THE PROBLEM OF FEMALE INFANTICIDE IN THE GRECO-ROMAN WORLD

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AFTER careful analysis of the literary evidence, earlier studies concerning the exposure of children (and any resultant infanticide) have established that the practice was of negligible importance in Greek and Roman society.[1] Recent attempts to draw conclusions from skeletal remains and other archaeological evidence that suggest male-female sex ratio imbalances and possible high rates of female infanticide are not convincing.[2] This analysis will attempt to show that, in fact, a high rate of female infanticide in antiquity was demographically impossible, and a rate of more than a few percent of live female births per year was highly improbable for more than a short period.

It has long been recognized that osteological evidence concerning the sex ratio and age structure of ancient populations is systematically biased against females and infants.[3] The survival of skeletal material depends to a large extent on the size and thickness of the bones and since infants and women have smaller, thinner bones than men, fewer are likely to survive. Furthermore, excavators are more likely to discard smaller, broken specimens, thus distorting the age of the remains upward and biasing the sex ratio towards males. Since health factors producing tougher skeletons also favor physical well-being and therefore greater longevity, the loss of weaker skeletons would also distort the age structure upward. Few infants, even

1. E A. Cameron, "The Exposure of Children and Greek Ethics," *CR* 46 (1932): 105–14; H. Bolkestein, "The Exposure of Infants at Athens and the *Egchutristriai*," *CP* 17 (1922): 222–39; L. Van Hook, "The Exposure of Infants at Athens," *TAPA* 51 (1920): 134- H. Bennett, "The Exposure of Infants in Ancient Rome," *CJ* 18 (1923): 341–51. Polybius 36.17 noted high rates of infanticide in Hellenistic Greece, but as A. W. Gomme, *The Population of Athens in the Fifth and Fourth Centuries B.C.* (Oxford, 1933), p. 81, observed, this was impossible except by a small group for a short period.

2. S. Pomeroy, *Goddesses, Whores, Wives, and Slaves: Women in Classical Antiquity* (New York, 1975), pp. 46, 69–70, 140, 164–65, 228. Pomeroy argued this position more forcefully in a lecture delivered at the University of Pennsylvania in February, 1975. Also, A. Preus, "Biomedical Techniques for influencing Human Reproduction in the Fourth Century B.C.," *Arethusa* 8 (1975): 237–63, believes that "female infants were killed so often, the ratio of males to females remained high even to the end of the Peloponnesian War." Both these authors, and others as well, seem to indicate a rate of female infanticide exceeding the rate given as a hypothetical reconstruction below.

3. J. L. Angel, "The Length of Life in Ancient Greece," *Journal of Gerontology* 2 (1947): 18–24; A. E. Samuel et al., *Death and Taxes*, American Studies in Papyrology, vol. 10 (Toronto, 1971), pp. 11- W. Petersen, "A Demographer's View of Prehistoric Demography," *Current Anthropology* 16 (1975): 232–34. It should be noted that the number of excavated skeletons represents only an infinitesimal fraction of any ancient population and can scarcely constitute a valid random sample upon which legitimate demographic interpretations can be based. The widespread practice of cremation further reduces the interpretive value of isolated skeletal remains.

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today, dying within a few days or weeks of birth, receive standard burials in cemeteries, and since infant mortality was likely to have been high in antiquity, this distorts the age-structure derived from osteological material. Of course, wealthy individuals were more likely to afford formal, well-protected graves than the poor, who may have had a higher mortality rate because of poor diet and substandard living conditions.

The nature of osteological material itself offers formidable obstacles to correctly determining the age and sex of a skeleton. Unless the entire skeleton is available for analysis, the probability of correct sex classification may fall as low as twenty percent.[4] The degree of wear on teeth is often given as a criterion for age; yet there is no common standard for measuring the rate of tooth wear for ancient or modern men, which would vary from individual to individual depending on diet and health factors. The closing of cranial sutures is another index of age, but unfortunately, the process follows no well-defined pattern. Moreover, acidic soils will open sutures that were closed during the individual's life. When maturational features of the skeletons of soldiers killed in Korea were matched with their known ages, the correlations were found to be poor.[5] All these limitations inherent in osteological data are well known to physical anthropologists and new analytic techniques are constantly being developed to compensate for them. At present, however, determinations of sex ratios and age structures of ancient populations derived from osteological evidence are unreliable, no matter how many skeletons one unearths.

Since Beloch wrote his fundamental work on the population of the Greek and Roman world in 1886, it has been recognized that data from ancient tombstones concerning sex ratios and death rates is inaccurate.[6] Indeed, K. Hopkins has shown that the death rates given on Roman tombstones are demographically impossible since they depict a massive mortality rate among adolescents and young adults with few dying in old age.[7] This was because an individual would usually be commemorated only if he was survived by a parent, sibling, or spouse, and this was more likely to occur if he died young. Since a wife would be commemorated by a husband only if he survived to commemorate her and since husbands were often older than their wives, wives who died young had a greater chance of being commemorated than those who died later. Furthermore, older relatives were more likely to put on tombstones the age at death of younger decedents than

4. S. Genovés, "Sex Determination in Earlier Man," in *Science in Archaeology*, ed. D. Brothwell and E. Higgs (New York, 1970), pp. 429–39. He is discussing positive evidence for sex classification, not just guesswork.

5. T. W. McKern and T. D. Stewart, *Skeletal Age Changes in Young American Males Analyzed from the Standpoint of Age Identification*, Environmental Protection Research Division, U.S. Army Technical Report EP-45 (Natick, Mass., 1957). Petersen, "A Demographer's View," p. 233, observes, "The problem [of correctly determining age and sex structures of populations from osteological material] in other words would seem to be to devise mathematical techniques based not on the postulate of a representative sample but on the assumption that the sample is systematically biased."

6. J. Beloch, *Die Bevoelkerung der griechisch-roemischen Welt* (Leipzig, 1886), pp. 41–54.

7. K. Hopkins, "On the Probable Age Structure of the Roman Population," *Population Studies* 19 (1966): 245–64.

were younger survivors who commemorated the death of older people. This has led to an incorrectable bias in the surviving age at death statistics. Once again, young infants were undercommemorated. In general, the pattern of commemoration is far too dependent on custom and the availability of a commemorator to reflect accurately actual demographic patterns.[8]

The sex ratio of an ancient population cannot be determined by counting the number of males and females portrayed in art and literature. Warfare was endemic to Greek and Roman society largely because of the classical system of competitive values.[9] Moreover, because of the primitive technological basis of the ancient economy, the motive force for commerce, industry, and agriculture was largely the muscle power of men and animals. All these occupations were accompanied by great risks to life and health, such as piracy, banditry, tedious drudgery, shipwreck, and disease. For these reasons, males outnumbered females in political and military activities and played more significant roles in the economic structure of antiquity. It is hardly surprising, therefore, that males are depicted more often than females in art and literature concerning political, military, or economic topics.

It may seem hazardous to reconstruct the demographic structures of ancient populations for which little reliable census data is preserved. Nevertheless, population differs from other topics of historical analysis because it is to some degree a self-contained process, invariant and irrespective of cultural context.[10] There are a few, basic demographic principles concerning ancient human populations, and these show that a high rate of female infanticide was impossible.

First, the sex ratio for newborn human infants is about 1 female for every 1.05 males in all populations for which there is recorded evidence, and, doubtless, this ratio was the same in antiquity.[11] The female-male ratio at birth fluctuates between 1:1.01 to 1:1.06, but averages 1:1.05 for any large group. For the sake of convenience, a sex ratio at birth of 1:1 will be used in the hypothetical reconstruction given below, but the use of this ratio rather than the actual ratio will not affect the conclusions of this paper.

Second, the rate of natural increase of any population—its growth rate excluding immigration and emigration—is based on the difference be-

8. Hopkins, "On the Probable Age Structure," p. 2 K. Hopkins, "The Age of Roman Girls at Marriage," *Population Studies* 18 (1965): 309–27; L. Henry, "L'âge du décès d'après les inscriptions funéraires," *Population* 14 (1959): 327–29.

9. M. I. Finley, *The World of Odysseus* (New York, 1954; repr. Chicago, 1972); in general, see Yvon Garlan, *Le Guerre dans l'Antiquité* (Paris, 1972); A. W. H. Adkins, *Merit and Responsibility: A Study in Greek Values* (Oxford, 1960); A. W. Gouldner, *The Hellenic World: A Sociological Analysis* (New York, 1965; repr. New York, 1969), pp. 41–77. Cf. Plato *Laws* 1. 626A: "Every state is in a natural state of war with every other, not indeed proclaimed by heralds, but everlasting."

10. Petersen, "A Demographer's View," p. 227.

11. A. J. Coale, "The History of the Human Population," *Scientific American* 231 (September, 1974) 43; A. J. Coale and P. Demeny, *Methods of Estimating Basic Demographic Measures from Incomplete Data*, U. N. Department of Economic and Social Affairs, Population Studies, 42 (New York, 1967), pp. 12–14; A. J. Coale and P. Demeny, *Regional Model Life Tables and Stable Populations* (Princeton, 1966), p. 23.

tween its birth rate and death rate.[12] If the former is higher than the latter, the population will grow, but if the latter is higher, it will decline. Both population growth and decline occur at geometric rates, since in the first instance, more numbers are added to an increasingly larger base while in the second, numbers are subtracted from an ever decreasing base.

The rate of natural increase for any ancient population was small or nonexistent. This may be determined in a variety of ways. First, one may compare the approximate rate of population growth during the demographic transition which occurred in the eighteenth century. During this period, when the first reliable data exist for much of the world's population, the human population began to experience an unprecedented rate of growth which still continues today.[13] This upsurge in growth during the eighteenth century resulted from a decline in the mortality rate rather than from an increase in the birth rate. Although the precise reasons for the declining death rate are not yet fully understood, they can be partially explained by an improvement in diet made possible by the diffusion of New World crops in the Old World, an increasing immunity to infectious diseases, improved hygiene, environment, and living conditions, as well as an increasing amount of useful medical knowledge.[14] In the fifty-year period from 1750 to 1800, when the transition was well under way, the world's population grew at an annual rate of about 4.2 per 1,000.[15] It is generally acknowledged that this rate of population growth was without precedent, and hence, when ancient populations grew at all, their growth rate must have been considerably less.[16]

An alternative method of analyzing population growth rates in antiquity is to examine the consequences that a given rate would have for the size of the population. For example, if there were 50,000 inhabitants in Attica in 800 B.C. and the population grew at an annual rate of 5 per 1,000 (only one-quarter of the present rate of increase), the population would increase to 100,000 by 661 B.C., to 200,000 by 522 B.C., and to 400,000 by 383 B.C., which is far higher than the most optimistic estimate of Attica's population.[17] Note also that these projected figures exclude any immigrants into

12. For demographic terminology and methods of population analysis, the reader is referred to any of the excellent handbooks on the subject such as G. W. Barclay, *Techniques of Population Analysis* (New York, 1958).

13. Coale, "The History of the Human Population," pp. 43, 48- J. D. Durand, "A Long-Range View of World Population Growth," *Annals of the American Academy of Political and Social Science* 369 (1967): 1 idem, "The Modern Expansion of World Population," *Proceedings of the American Philosophical Society* 111 (1967): 136–59.

14. Durand, "Modern Expansion," p. 1 T. McKeown and R. G. Record, "Reasons for the Decline of Mortality in England and Wales During the Nineteenth Century," *Population Studies* 16 (1962): 94–122; Coale, "The History of the Human Population," pp. 48–51.

15. Durand, "Modern Expansion," pp. 137–39. The population grew from about 791 million to 978 million. Cf. Coale, "The History of the Human Population," p. 43.

16. Durand, "Modern Expansion," p. 136; Coale, "The History of the Human Population," p. 43; Durand, "Long-Range View," p. 2; and below.

17. Gomme, *The Population of Athens*, p. 26, estimated the total population of Attica in 431 B.C. as 315,500 which included 28,500 metics (foreigners) and 115,000 slaves, many of whom were foreign born. Beloch, *Die Bevoelkerung der griechisch-roemischen Welt*, p. 507, estimated the population of the Roman Empire in 14 A.D. to be about 54 million. The problem of estimating the sizes of ancient populations is notoriously difficult. Nevertheless, the absolute numbers of populations

Attica, which we know from historical sources composed a substantial portion of the population. Similarly, if there were 50,000,000 inhabitants of the Roman Empire in 1 A.D. and the population grew at a rate of 5 per 1,000 per year, there would be 100,000,000 by the death of Hadrian, and 200,000,000 by the death of Aurelian, which is approximately the size of the population of modern Europe. These large figures for the number of inhabitants in Attica and the Roman Empire never occurred because the rates of population growth within these regions were far less than 5 per 1,000 per year.

In fact, even under the most favorable circumstances, the highest average population growth rate in antiquity was probably little more than 1 per 1,000 per year for any long period and for any large population. During the Neolithic Revolution in Mesopotamia when society changed from a food-gathering to a food-producing economy and conditions for a high rate of natural increase were favorable, the average population growth rate seems to have been less than 1.3 per 1,000 per year including immigration into the region.[18] When an ancient population suffered from an epidemic or famine—a far from infrequent occurrence—its numbers decreased. It is for these reasons that demographic historians assume a stable population for ancient societies, one in which the death rate was in essential equilibrium with the birth rate.[19]

Finally, the average life expectancy at birth in antiquity was low, less than thirty years but above twenty years. This may be determined by analyzing the life expectancy in pre- and non-industrial societies where, as in the Greek and Roman world, agriculture predominates and there is a lack of doctors and useful medical knowledge. In such societies the life expectancy is regularly below 30 years.[20] Life expectancy at birth would

are not as important for this study as their rates of growth, which can be shown to have been low, regardless of initial population estimate. Population growth rates might have been higher among small groups within a population or in a larger group for a short period. The Greek world during the era of colonization in the eighth and subsequent centuries B.C. is often alleged to have experienced a high rate of population increase, but as C. Starr, *The Economic and Social Growth of Early Greece, 800–500 B.C.* (Oxford, 1977), p. 44, observes, this supposition is more asserted than demonstrated. Perhaps one could extend this observation to other eras of antiquity which allegedly experienced high population growth rates.

R. L. Carneiro and D. F. Hilse, "On determining the Probable Rate of Population Growth During the Neolithic," *American Anthropologist* 68 (1966): 177–80. They note that if starting from a base of 100,000 the rate of population growth had been 5 per 1,000 per year beginning in 8000 B.C., by 4000 B.C. the population of Mesopotamia would have been 46,200,000,000,000. Expressed differently, if starting from one couple in 10,000 B.C., the world's population expanded at a rate of 10 per 1,000 per year, the world population would form today a sphere many thousands of light years in diameter, expanding with a radial velocity many times the speed of light, C. M. Cipolla, *The Economic History of World Population* (Baltimore, 1967), p. 81.

19. Hopkins, "On the Probable Age Structure," p. 256; Durand, "Long-Range View," p. 6; Petersen, "A Demographer's View," p. 232; Coale, "History of the Human Population," pp. 43–44.

20. Hopkins, "On the Probable Age Structure," p. 263; Durand, "Long-Range View," p. 6; W. Petersen, *Population* (New York, 1961), p. 343; Coale, "History of the Human Population," pp. 44–45. Concerning the life expectancy of the Roman Empire, Hopkins notes (p. 264), "it seems to me that the burden of proof is firmly on those who wish to assert that the Roman population in general had a lower mortality than other pre-industrial populations with similar technical achievements or towns; they must show that there were present in the Roman Empire factors which could have led to a general diminution of mortality." He additionally notes (p. 250) that life expectancy in Rome was roughly comparable to that in Greece.

generally be little above 20 years because of the difficult problem of maintaining a birth rate high enough to counterbalance the extremely high death rate in such a society.[21] Fortunately, we are not confined to generalizations about life expectancy in antiquity. Two important independent sources, census lists and tax receipts from Roman Egypt, show a population in which the life expectancy at birth is about 25 years.[22] There is little reason why life expectancy should not have been roughly equivalent in other periods or geographical regions of the ancient world.[23] Since these lists and receipts

21. Coale, "History of the Human Population," pp. 44–45; Hopkins, "On the Probable Age Structure," p. 263; E. A. Wrigley, *Population and History* (New York, 1969), p. 62. Certain modern groups such as the Hutterites have a higher birth rate than was possible in antiquity. This is a result of the higher rates of mortality among husbands and wives of childrearing age, higher specific mortality rates among women because of medical complications arising from the birth of a child, and the higher perinatal mortality among infants in pre-industrial societies than in modern populations. For similar reasons, ancient birth rates probably never exceeded 50 per 1,000 per year. Indeed, John Durand has informed me by personal communication that for an ancient society to attain a birth rate as high as 50 per 1,000 per year may require the abandonment of the institutions of marriage and the family by that society.

22. M. Hombert and C. Préaux, "Recherches sur le recensement dans l'Egypte romaine," *Papyrologica Lugduno-Batava* 5 (1952): 40–41, 159, record the mean age for the Egyptian population of the Arsinoite, Oxyrrhynchite, and Prosopite nomes as 26.60 years, the mean age of men as 27.23 years, and the mean age of women as 26.38 years. The actual mean ages may have been slightly lower since the bottom sections of some papyri were damaged or destroyed and the ends of the lists included the children in a given family. Samuel et al., *Death and Taxes*, p. 25, derive a mean age of 25 years for the Theban population on the basis of tax receipts which would give a life expectancy at birth of about 20 years; see also Coale and Demeny, *Methods of Estimating Basic Demographic Measures*, p. 95. However, it has been notec P. S. and E. O. Derow, review of *Death and Taxes* by A. E. Samuel et al., (*Phoenix* 27 [1973]: 80–88), that these figures are probably too low since they fail to include taxpayers who evaded payment by fleeing from their domicile. Hence, Samuel et al.'s mortality rates for Thebes may have been as much as 20 percent too high.

23. Although geographical and climatic conditions in Egypt are markedly different from other regions of the Mediterranean, the demographic structure of the Egyptian population may not have differed greatly from that of the rest of the ancient world. There are many social, economic, genetic, environmental, climatic, and technological factors which affect mortality rates. Among the most important of these are the amount of useful medical knowledge possessed by the society, diet, public health factors, the percentages of the population living in cities and in rural areas, and the percentage of the population engaged in primary agricultural production. Medical knowledge in antiquity concerning the causes and cures of disease was virtually nonexistent. Doubtless, the "cures" recorded by ancient medical authorities for disease—excessive bloodletting, cold baths, and foul potions—would have been just as ineffective, if not positively dangerous, in Egypt as they were in Rome or Athens; J. Scarborough, *Roman Medicine* (Ithaca, 1969), pp. 94–99, 135. The hygienic conditions in Lower Egypt were probably not much different than elsewhere in the ancient world; D. M. Dixon, "The disposal of certain personal, household, and town waste in ancient Egypt," in P. Ucko, ed., *Man, Settlement, and Urbanism* (London, 1972), pp. 647–50. Furthermore, morbidity and mortality rates from geographically specific diseases in Lower Egypt would have been counterbalanced to some extent by the remoteness of the country from sea ports and foreign contacts which greatly facilitate the spread of epidemics and communicable diseases, Wrigley, *Population and History*, pp. 62–98; R. Boyd, "Urbanism, Morbidity, and Mortality," in Ucko, ed., *Man, Settlement, and Urbanism*, pp. 345–52; D. Brothwell, "Community Health as a Factor in Urban Cultural Evolution," in Ucko, ed., *Man, Settlement, and Urbanism*, pp. 353–62. Furthermore, the fact that most of the Egyptian population was engaged in primary agricultural production, probably to a greater extent than almost anywhere else in the ancient world, would lessen the effects of famines frequently suffered in more urbanized areas; even in a city such as Rome, where every effort was made by the emperor himself to secure adequate food supplies, shortages were common and famines not unknown, Wrigley, *Population and History*, pp. 62–98; L. Friedlaender, *Roman Life and Manners Under the Early Empire*, vol. 1, trans. by L. A. Magnus (New York, 1968), pp. 24–29. The predominantly rural character of the Lower Egyptian population and its relative lack of urbanized centers, common throughout the rest of the ancient world, would have lessened the spread of infectious diseases and epidemics, since the high population thresholds necessary for the transmission of many infectious diseases are not present in rural communities, Wrigley, *Population*

have only minor, correctable biases regarding sex ratios and ages, they are the most valuable data available for life expectancy in antiquity, and they provide a welcome corrective to the highly improbable and frequently bizarre sex and age structures derived from skeletal evidence and tombstones.

Furthermore, when a society's average life expectancy is low, the proportion of women surviving to the mean age of reproduction is small. Since there is a close mathematical relationship between these two numbers, the proportion of women surviving to childbearing age can be calculated when the society's average life expectancy at birth is known.[24] Because of these constant relationships and the constant sex ratio at birth of 1:1.05, it is possible to calculate a society's birth rate for any given rate of natural increase once the average life expectancy is known. For a society with a stable rate of growth and an average life expectancy at birth of 25 years, the birth rate and the death rate will be about 40 per 1,000 per year. For a stable population with a life expectancy of about 20 years, the birth and death rates will be about 50 per 1,000 per year; and for a stable population with a life expectancy of about 30 years, the birth and death rates will be about 34 per 1,000 per year.[25]

To sum up so far, Greek and Roman populations had a stable or extremely low rate of natural increase (probably not exceeding 1 per 1,000 per year for more than a short period), a life expectancy at birth of between 20 and 30 years, most probably about 25 years, and birth and death rates between 34 and 50 per 1,000 per year, probably averaging about 40 per 1,000 per year. As in all human populations, the sex ratio at birth was 1:1.05. The conclusions of this analysis are unaffected if there was a decline in the rate of natural increase or a moderate growth (under 4 per 1,000 per year), if life expectancy at birth was 20 or 30, or any age in between, or if the birth rate averaged anywhere between 34 and 50 per 1,000 per year.

Now consider the consequences of a high rate of female infanticide in such a population. If one-fifth of all female births per year were killed, this would have two effects on a population, one immediate and the other completed in about 45 years. First, such wholesale slaughter would obviously increase the population's death rate. If birth and death rates were in equilibrium at about 40 per 1,000 per year, and the sex ratio at birth was about 1:1, the killing of one-fifth of all newborn girls will immediately raise the death rate to 44 per 1,000 per year. The second effect will be completed in

and History, pp. 69–98; Boyd, "Urbanism, Morbidity, and Mortality," pp. 345- T. A. Cockburn, "Infectious Diseases in Ancient Populations," *Current Anthropology* 12 (1971): 50–51. Cf. Thuc. 2. 54. 5. See now C. G. Merino, *Población y Poblamiento en Hispania romana, El Conventus Cluniensis* (Valladolid, 1975), who estimates that the population of Roman Spain had a life expectancy at birth of about 27 years.

24. These relationships were first recognized by L. Euler, "Recherches générales sur la mortalité et la multiplication du genre humaine," *Histoire de l'Académie Royale des Sciences et Belles-Lettres* (1760), pp. 144–64, and received their final mathematical formulation A. J. Lotka, "Relation between Birth Rates and Death Rates," *Science* 26 (1907): 21–22, no. 653. Cf. Coale and Demeny, *Methods of Estimating*, pp. 12–14; Coale, "History of the Human Population," pp. 44–45.

25. Coale and Demeny, *Methods of Estimating*, p. 96; Coale and Demeny, *Regional Life Tables*, pp. 26, 30, 35; Coale, "History of the Human Population," p. 44.

about 45 to 49 years, when the first cohort of girls whose numbers had been reduced by infanticide reaches menopause. Since there would be only four-fifths as many women in the population as before and since only women give birth, exterminating one-fifth of infant girls will effectively reduce the population's birth rate by one-fifth, or in this case to 32 per 1,000 per year. In other words, after the first cohort of girls whose numbers were reduced by infanticide reached menopause, the population would have a death rate of 44 per 1,000 per year and a birth rate of only 32 per 1,000 per year. This would yield a negative rate of natural increase of 12 per 1,000 per year which would reduce the population by half in 57.75 years, by three-quarters in 115.5 years, and by seven-eighths in only 173.25 years.[26]

Even if by a heroic effort the society increased its birth rate from 40 per 1,000 per year to 50 per 1,000 per year, the demographic consequences of a high rate of female infanticide would still be catastrophic. This is because raising the birth rate from 40 to 50 per 1,000 per year in a society where the birth rate and death rate were in essential equilibrium at 40 per 1,000 would have little effect on the rate of natural increase, since the 10 additional individuals per 1,000 would not be immortal but would be subject to the same high mortality rates as the rest of the population. Hence, after the birth rate increased, the natural death rate (the death rate excluding infanticide) would increase substantially above 40 per 1,000 per year. Because of the high infant mortality in societies with an average life expectancy of 25 years, there is a good chance that of the 10 additional individuals per 1,000 added to the population after the birth rate was increased, 3 would die within one year of birth. In subsequent years, the death rate for the 10 additional individuals would include not only infant mortality, but also deaths in other age categories.[27] Obviously, such a preposterous situation would never occur in any human or even animal population. It would not require a great deal of collective wisdom by any society to perceive that when one-fifth of female infant births were killed, the population suffered drastic declines in numbers. Nor would it require much intelligence to see that the only way to arrest such a decline was not to increase the

26. A simple way to determine the period of time required for a population to halve in size if the rate of natural increase (RNI) decreases (or the doubling time if it increases) is to divide the RNI per 1,000 per year into 693. If the birth rate (BR) and death rate (DR) were in equilibrium at 34 per 1,000, killing one-fifth of female infants would raise the death rate to 37.4 per year and lower the BR to 27.2 per year, causing an imbalance of the DR over the BR of 10.2 per year, and halving the population in about 68 years. If the BR and DR were in equilibrium at about 50 per 1,000, this rate of infanticide would increase the DR to 55 and lower the BR to 40, causing an imbalance of 15 which would halve the population in about 46 years.

27. Hence, if the BR was increased to 50 per 1,000 per year and one-fifth of all female births were killed per year, the DR would increase to at least 48 per 1,000 per year, and the BR would increase to 40.0 per 1,000 per year. This still yields a negative growth rate of about 8 per 1,000 per year which would halve the population in about 87 years, reduce it by three-fourths in about 173 years and seven-eighths in about 260 years. In a population where the BR and DR are in essential equilibrium at 40 per 1,000 per year, the chances are that three children out of 10 will die from natural causes during their first year of life (Coale and Demeny, *Regional Life Tables*, p. 31). Hence of the five girls killed by infanticide in this hypothetical model, 1.5 might have died from natural causes in their first year of life, had they been allowed to live. This fact, however, does not affect the conclusions of this analysis.

birth rate only to kill off large numbers of infant girls, but not to kill the girls in the first place.

Clearly, high rates of female infanticide were impossible for any ancient population.[28] Even low rates of female infanticide would increase the death rate and lower the birth rate, and in a stable or nearly stable population, this would cause the population to decline at a geometric rate. For these reasons, a rate of 10 percent of female births killed per year would be highly improbable, and the rate almost certainly never exceeded more than a few percent of female births in any era.[29]

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28. Of course, it is possible for a society to maintain its numbers despite a high rate of infanticide by importing massive numbers of migrants from elsewhere. These migrants, however, would submerge the native population in a relatively short period if a stable population and a high rate of infanticide were to be maintained. It is doubtful many would seriously postulate such an enormous rate of migration into any nation to maintain a contrived, complex hypothesis of a high rate of female infanticide. Any economical hypothesis would reject both high rates of infanticide and the massive immigration required to maintain a stable population under those circumstances.

29. I am grateful to Keith Hopkins and the anonymous referee of *Classical Philology* for their helpful suggestions.