1

Introduction

1.1 THE PRINCIPAL CONCERNS OF DEMOGRAPHY

1.1.1 *What is a population?*

The term 'population' refers to a bounded group of living individuals, but
the concept of a population is fluid depending on whether it is used in a
biological or a sociocultural context. In biology, a population is a group of
interbreeding organisms, or more formally a cluster of individuals which
have a high probability of mating with each other compared to their prob-
ability of mating with members of some other population (Pianka, 1978).
Biological populations have many properties, only some of which are the
primary concern of demography. For example, the interaction between a
population and its environment is the concern of ecology, while the varia-
tion of genes within and between populations is the concern of population
genetics and evolutionary biology. Demography considers the population
as a singular object for quantitative analysis, and seeks to explain variations
in population size, structure and dynamics.

An alternative definition, more frequently encountered in the human
sciences, views the population as a social unit in which individuals are
linked by their common linguistic, cultural or historical experience. This
kind of population, sometimes labelled a 'community', a 'culture' or a
'people', refers to a group of individuals united by their mutual social
recognition of ancestry and kinship, by other cultural affinities and by

co-residence or geographical proximity (Kreager, 1997). This definition emphasises socioeconomic and sociocultural factors in the formation and maintenance of human populations.

In considering archaeological populations both the biological and the social perspectives are important. Economic factors are often deeply implicated in the determination of patterns of migration and in an individual's reproductive decisions, while at the same time the constraints of biology are evident in regular patterns of fertility and mortality that are common to all human and animal populations.

1.1.2   Population characteristics

The following characteristics or attributes of populations are important in demographic analysis (Daugherty and Kammeyer, 1995: more formal quantitative definitions of these attributes are provided in Chapter 2).

- Population size: the number of individuals in the population
- Population structure: the distribution of the individuals across designated categories, principally those of age and sex
- Population dynamics: the growth or decline in the size of the population or of its component parts over time
- Population density: the number of individuals resident per unit area of territory
- Fertility: the number of offspring produced by an individual in a given time interval
- Mortality: the likelihood of death occuring to an individual in a given time interval
- Migration: the proportion of individuals entering or leaving the population, other than through fertility or mortality.

Changes in the first four of these attributes (size, structure, dynamics and density) can in principle be predicted for a particular population if fertility, mortality and migration rates for that population are known. However, in real examples of living populations fertility, mortality and migration rates

vary substantially across age and sex categories, and they also change over time. As a result, quantitative demographic models of real populations are often complex and population characteristics occasionally change in a counter-intuitive fashion.

1.1.3   Demographic data: from individual life histories to population parameters

Life-history variables are chronological properties of an organism's life cycle, such as gestation period, time to maturation, frequency of reproduction and longevity (Roff, 1992; Stearns, 1992). In all successful groups of animals individuals are born, move around their environment, potentially reproduce and eventually die. These four classes of life-history events, which are fundamental to the lives of all animals, generate the data for demographic analysis. Within every population individuals vary in their probability of death, in their fertility and in their participation in migration. In the case of mortality and fertility, these events are strongly age structured, with the probability of death usually being much higher in the very young and in the very old, while fertility is usually at a maximum during the early and middle part of adult life. Age and sex differences in migration are observed in most animal species and are also characteristic of many human groups, as the propensity to migrate is strongly conditioned by socioeconomic circumstances and by cultural norms.

The demographic properties and behaviour of a population are therefore a summation and an average of the characteristics and behaviour of its constituent members. The total number of individuals in a population will vary over time if the number of births, deaths, immigrants and emigrants do not balance to zero over the relevant time period. The structure of a population can also change over time independently of the size of the population, and short-term changes in size and structure may be hidden from view by temporal averaging if the data are accumulated over a series of lifespans or generations (such as may happen when vital records are aggregated or when cemetery data are analysed).

1.2   DEMOGRAPHY IN ARCHAEOLOGY

1.2.1   *Archaeology and people*

In seeking to reconstruct the cultures and societies of the past, archaeology primarily investigates the material remnants that survive in the present-day environment. This evidence consists typically of the more robust elements of material culture, supplemented by the organic evidence for past environments and to a lesser extent by the surviving skeletal remains of the people themselves. There is no quick and easy route by which population size and structure can be inferred from these kinds of archaeological data. A multitude of confounding factors, including the differential deposition, preservation and recovery of archaeological remains, conspire to render samples incomplete and unrepresentative, while indirect evidence for population numbers (such as settlement size) is amenable to a variety of conflicting interpretations. However, the following examples outline some of the ways in which demographic models and data can play an important role both in underpinning the theoretical basis of archaeology and in aiding the interpretation of particular sites and assemblages.

1.2.2   *Population pressure: cause or effect?*

Qualitative demographic models have frequently played an important role in theoretical archaeology, as they have more widely within social history. Significant increases in population seem to have accompanied major technological advances such as the invention of Upper Palaeolithic blade industries (Shennan, 2001), the origins of food production (Hassan, 1973; Bronson, 1975; Cohen, 1977) and the onset of industrialisation in western Europe (McKeown, 1976). One general explanation for these episodic rises in population numbers, presented by Childe (1936) and endorsed by subsequent generations of economic historians and prehistorians, is the neo-Malthusian axiom that under normal circumstances the size of a population approaches an upper limit determined by the availability of

critical resources. According to this viewpoint, technological, social and/or ideological change brings about the conditions under which a population is free to expand beyond these restraints until it is limited by a new barrier to growth. The recurring resource 'problem' is solved through a succession of sociocultural innovations, including change in land use, novel patterns of exploitation of resources, technological advance, specialisation, increased economic exchange and so on, enabling the population to periodically increase in size and density.

Set against this view is the theory, first articulated by Boserup (1965) and Dumond (1965), and taken up with enthusiasm during the rise of New Archaeology by Binford (1968), Carneiro (1970) and Renfrew (1973), that cultural change is primarily a *consequence* of population growth rather than a trigger for growth. It is perhaps noteworthy that Boserup's model not only appealed to Processual Archaeologists as a plausible exemplar of the theorised ecological basis of cultural change, but it also coincided with wider concerns about the possible economic and social consequences of unconstrained twentieth-century global population growth (Ehrlich, 1968). Population growth has been invoked as a prime mover in prehistoric cultural change, e.g. in the replacement of Neanderthals (*Homo neanderthalensis*) by anatomically modern *Homo sapiens* (Zubrow, 1989), in the rapid peopling of the Americas (Martin, 1973) and in the wave of advance model for the spread of agriculture in Europe (Ammerman and Cavalli-Sforza, 1973).

Case Study 1.1 Colonisation and population growth in the Late Pleistocene Americas

The Americas constitute the last continental land mass to be colonised by humans. This event took place in the Late Pleistocene, and although there is sporadic evidence for earlier settlement the main colonisation event probably occurred towards the end of the last Ice Age and involved the migration of hunter-gatherers into North America from eastern Siberia. The timing

and rate of spread of this major colonisation event is controversial, and several lines of evidence have been pursued in order to investigate the early demographic history of the Americas including linguistic diversity amongst present-day native Americans (Nettle, 1999), genetic diversity in modern and ancient native populations (Torroni et al., 1994; Stone and Stoneking, 1999), morphological comparisons amongst human skeletal remains (Jantz and Owsley, 2001), chronological patterning of archaeological sites (Meltzer, 1995) and computer geographical modelling of population dispersal routes (Anderson and Gillam, 2000).

The colonisation process in the initial inhabitation of the Americas is believed to have been very rapid, based on the near contemporaneity between the earliest dated Palaeoindian sites in North and South America and the abundance of archaeological sites that emerge across North America at around 12,000 years BP. The colonisation of an unoccupied space is relatively easy to simulate mathematically, and several authors have generated numerical models that reconstruct the colonisation process. These models, which incorporate high average rates of population growth (increase in numbers of 1% to 3% per annum) and rapid geographical migration (up to 300km per generation), show that the Americas could have been occupied to carrying capacity within 2,000 years starting from a relatively small initial founding population (Young and Bettinger, 1995; Steele et al., 1998; Anderson and Gillam, 2000; Hazlewood and Steele, 2004). The demographic models rely on the assumption that hunter-gatherer populations migrating through unoccupied territory can pursue the option of long-distance 'leap-frog' colonisation movements to ensure that unexploited and productive foraging territory is immediately available for population expansion.

1.2.3 Population structure

Quite apart from the importance of overall numbers and rates of population growth, the analysis of population structure can also provide significant insights into past lifestyles and processes. Both human and animal populations exhibit a restricted range of age–class structures and sex ratios under natural circumstances. These structures of the living community

translate into regular mortality profiles which can be reconstructed from assemblages of skeletal remains (see Chapter 2). Mortality profiles provide two key lines of information about past communities and processes. If a mortality profile reconstructed from archaeological evidence bears a close resemblance to a previously established profile derived from a present-day population, then it is reasonable to assume that the attributes of the modern population also apply to the archaeological sample. In contrast, the extent to which the age structure of an archaeological sample departs from the mortality profile of the modern population can provide the investigator with evidence about specific cultural and natural (taphonomic) processes that may have biased the composition of the archaeological sample.

1.2.4   *Health and disease*

Palaeopathology (the study of disease in past populations: Roberts and Manchester, 1995; Larsen, 1997) provides important evidence for past lifestyles and adaptations. Population statistics are now recognised to be crucially important in studies of medical history and palaeopathology (Waldron, 1994), as the prevalences of many diseases are age and sex dependent, and morbidity from infectious disease in particular is strongly dependent on population size and density. The demographic structure of a population, in turn, is influenced by the cumulative effects of the current and historical experience of health and disease in that population.

In some circumstances demographic data may provide evidence of a particular cause of death (Margerison and Knüsel, 2002; Dutour et al., 2003; Gowland and Chamberlain, 2005). Catastrophic mortality, occurring as a result of a natural mass disaster or from an outbreak of disease with high infectivity and mortality, will generate a mortality profile that reflects the living-age structure of the population at risk, whereas chronic malnutrition and ill health will tend to have a greater impact on the youngest and oldest age classes. Human migration and colonisation have had a profound effect on the global distribution of disease, with catastrophic consequences

for many aboriginal populations (Verano and Ubelaker, 1992; Larsen and Milner, 1994).

Case Study 1.2 Impact of European contact on aboriginal North American populations

When Europeans began to colonise the New World in the late fifteenth century they encountered native aboriginal populations who lacked immunity to some infections such as measles, smallpox and scarlet fever, diseases that were common in Old-World communities. Following the arrival of European colonists outbreaks of these diseases became frequent amongst the native New-World populations, and although estimates of precontact aboriginal population numbers vary widely there is little doubt that contact-induced infectious disease was a major contributor to the decline of the native-American populations. The cumulative effects of repeated outbreaks of epidemic disease could be very great, as individual epidemics often killed more than 50% of the exposed native population.

Detailed studies of archaeological settlement data, combined with historical demographic records have provided clear evidence for the timing and cause of this 'crisis' mortality in native northeastern North America during the seventeenth century (Snow, 1996; Warrick, 2003). These studies indicate that there was a delay of about one century between initial European colonisation of North America and the arrival and spread of pandemic European diseases in the native populations. Warrick (2003) has attributed this delay to the small size of the original colonising populations and the fact that subsequent waves of European immigrants included larger numbers of children who were more likely to carry contagious diseases.

1.2.5   *Migration*

Hypotheses of human migration are often central, if controversial, in reconstructions of culture change. The physical migration of populations is sometimes put forward as a competing hypothesis to set against non-migrational models of cultural diffusion and indigenous

development. Culture change may itself result in demographic change, thus the demographic signature of migration, particularly in prehistory, may be unclear. Nonetheless, there exist a wide range of historical and ethnographic studies of migration that can provide the theoretical basis for understanding the importance of migration in archaeology and the circumstances under which it takes place (Adams et al., 1978; Anthony, 1990). Information about the history of residence of individuals represented in the archaeological record can also be obtained from the chemical analysis of human skeletal remains.

Case Study 1.3   Isotopic evidence for prehistoric migration in Europe

Stable isotopes are non-radioactive, chemically similar forms of an element that can be detected and discriminated through small differences in their physical properties. Stable isotopes can be used in studies of migration, because individuals who are born and live in a specific geographical region will have an isotopic signature in their skeleton that is characteristic of the local sources of ingested nutrients (i.e. food and water) found in that region (Katzenberg, 2000). The presence of migrants in past populations can be detected by unusual isotopic values in their skeletal remains: this is normally undertaken using stable isotope ratios of bone-seeking elements such as strontium and lead, although in some regions of the world the isotopic ratios of oxygen can also be used to infer place of residence.

Migration has been invoked to explain the origin and rapid spread of various prehistoric cultures in Europe, including the early Neolithic Linearbandkeramik (LBK) and the late Neolithic Bell-Beaker culture. Price et al. (2001) used the ratio of ^{87}Sr to ^{86}Sr in the tooth enamel of skeletons from LBK cemeteries in Flomborn and Schwetzingen in the Upper Rhine Valley, Germany, to distinguish locally born individuals from people who had migrated into the Rhine Valley from elsewhere. Tooth enamel, which is formed during infancy and early childhood, retains the isotopic signature of the early years of an individual's life, whereas bone which is continually remodelled throughout the lifespan has isotopic values that reflect approximately the last decade of life. At the Flomborn LBK cemetery 7 (64%) of the 11 individuals were classified

as migrants on the basis of their elevated strontium isotopic ratios (indicating that they had grown up outside the region), while at the Schwetzingen cemetery 33% of 21 individuals were classified as migrants. At both cemeteries females were over-represented amongst the migrants, a finding that is consistent with genetic evidence for historically higher migration rates in females than in males (Seielstad et al., 1998).

Grupe et al. (1997) sampled tooth enamel and bone from 69 skeletons from Bell-Beaker cemeteries in southern Bavaria, Germany, and identified 17 immigrants (25% of the sample) on the basis of discrepancies between the strontium isotope ratios of enamel when compared to the isotopic ratios in bone from the same skeleton. As with the study of LBK cemeteries, a higher proportion of females than males exhibited residential mobility as evidenced by their isotopic ratios. In both studies these estimates of migration frequency are minimum values, as it is not possible to detect individuals who move between regions that have the same underlying geology.

1.3   SOURCES OF EVIDENCE

1.3.1   *Theoretical models*

As is the case in many areas of archaeological research, uniformitarian models play a very important role in palaeodemography. Certain life-history parameters such as age at reproductive maturation, age at menopause and longevity are subject to evolutionary constraints and are relatively invariant across human populations, and patterns of age-specific fertility and mortality tend to vary in predictable and easily modelled ways (Coale and Trussell, 1974; Coale and Demeny, 1983).

The application of the uniformitarian principle in palaeodemography is still controversial, as there are persistent claims that the human populations of the past differed systematically from present-day populations in their structure and dynamics. For instance, there is a durable belief that people in the past aged more rapidly, died at a young age and that few individuals survived beyond what would today be regarded as middle age. This belief has been sustained by a combination of systematic bias in skeletal-age