143	0,114	0,371
Kelbey's Ridge	0,400	0,100	0,200	0,000	0,025	0,025	0,125	0,125
Pointe de Caille	0,237	0,142	0,000	0,017	0,078	0,121	0,202	0,202

Age category

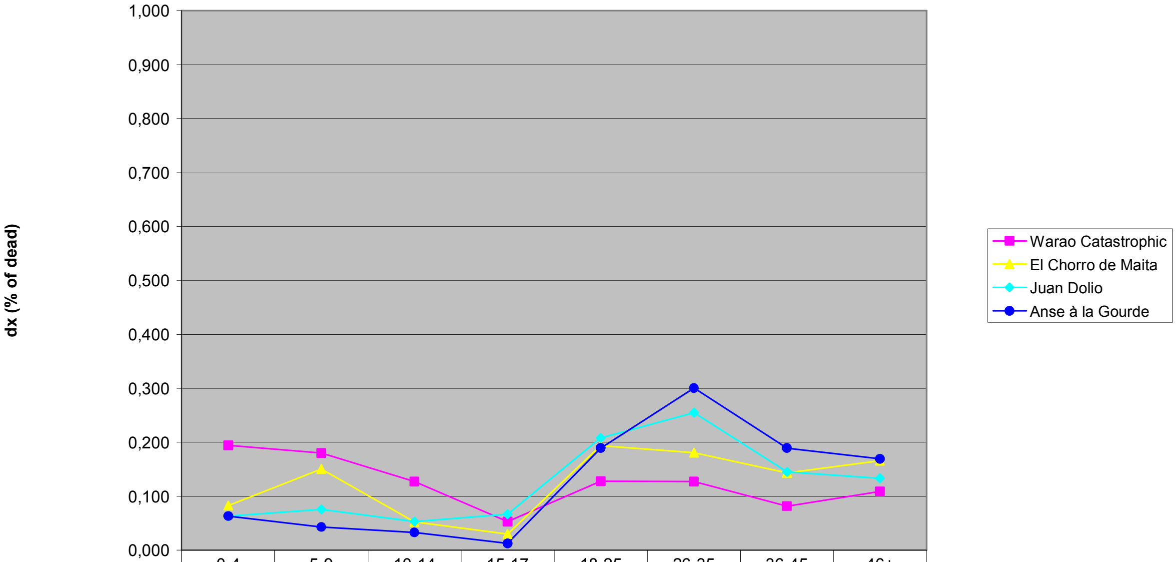
Figure 42: Comparison of % of dead (dx) for the population of Maisabel, Kelbey's Ridge, Pointe de Caille and Warao attritional standard model.

The slight differences between the sites themselves and between them and the standard model can be explained by the fact that they can be attributed to a standard attritional model but they themselves are of course in no way a direct match, but rather a representation or slight deviation on the norm. It has been postulated that the graveyard at Maisabel is much larger than the area which has been recovered as of now (Siegel 1996: 323). This would mean that the retrieved individuals are a sample of a larger group, which resembles the attritional model more closely. The site of Kelbey's Ridge is a small seasonal outpost where the people interred there are also a sample of a population which most likely resided somewhere else primarily. This then would mean that the individuals at Kelbey's Ridge are a sample out of a larger population, indicating that this larger population also is attritional in nature. The site of Pointe de Caille only suffers from a slight preservational bias, as some of the skeletons were badly preserved (Fabrizii-Reuaer & Reuer 2005), causing an underenumeration of Sub-Adults, as these bones are most easily destroyed under harsh conditions.

These sites have similar profiles and yet are located on different islands during different time periods. This then means that these attritional populations cannot be defined to an island or time period.

6.3 Catastrophic profiles

The sites of El Chorro de Maíta, Juan Dolio and Anse à la Gourde have been identified as sites suffering from a catastrophic event, which resulted in a catastrophic mortality profile. As with the sites which have been classified as belonging to an attritional population, these sites classified as belonging to a catastrophic population have been submitted to a Kolmogoroff-Smirrnoff two sample test. The results of this test indicate that these sites are not comparable to each other or to the Warao catastrophic standard model. They will be treated together here however, based on their overall similarity to these profiles. Figure 43 depicting these sites and the catastrophic standard can be found below.



	0-4	5-9	10-14	15-17	18-25	26-35	36-45	46+
Warao Catastrophic	0,194	0,180	0,127	0,053	0,128	0,127	0,082	0,109
El Chorro de Maita	0,083	0,150	0,053	0,030	0,194	0,181	0,144	0,166
Juan Dolio	0,063	0,076	0,053	0,067	0,208	0,255	0,145	0,133
Anse à la Gourde	0,063	0,043	0,033	0,013	0,189	0,301	0,189	0,169

Age category

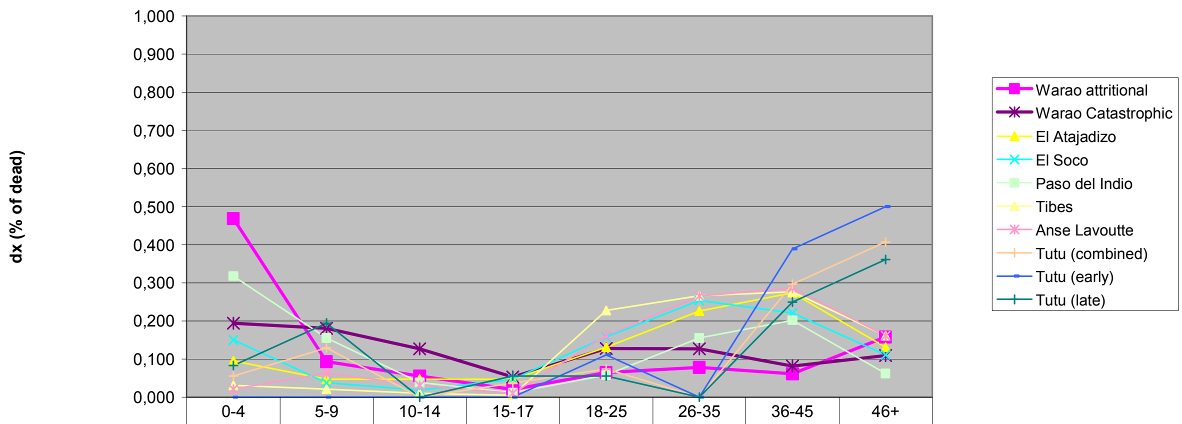
Figure 43: Comparison of % of dead (dx) for the population of El Chorro de Maíta, Juan Dolio, Anse à la Gourde and Warao catastrophic standard model.

The three sites depicted here still differ at times from the standard model. These discrepancies can be explained however, by the nature of these sites. El Chorro de Maíta, being a contact period site, most likely suffered from an epidemic of sorts which killed most of the population. Anse à la Gourde is a composition of at least two different occupation periods. These time periods however, could not be distinguished for all of the population, which means that the discrepancies in the overall composition is most likely caused by the difference between the two profiles. All three of the sites show an underenumeration of Sub-Adults. At the sites of El Chorro de Maíta and Anse à la Gourde this underenumeration can be attributed to an unfavourable preservation of Sub-Adult bones. The preservational status of the individuals at Juan Dolio has however, not been documented and therefore it cannot be assumed that this unfavorable preservation towards Sub-Adults, is also the case here.

These three sites are to be found on three different islands and during three different time periods. Whereas with El Chorro de Maíta the cause for the catastrophic profile can be found in both the time and location of the site, the other two sites catastrophic profiles offer no easy explanations. The reason behind the existence of this catastrophic profile must be sought in local causes and need further investigation into these sites. Rather than speculation which is the most that can be offered here.

6.4 Other profiles

It has become clear that most of the sites discussed here cannot be matched positively to any standard profile. Most of the sites suffered from incomplete analyses and biases resulting from methodological and preservational problems, as can be seen in Figure 44.



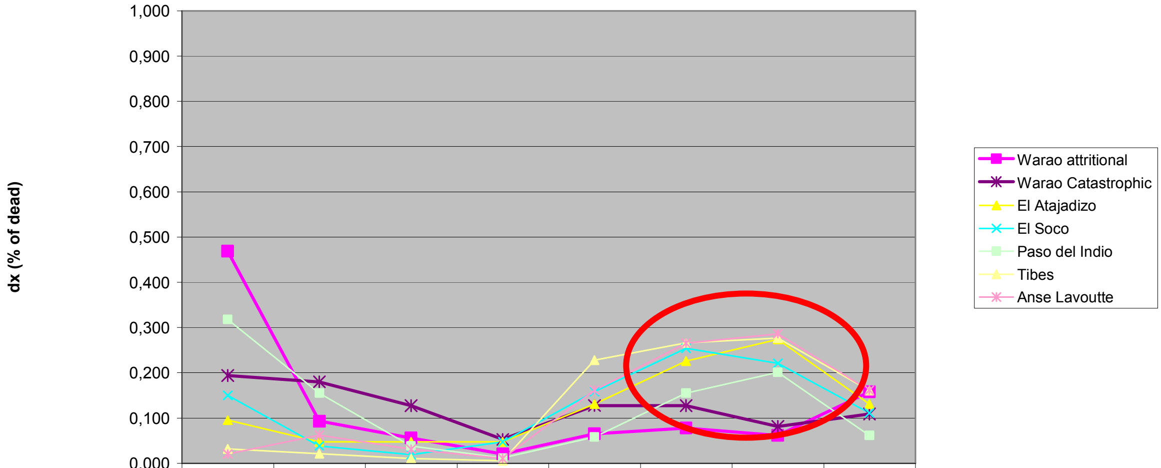
	0-4	5-9	10-14	15-17	18-25	26-35	36-45	46+
Warao attritional	0,468	0,093	0,056	0,020	0,065	0,078	0,061	0,158
Warao Catastrophic	0,194	0,180	0,127	0,053	0,128	0,127	0,082	0,109
El Atajadizo	0,095	0,048	0,048	0,048	0,131	0,226	0,274	0,131
El Soco	0,150	0,038	0,019	0,048	0,158	0,254	0,221	0,111
Paso del Indio	0,318	0,155	0,039	0,012	0,058	0,155	0,202	0,062
Tibes	0,032	0,021	0,011	0,005	0,228	0,266	0,277	0,161
Anse Lavoutte	0,021	0,063	0,031	0,010	0,161	0,266	0,286	0,161
Tutu (combined)	0,056	0,130	0,000	0,037	0,074	0,000	0,296	0,407
Tutu (early)	0,000	0,000	0,000	0,000	0,111	0,000	0,389	0,500
Tutu (late)	0,083	0,194	0,000	0,056	0,056	0,000	0,250	0,361

Age category

Figure 44: Comparison of % of dead (dx) for the population of El Atajadizo, El Soco, Paso del Indio, Tibes, Anse Lavoutte, Tutu (combined), Tutu (early), Tutu (late), Warao attritional standard model and Warao catstrophic standard model.

Although none of these sites can be clearly assigned t one of the two standard models, there is a pattern to be discerned. This pattern does not apply to the Tutu population (combined or one of the two components) as this profile is different even within this group. To make the pattern even clearer the figure below depicts those sites who match this pattern. For these sites a

Kolmogoroff-Smirnoff two sample tests were performed showing that they are not comparable from a statistical standpoint. However, since it is known that they are affected by biases and an incomplete dataset, trying to ascertain if these sites are comparable is futile as these sites are not comparable because of the aforementioned biases.



	0-4	5-9	10-14	15-17	18-25	26-35	36-45	46+
Warao attritional	0,468	0,093	0,056	0,020	0,065	0,078	0,061	0,158
Warao Catastrophic	0,194	0,180	0,127	0,053	0,128	0,127	0,082	0,109
El Atajadizo	0,095	0,048	0,048	0,048	0,131	0,226	0,274	0,131
El Soco	0,150	0,038	0,019	0,048	0,158	0,254	0,221	0,111
Paso del Indio	0,318	0,155	0,039	0,012	0,058	0,155	0,202	0,062
Tibes	0,032	0,021	0,011	0,005	0,228	0,266	0,277	0,161
Anse Lavoutte	0,021	0,063	0,031	0,010	0,161	0,266	0,286	0,161

Age category

Figure 45: Comparison of % of dead (dx) for the population of El Atajadizo, El Soco, Paso del Indio, Tibes, Anse Lavoutte, Warao attritional standard model and Warao catastrophic standard model, and a circle depicting the grouped abnormality

When one looks at the Figure 45 it is clear that the Sub-Adult category of these populations differ widely. Only the site of Tibes has a proportion of Sub-Adults that comes close to the values of the standard model. The other sites (El Atajadizo, El Soco, Paso del Indio and Anse Lavoutte) have proportions of Sub-Adults far below the expected values as derived from the standard model.

What then makes these sites interesting are the proportions of Adults. As can be seen from the cicle in the above figure the Adult portion of these populations all describe an arc, which starts near the attritional standard models values for the 18-25 age category then stay above the line for the catastrophic standard model and continues far above both standard models. As of yet there are no standard models or theories which might explain this line observed here. It is most unlikely that this is a natural phenomenon, since it occurred over many different sites, of different sizes, at different time periods. Any such natural pattern would also mean that those people in their reproductive years would die at a rate that is higher than at a catastrophic event, meaning that this would be an age specific mortality. There are no natural pathological conditions known to me at this time that would be responsible for such a high age-specific mortality at this time. Such a high level of Adult deaths would also mean that the population at these sites would be shrinking at tremendous rates, something that cannot be upheld when one looks at the long span of occupation at most of them. A cultural explanation is also lacking at this time. The only cause for higher than normal age-specific mortality (even at the levels seen here) would be chronic warfare or raiding. This bulge of high mortality would then however be observed more at the Younger Adult age categories, rather than at the Older Adult age categories. It would also mean that there would be a disproportionate number of males present in the burial assemblage, who would show some signs of violent death. None of these things is the case however with any of these sites. A preservational or methodological bias can also not be substantiated here, as the categories which are overrepresented would then be of roughly equal values, since the methodological and preservational biases affect these categories equally, something that is clearly not the case here. It is clear that these biases also do not affect the sample when one looks at the site of Paso del Indio. Here the number of Sub-Adults is not disproportionately low, but rather is very similar to the values that one is to expect.

The reason behind this correlation of the mortality for Older Adults at these sites remains unknown at this time and further investigations into the matter are necessary to find any possible explanation and solution to the problem at hand.

6.5 Sub-Adult underestimation

A general pattern can be observed when looking at most of the sites under investigation here. All of these sites, with the exception of Kelbey's Ridge, have a number of Sub-Adults which is lower then were to be expected. This may be the result of a methodological or preservational bias at some times, but it is uncommon that such a pattern would persist on a wider regional and chronological scale as is the case here. The systematic underrepresentation then cannot be sought in natural or methodological explanations and must therefore come forth out of a cultural reasoning.

As mentioned before (Duday 2009: 58) children might not be buried in the same locality as older individuals since they have not yet achieved a status in life (Gowland 2006). A systematic underenumeration might then also be caused by the decision to not bury Sub-Adults among the regular population, since they have not yet achieved the same status as Adults (Baxter 2008: 165). With his cultural practice in mind it is argued here that the systematic underenumeration of Sub-Adults in the Caribbean is caused by a cultural practice in which these individuals are not buried among the remaining population in the main graveyard, but rather are buried elsewhere (Parker Pearson 2008: 75-78, 103) or even discarded at death. The fact these individuals then are not interred means that the bones are even more likely to be destroyed by natural forces (i.e. washed away by rain or mauled by wild animals) further enhancing the underenumeration of these individuals in the graveyard assemblage.

This cultural practice also means that the people inhabiting these sites had a worldview in which a social status not only existed, but to which also was adhered, even after death, suggesting a strict adherence to not only a social status (being it achieved or ascribed), but also to the worldview in compliance with that social status. Being that this practice was widespread through the Caribbean, from Cuba to Trinidad and in time, would seem to indicate that this worldview and the concomitant cultural practice were most likely homogenous throughout the Caribbean region. This would also mean that not only the children did not have a certain status, but that adults did. People interred in these graveyards then, were considered of value to their society and were therefore buried n the communal graveyard.

7. Conclusions

In this thesis it has been shown that paleodemography is a valuable addition for the many lines of research which exist in the Caribbean. When researching such topics as mobility and migration, the development of social complexity or adherence to social values and rules, paleodemography can be exceptionally helpful. By adhering to the methodology specified in this research it is clear that paleodemography is not only useful when considering large scale European graveyards, but can also be used to analyze the smaller communities that characterize the pre-Columbian Caribbean.

Through analysis of graveyard assemblages of the sites in this research three main points have become clear about the demography of the pre-Columbian Caribbean.

Firstly it has become evident that there is no standard community which can be found throughout the Caribbean, both geographically and temporary. The communities found in the Caribbean can be characterized as diverse and dynamic, with different sites displaying different characteristics. This diversity ranges from sites suffering from catastrophic events, which are reflected in the mortality patterns of the sites, to sites where the population can be characterized as suffering from a 'regular' or attritional mortality profile. This research has even given us the chance to identify the site of Punta Candalero as a failed migration attempt, something that underlines the mobility of the Caribbean people. The results of all the analysis performed in this research have been summarized in Table 21.

Secondly it has been shown that the chronic underenumeration of Sub-Adults cannot be explained by natural or methodological causes, but rather must be attributed to a cultural practice in which children, infants and adolescents were systematically excluded from the regular population after death. This shows that there was some form of achieved status present in the Caribbean during Ceramic times, as evidenced by the fact that younger individuals who not yet had achieved a status in society were shunned from the regular population after death.

Site	Dating	Results
El Chorro de Maita, Cuba	AD 1400-1600	Catastrophic mortality profile
El Atajadizo, Dominican Republic	Ostionoid & Chicoid phases	Incomplete analysis
El Soco, Dominican Republic	Ostionoid & Chicoid phases	Incomplete analysis
Juan Dolio, Dominican Republic	AD 1400-1600	Catastrophic mortality profile
Punta Macao, Domincan Republic	AD 800-1500	Incomplete analysis
Anse a la Gourde, Guadaloupe	AD 400-1400	Catastrophic mortality profile
Maisabel, Puerto Rico	Hacienda Grande - Ostionoid	Attritional mortality profile
Punta Candalero, Puerto Rico	AD 400-600	Failed migration attempt
Paso del Indio, Puerto Rico	Elenan Ostionoid	Biased sample
Tibes, Puerto Rico	Ceramic, no age on burials	Biased sample
Kelbey's Ridge, Saba	AD 1350-1450	Attritional mortality profile
Anse Lavoutte, St. Lucia	AD 400-1400	Biased sample
Pointe de Caille, St. Lucia	AD 300-1000	Attritional mortality profile
Tutu, St. Thomas	AD 450-1535	Incomplete analysis

Table 22: List of researched sites. Sites are ordered according to alphabetical order of country and name of the site. Also listed are dating and results of the paleodemographic analyses.

Lastly is has been shown that a standard model which is derived from ethnographical research in Lowland South America can serve as a viable alternative to the more often used model life tables derived from European contexts. In this manner the analogy between the Amerindians living nowadays in South America and those who lived in the Caribbean during pre-Columbian times is strengthened.

It is also important to note the two main conclusions which can be drawn on the methodology used in this research, as this methodology is of importance as well.

First and foremost it has been found that the research done here is hampered by the fact that many sites with a skeletal assembly have been incompletely excavated and/or analyzed or a full and complete physical anthropological report is not available for that site. These problems are not easily overcome, but can be solved in the future by putting more emphasis on the retrieval of the graveyard assembly of a site, rather than seeing it as a complementary element to the main site. Furthermore the statistical analyses have shown that many of the sites are not comparable to the standard model used here. This can be attributed to the fact that the sites excavated in the Caribbean usually consist of small numbers of individuals, which as mentioned earlier affects the statistics of these populations.

Although the methodology used in this research cannot always be adhered due to the abovementioned fact of incompleteness of excavations, analyses or reports and the statistical problems resulting from small numbers of individuals this research has shown that it is possible to use a standardized framework in which different sites, from different time periods, excavated and reported on by different researchers are placed. The usage of Bradford age categories allows for the easy redistribution of individuals from specific reports into broad categories, allowing for a lower misclassification of individuals. Also, the usage of standardized automatic spreadsheets allowed for the fast and precise calculations of the necessary life table and mortality profiles. Because of the easiness to use the methodology outlined in this research it is possible to take new data which might become available in the future and use it within the dataset created here. The use of standardized methodology in Caribbean paleodemography must also be encouraged, since this research has shown that the wide variety of methods used by other researchers and the (sometimes) incompleteness of reports and indication of what methods were used for aging and sexing the skeletal assembly results in the fact that much essential data for sites is missing to perform the proper in depth analyses.

The possibility to use this methodology and these results in the future is also something that should stimulate future research in this area. This future research should then not only try to broaden the scope of paleodemographical investigations by incorporating more and more sites, but also try to deepen the field with the usage of newer or more sophisticated techniques, which might enhance results.

The incorporation of new sites should not only focus on ceramic sites, but also on Archaic and Colonial sites. These sites most likely have a distinctive profile themselves and should therefore proof to be an interesting research topic. Moreover, researching these sites can give a more detailed image about the changes in the demographical landscape of the Caribbean through the ages. These future investigations can then provide a better image on the islands or even specific sites by being to place them demographically in a wider timeline.

Newer or more sophisticated techniques could help in the future with discerning more details about the paleodemography of the Caribbean region. This research used a standardized framework to fit a large number of sites. When researching single sites more in depth it can be possible to use such techniques as MLE (Maximum Likelihood Estimation), which was not possible to do here due to the incompleteness of many physical anthropological and excavation reports. This would allow researchers to gain more information from single sites and thus be able to better understand them.

Overall this research must be seen as yet another step towards the goal of understanding Caribbean topics such as mobility, culture contact and status within a community. It was not the first step nor will it be the last, but rather it is one in a long journey of Caribbean archaeology in which the archaeologists and historians attempt to understand those people who they investigate.

Samenvatting

Dit onderzoek doet een poging om paleodemografie op grote schaal te introduceren in het Caraïbisch gebied. Hierbij wordt eerst de geschiedenis van het vakgebied beschreven waarbij aandacht wordt geschonken aan de ontwikkeling vanuit historische demografie naar demografie waarbij fysisch antropologisch onderzoek centraal staat aan de analyses. Hierbij wordt ook gelet op de grote vooruitgangen, struikelblokken en oplossingen die door de jaren heen zijn ontwikkeld. Als laatste wordt aandacht geschonken aan de ontwikkeling van paleodemografie in het Caribische gebied, waarbij werk van de auteur en anderen centraal staat. Als tweede worden de methoden en technieken van deze studie uitgelegd. Hierbij wordt gebruik gemaakt van Bradford leeftijdscategorieën die door het systeem van het gebruik van categorieën in plaats van precieze leeftijden een minder grote kans op misclassificatie heeft. Het gebruik van dit systeem zorgt er ook voor dat data van andere onderzoeken gemakkelijk kan onder worden gebracht in het onderzoek dat hier plaatsvindt. Ook wordt het gebruik van de life table uitgelegd, waarbij de verschillende categorieën en berekening die nodig zijn om die categorieën te berekenen uitgebreid worden uitgelegd. Hier op volgend wordt bepaald wat voor verschillende bevolkingen verschillende karakteristieke profielen opleveren. Deze verschillende profielen zijn onder andere migratie, standaard en catastrofaal. Wat voor implicaties deze profielen voor de interpretatie van een site hebben wordt ook bepaald. De 15 sites die centraal staan in dit onderzoek zijn geselecteerd op basis van hun representatie van de pre-Columbiaanse Ceramische periode, hun grootte van het grafveld (aangezien te kleine populaties grote statistiek fluctuaties kunnen opleveren) en/of hun specifieke functie. Als laatste wordt een nieuwe standaard populatie ter vergelijking geïntroduceerd, die gebaseerd is op etnografisch gegevens van de Warao die heden ten dage leven in de delta van de Orinoco rivier in Zuid-Amerika. Het volgende hoofdstuk introduceert de 15 sites aan de hand van hun geografische locatie, tijdsperiode en de karakteristieken van hun grafveld. Waar mogelijk word uiteengezet hoe de verhoudingen zijn binnen het grafveldassemblage tussen mannen en vrouwen en kinderen en volwassenen. Ook wordt aangegeven hoe goed bewaard en compleet de skeletten zijn, allen zijn elementen die van invloed kunnen zijn op de conclusies die later getrokken gaan worden. Na de introductie van deze sites worden de resultaten gepresenteerd waaruit blijkt dat drie sites een catastrofaal demografisch karakter hebben (El Chorro de Maita, Juan Dolio en Anse à la Gourde), drie een normaal demografisch karakter hebben (Maisabel, Kelbey's Ridge en Pointe de Caille), eentje een mislukte migratiepoging is (Punta

Candalero) en de overige sites gekenmerkt worden door incomplete analyses. Deze sites die incompleet geanalyseerd werden blijken allemaal een overeenkomend patroon te hebben waarbij de sterfte in oudere leeftijdscategorieën hoger dan verwacht is. Een verklaring voor dit patroon kan helaas niet gevonden worden. Uit de analyses blijkt dat de demografie van de pre-Columbiaanse Cariben gekarakteriseerd kan worden als zeer divers, zonder een algemeen regionaal beeld. Verder blijkt dat de standaard ontleend aan de Warao een goed werkend alternatief voor de Europese standaarden is. De methodologie blijkt goed te hebben gewerkt en het is mogelijk om via deze werkwijze in de toekomst nog meer sites te analyseren om ze zo in een breed frame voor demografisch onderzoek te plaatsen.

Abstract

This research makes an attempt at introducing paleodemography on a large scale in the Caribbean. Firstly the history of the discipline will be outlined, focusing on the development from historical demography to demography where physical anthropology is central to the analyses made. Attention will be paid to major advancements, pitfalls and solutions which have been developed through the years. Lastly the development of paleodemography in the Caribbean will be described, giving special attention to the work of the author and others. Secondly the methods and techniques associated with this study will be explained. The methodology uses the Bradford ageing categories which by the usage of categories rather than precise ages allows for a lower number of misclassifications. Using this system also facilitates for data from other investigations to be easily incorporated in this research. The usage of the life table will also be explained, where the different categories and calculations necessary to determine those categories will be introduced. Following this it will be determined which different populations have different population profiles. These different profiles, amongst others, are migratory, standard and catastrophic. The implications these profiles have for the interpretation of the sites will also be determined. The 15 sites which are central to this investigation are selected on the basis of their representation of the Pre-Columbian Ceramic period, the size of their cemeteries (since small population can cause statistical fluctuations) and/or their specific function. Lastly a new standard population for comparative purposes will be introduced which is based on ethnographic data from the Warao who nowadays inhibit the Orinoco Delta in South America. The next chapter introduces the 15 sites based on their geographic location, time period and the characteristics of their graveyards. Where possible the proportions within the graveyard assemblage between males and females, and Adults and Non-Adults will be reviewed. It will also be indicated how well preserved and complete the skeletons are, all of which can have influence on the conclusions which will be drawn later on. After the introduction of these sites the results are presented, indicating that three sites have a catastrophic demographic profile (El Chorro de Maita, Juan Dolio en Anse à la Gourde), three have a normal demographic profile (Maisabel, Kelbey's Ridge en Pointe de Caille), one is a failed colonization attempt (Punta Candalero) and the other sites are characterized by incomplete analyses. The sites which have been incompletely analyzed appear to have a common pattern in which the mortality rates of the older age categories is higher than expected. An explanation for this pattern can however not be found. Form the

analyses it is apparent that the demography of the pre-Columbian Caribbean can be characterized as being very divers, without a general regional image. Furthermore it becomes clear that the standard population derived from the Warao is an alternative to the standard European models which works well in this context. The methodology worked and it is therefore possible to use this methodology in future researchers to allow for these researches to be placed in a broader context of demographic research.

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