ROMAN LIFE EXPECTANCY: THE PANNONIAN EVIDENCE

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IN A RECENTLY PUBLISHED ARTICLE, I used the document commonly called "Ulpian's life table" (Aemilius Macer, *Dig.* 35.2.68 pr.) in order to develop a hypothetical Life Table for the Roman Empire.[1] At the end of that article, I argued that, in all likelihood, "only new evidence (such as a more complete collection and analysis of skeletal remains) will prove final and decisive" in establishing the validity of my hypothetical Life Table. In the present article I will discuss some little-known skeletal evidence from western Hungary, evidence that offers considerable support for my Life Table. This evidence has the additional merit of helping to explain why the epigraphic data on mortality, despite their almost overwhelming quantity, are of marginal use to historical demographers.

Table I presents the basic details of my Life Table.[2] A life table is a device for describing, through statistics, the mortality experience of a given population; it might be thought of as a series of "snapshots," from different angles, at the exact birthdays of the members of the population. By convention, these data are given for birth (age 0), age 1, age 5, and then at five-year intervals up to 80. In my Table I, the first column, *q(x)*, describes the likelihood that a person of age *x* will die before the next indicated birthday, the *probability of death*; thus, the Life Table indicates that about 10.6 of every 100 persons reaching their thirtieth birthday will die before their thirty-fifth. The second column, *l(x)*, provides the corresponding figure for the *number of survivors* from an original "cohort" of 100,000 babies; by following these figures down the column, one can observe the toll of mortality upon the model population. In my Life Table, about two-thirds of all live-born children are dead by age 30. The third column, *e(x)*, gives *average life expectancy*; those persons who reach the birthday of age *x* can anticipate living this many additional years, on average. A person of age 30 has, in my Life Table, a mean of about 23 years of life remaining. Finally, the fourth column, *1000m(x)*, gives the age-specific death rate per thousand from age *x* to the next indicated birthday; this statistic, called the *central death rate*, gives an idea of the rate of mortality during the interval: from age 30 to 35, about 22 per thousand.

[1]B. W. Frier, "Roman Life Expectancy: Ulpian's Evidence," *HSCPh* 86 (1982) 213–251, Table V (245). My article fully describes the derivation of this life table.

[2]The mathematical relation of mortality functions to one another is discussed by N. Keyfitz and W. Flieger, *Population: Facts and Methods of Demography* (San Francisco 1971) 127–143; and also in most standard introductions to demography.

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TABLE I
A LIFE TABLE FOR THE ROMAN EMPIRE

Age	*q(x)*	*l(x)*	*e(x)*	*1000m(x)*	Age
0	.3582	100,000	21.11	466.9	0
1	.2370	64,178	31.70	70.2	1
5	.0641	48,968	37.13	13.2	5
10	.0482	45,828	34.50	9.9	10
15	.0741	43,618	31.12	15.4	15
20	.0827	40,385	28.41	17.2	20
25	.0929	37,047	25.75	19.5	25
30	.1056	33,604	23.13	22.3	30
35	.1216	30,055	20.56	25.9	35
40	.1424	26,401	18.05	30.6	40
45	.1707	22,642	15.63	37.3	45
50	.2114	18,777	13.33	47.3	50
55	.2506	14,807	11.23	57.3	55
60	.3278	11,096	9.14	78.4	60
65	.4132	7,459	7.38	104.2	65
70	.5278	4,377	5.82	143.4	70
75	.6753	2,067	4.53	203.9	75
80	1.0000	671	3.77	265.4	80

Key:

x	age at birthday
q(x)	probability of dying before next indicated birthday
l(x)	survivors to age *x*
e(x)	life expectancy in years at age *x*
1000m(x)	central mortality rate per thousand from age *x* to next indicated birthday

The Life Table give values of life expectancy that are quite low, but that nonetheless lie within the general range usually presupposed for the Roman Empire.[3] One noteworthy feature is the extremely steep decline in life expectancy during adulthood; life expectancy at age 65 (7.38 years) is equal to only about 20% of that at age 5 (37.13 years). The corresponding

[3]For numerous citations, see my article (above, n.1) esp. notes 79-80; there are further citations in D. Engels, "The Problem of Infanticide in the Greco-Roman World," *CP* 75 (1980) 112–120, at 116–117. Add P. R. Cox, *Demography*[5] (Cambridge 1976) 171: "On general grounds, however, it seems likely that the [Roman] expectation of life at birth was of the order of twenty years . . .;" and M. Golden, "Demography and the Exposure of Girls at Athens," *Phoenix* 35 (1981) 316–331, at 323–324; W.V. Harris, "The Theoretical Possibility of Extensive Infanticide in the Greco-Roman World," *CQ* 32 (1982) 114–116, at 115. By and large, the now prevalent scholarly view that Roman life expectancy at birth must have been ca 20–30 years seems in accord with evidence emerging on pre-Industrial Europe; for a survey, see W. V. Flinn, *The European Demographic System 1500–1820* (Baltimore 1981) esp. 20-22, 47–64. On Roman demography in general, see R. P. Duncan-Jones, "Demographic Changes and Economic Progress under the Roman Empire," in *Tecnologia, economia e società nel mondo romano* (Como 1980) 67-80.

TABLE II

A Life Table for the Keszthely-Dobogó Population

Age	q(x)	l(x)	e(x)	1000m(x)	Age
5	.0967	48,968	37.38	20.54	5
10	.0336	44,232	36.17	6.83	10
15	.0480	42,747	32.34	9.85	15
20	.0591	40,695	28.85	12.19	20
25	.0636	38,292	25.51	13.15	25
30	.0637	35,858	22.08	13.07	30
35	.1414	33,575	18.40	30.29	35
40	.1364	28,826	15.98	29.39	40
45	.2410	24,896	13.13	54.47	45
50	.2809	18,895	11.47	64.88	50
55	.3257	13,587	9.93	78.97	55
60	.2825	9,161	8.61	66.85	60
65	.4401	6,573	6.11	111.30	65
70	.6904	3,680	3.85	214.10	70
75	1.0000	1,139	2.02	495.00	75

Source: Acsádi and Nemeskéri (above, n. 5) 296–297

Coale-Demeny model life table[4] registers a similar decline in life expectancy: for males, from 37.4 years to 7.36 years (20% of the former value); for females, from 38.31 years to 7.95 years (21% of the former value). My Life Table may thus be regarded as extremely realistic.

The comparative data from Hungary consist of 120 skeletons from a cemetery at Keszthely-Dobogó, on the western shore of Lake Balaton (in Roman Pannonia); these data were analyzed by the Hungarian demographers G. Acsádi and J. Nemeskéri, using modern techniques of physical and demographic anthropology.[5] All the burials apparently date to the period

[4]A. J. Coale and P. Demeny, *Regional Model Life Tables and Stable Populations* (Princeton 1966) 3 (Model West, Level 2); figures from this model are also frequently cited below. The reasons for using this model as a basis for comparison are fully explained in my article (above, n. 1) 246 n. 70. In general, the Coale-Demeny models assist discussion of the realism of life tables derived from empirical evidence. The theoretical justification of this position is discussed by N. Howell, "Toward a Uniformitarian Theory of Human Paleodemography," in R. H. Ward and K. M. Weiss (edd.), *The Demographic Evolution of Human Populations* (London 1976) 25–40. (This volume is cited hereafter as *DEHP*.)

[5]*History of Human Life Span and Mortality* (Budapest 1970) 228 and 296–301, with a discussion at 215–234. (This important book, well-known among demographers, deserves recognition from ancient historians; the earlier chapters have an excellent discussion of technique.) The original excavations of Keszthely-Dobogó are described at 227; cf. K. Sági, "Die spätrömische Bevölkerung der Umgebung von Kezthely," *Acta Arch. Hung.* 12 (1960) 187–256, at 206–218, and also V. Lanyi, "Die spätantiken Gräberfelder von Pannonien," *id.* 24 (1972) 53–212, on fourth-century cemeteries in general. The time was one of prosperity for Pannonia: A. Mócsy, *Pannonia and Upper Moesia* (London 1974) 297–338; L. Barkóczi, "A History of Pannonia," in A. Lengyel and G. T. B. Radan (edd.), *The*

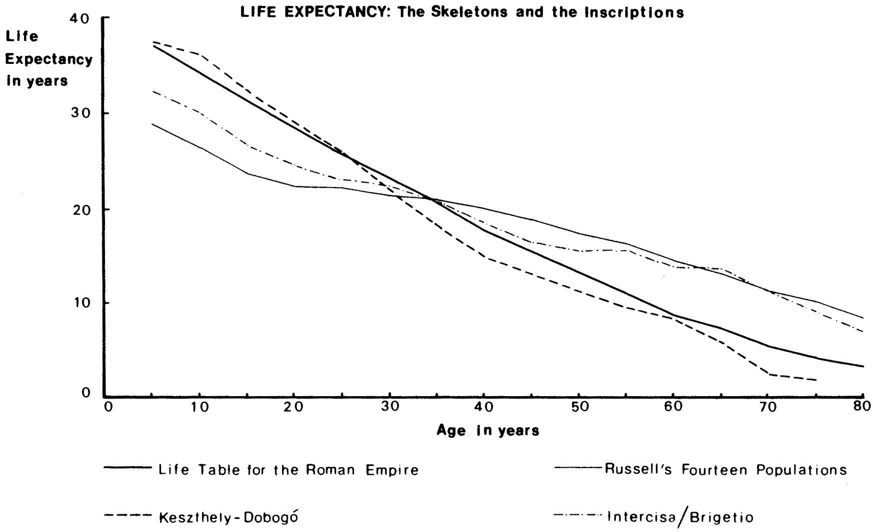

CHART I

A.D. 340–374. The population was made up of peoples from adjacent Roman provinces, together with an admixture of settlers from beyond the frontier. The grave goods were not rich, suggesting perhaps a community of small craftsmen and traders.

These skeletons establish the life table that is presented in Table II. I have omitted the data on the early years of childhood (ages 0–4), since the cemetery grossly underrepresents young children. In Table II, the *l(x)* figure for age 5 comes from my Life Table; the following survivorship statistics decline from this figure proportionally to the *l(x)* values given by Acsádi and Nemeskéri. The other two columns, which give the mortality rates *q(x)* and *1000m(x)*, I have calculated on the basis of the first two values.

From ages 5 to 60, with very high regularity, the life expectancy of the Keszthely-Dobogó population is equal to about 95% of the life expectancy at equivalent ages in my Life Table (cf. Chart I); the standard deviation is

Archeology of Roman Pannonia (Budapest 1980) 85–124, at 113–115. It should be noted that my Table II tacitly assumes that the underlying population was stationary (i.e., both stable and constant); for the reason see N. Keyfitz and W. Flieger (above, n. 2) 247–267. However, the actual number of skeletons of various ages (cf. Table III) suggests that the population at Keszthely-Dobogó was in fact slightly declining; this should be the explanation for the relative underrepresentation of younger skeletons (aged 5–20), and the overrepresentation of older ones (aged 30–55), in relation to my Life Table. The age-distribution at Keszthely-Dobogó is generally consistent with a population declining at a rate of somewhat less than .5% per year. Adult men at Keszthely-Dobogó are reported as outnumbering adult women in a ratio of about 3 to 2; but this bias, standard in such reports, is probably inaccurate: see K. M. Weiss, "On the Systematic Bias in Skeletal Sexing," *American Journal of Physical Anthropology* 37 (1972) 239–250.

quite small (less than plus or minus 7.5%), which means that most values lie in a range from 87.5% to 102.5% of those in my Life Table. The closeness of the two models is particularly evident in their *l(x)* statistics on survivorship. The Keszthely-Dobogó mortality rates are in general slightly lower that the Life Table's up to age 35, and slightly higher thereafter. The decline in life expectancy, from 37.38 years at age 5 to 6.11 years at age 65 (16% of the former value), is close to that of the Life Table. The residents of this Pannonian community probably had a life expectancy at birth of close to 20 years.

The correlation between my Life Table and the Keszthely-Dobogó figures can also be examined by more sophisticated statistical methods. For example, if we run a linear regression of the Life Table *l(x)* statistics (independent variable) on the Keszthely-Dobogó *l(x)* statistics (dependent variable), the resulting equation has an intercept of -427, a slope of 1.023, and a coefficient of determination r^2 of .990.[6] This last figure means that 99% of the variance in the Keszthely-Dobogó data is "explained" by the correlation with the Life Table. However, this high percentage is a bit misleading, since the nature of survivorship tables guarantees that they always tend to have some degree of correlation.[7] A different type of test for the conformity of empirically observed populations to theoretical models was devised by the anthropologist Kenneth Weiss, using life table predictions about the age-distribution of stationary populations.[8] This test is very exacting, since any discrepancy is doubled in making the calculation; a value less than .1 is considered to be a very close fit. If we assume that the mortality figures for ages 0–4 in the Keszthely-Dobogó population are equal to those in the Life Table,[9] then the Weiss test yields a value of .0508. This is yet another indication of the close relation between the two life tables. As

[6]On the basic method, see (e.g.) H. M. Blalock, *Social Statistics*[2] (New York 1979) 381–410. The values of slope, intercept, and r^2 indicate virtual identity in this case.

[7]Cf. J. Neter and W. Wasserman, *Applied Linear Statistical Models* (Homewood, Ill. 1974) 352.

[8]*Demographic Models for Anthropology* (Society for American Archaeology, *Memoirs* 27 [1973]) 65, where the test is described in detail.

[9]In this case, incidentally, life expectancy at birth in the Keszthely-Dobogó population is 21.24 years. If this cemetery has a nearly complete record (except for young children) of mortality at Keszthely-Dobogó from 340–374, the settlement must have been very small, around 125 persons; the formula for making this calculation is given by D. H. Ubelaker, *Reconstruction of Demographic Profiles from Ossuary Skeletal Samples: A Case Study from the Tidewater Potomac* (*Smithsonian Contributions to Anthropology* 18 [1973]) 65–68. M. Henneberg fashioned two indices measuring, first, the sum of the reproductive potential remaining to a group after the premenarchal deaths of adults (the Potential Gross Reproduction Rate, PGRR); second, the totality of biological and cultural characteristics making the reproductive success of a population possible although not necessarily inevitable (the Biological State Index, BSI). Both indices vary from a high of 1.0 to a low of 0; in modern societies both indices always approach 1.0, indicating low levels of both

TABLE III
ACTUAL AND PROJECTED NUMBERS OF SKELETONS FROM KESZTHELY-DOBOGÓ

Age	Actual Numbers	Projected Numbers (from Life Table)
0	5.097	(72.074)
1	16.379	(30.503)
5	9.525	6.318
10	2.999	4.447
15	4.125	6.505
20	4.849	6.716
25	4.895	6.927
30	4.583	7.147
35	9.541	7.352
40	7.915	7.563
45	12.076	7.776
50	10.671	7.988
55	8.916	7.467
60	5.210	7.318
65	5.810	6.201
70+	7.409	8.807
Total (5+)	98.524	98.524
Grand Total	120.000	(201.101)

was predictable from the general pattern of their mortality rates, the Keszthely-Dobogó stationary population has a slightly higher number of young adults aged 20–49 than does the Life Table, and a slightly lower number both of youths aged 19 and below, and of adults aged 50 and above.

One final test can be applied. The Keszthely-Dobogó cemetery comprises 120 skeletons, of which about 99 were considered to be of people aged 5 and above. The age-distribution of these skeletons is given in Table III;

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premenarchal mortality and adult premenopausal mortality. If my assumption about infant mortality at Keszethely-Dobogó is correct, the PGRR is a high .84, while the BSI is a rather low .36. This conforms with the generally observed historical fact that the "advance" of civilization into the "pre-modern" demographic regime was marked by improvement in the biological situation of adults (as reflected in life expectancy at age 20) occurring long in advance of the decline in child mortality (as reflected in life expectancy at birth). Cf. M. Henneberg, in *DEHP* (above, n. 4) 41–48; also M. Henneberg and J. Piontek, "Biological State Index of Human Groups," *Przeglad Antropologiczny* 41 (1975) 191–201. Contrast the very low adult life expectancies from the fourth-century A.D. non-Roman population of Muntenia (in modern Romania): D. Nicolaescu-Plopsor and W. Wolski, "Necropole de Secol IV E.N. dîn Muntenia," *Studii şi Cercetari de Antropologie* 9 (1972) 109–117; the excavations are published in B. Mitrea and C. Preda, *Necropole dîn Secolul al IV-lea E.N. in Muntenia* (Bucharest 1966).

fractions reflect the distributing over several years of skeletons for which the age at death could only be approximated.[10] What is the likelihood that the observed age-distribution in this sample population is consistent with the expected age-distribution resulting from the Life Table? One standard statistical test for this is the chi-square test.[11] In Table III I have also displayed the "predicted" number of the 99 skeletons that would fall into each age group, if Life Table conditions of mortality prevailed.[12] The two sets of data yield a chi-square figure of 10.125, which indicates that they are interrelated at a .684 level of significance—an extremely high degree of consistency. In short, we are permitted to argue, with considerable confidence, that the actual distribution by ages in the Keszthely-Dobogó cemetery can in fact be represented by the theoretical distribution in the Life Table, and that the discrepancies between them are the result of chance.

To this extent, it is fair to say that the Keszthely-Dobogó population is an example of the theoretical population described in my Life Table, and, as such, offers initial empirical evidence to support that Life Table.

The great virtue of the Life Table, as supported by the skeletal data from Keszthely-Dobogó, is that it yields a mortality pattern which is plausible when measured against the standard of the Coale-Demeny model life tables. However, we are fortunate to have another possible "control" for the Keszthely-Dobogó population, in the form of 184 gravestones from nearby Intercisa (Dunaújváros) and Brigetio (Szöny). These gravestones all record the decedent's age at death. Out of them Acsádi and Nemeskéri calculated a second life table.[13] A comparison between the Keszthely-

[10] Acsádi and Nemeskéri (above, n. 5) 62; data from 296–297. Excavations of the nearby Intercisa cemeteries are now being published; see E. B. Vágó and I. Bóna, *Die Gräberfelder von Intercisa, I: Der spätrömische Südostfriedhof* (Budapest 1976), esp. 147–148 giving an age-distribution of skeletons almost identical to that at Keszthely-Dobogó. Of course, this merely confirms the inaccuracy of the Intercisa inscriptions, discussed below. *Caveat lector*: the data in Table III suggest, at first glance, that the "aging" of skeletons is a precise business; however, that is a delusion, since the figures given here reflect both distribution over a period of years in the case of skeletons inexactly "aged," and a process of statistical smoothing. Nonetheless, 120 skeletons would normally be considered an adequate basis for demographic generalization.

[11] This test is widely described in handbooks: e.g., D. A. Leabo, *Basic Statistics*[5] (Homewood, Ill. 1976) 576–594.

[12] For ages 0–4, the figures in parentheses represent the number of skeletons that, under Life Table mortality conditions, would have been expected. I have calculated these figures in order to illustrate the extent to which Keszghely-Dobogó data underrepresent mortality among young children. The chi-square test was applied only to the data from age 5 onward. Ages 70 onward are lumped together because the chi-square test requires about five observed instances, at a minimum, in each category.

[13] (above, n. 5) 220 and 289–296. A similarly derived life table for Pannonia as a whole is virtually identical; the data are in J. Szilágyi, "Beiträge zur Statistik der Sterblichkeit in der illyrischen Provinzgruppe und in Norditalien (Gallia Padana)," *Acta Arch. Hung.* 14 (1962) 297–396, at 312–316.

TABLE IV
COMPARISON OF LIFE EXPECTANCY IN THE LIFE TABLE, THE KESZTHELY-DOBOGÓ CEMETERY, AND SELECTED EPIGRAPHIC POPULATIONS

Age	Life Table	Keszthely-Dobogó	Intercisa/Brigetio	Egypt	Asia, Greece, Illyricum	Spain, Males
0	21.11	—	(25.75)	(28.7)	(29.2)	(35.3)
1	31.70	—	34.04	32.7	33.1	39.1
5	37.13	37.38	32.27	30.8	31.2	37.0
10	34.50	36.17	30.02	28.0	28.7	33.1
15	31.12	32.34	26.69	25.3	25.3	29.5
20	28.41	28.85	24.57	23.1	22.7	27.5
25	25.75	25.51	23.08	22.6	21.1	26.7
30	23.13	22.08	22.15	22.2	19.6	25.7
35	20.56	18.40	20.90	20.2	20.1	24.6
40	18.05	15.98	18.79	18.8	18.9	22.4
45	15.63	13.13	16.95	17.3	18.7	20.9
50	13.33	11.47	15.74	16.0	16.5	18.2
55	11.23	9.93	15.85	14.7	15.7	16.4
60	9.14	8.61	13.98	13.7	11.9	13.7
65	7.38	6.11	13.74	12.7	12.4	13.0
70	5.82	3.85	11.39	11.4	9.1	10.1
75	4.53	2.02	9.43	10.0	8.9	9.9
80	3.77	—	7.14	7.8	6.0	8.1

Sources: Acsádi and Nemeskéri (above, n. 5) 289–291, 296–297; Russell (above, n. 14) 25–29.

Dobogó data and the Intercisa/Brigetio data can help to establish the credibility of mortality patterns derived from funerary inscriptions.

In Table IV, I provide six sets of life expectancies. The first set comes from my Life Table, the second from the Keszthely-Dobogó data. The third set is the Acsádi-Nemeskéri figures for Intercisa and Brigetio. The last three columns are a sample of life expectancies derived from funerary inscriptions found in other sections of the Roman Empire; they come from a set of 14 regional life tables calculated by Josiah Russell on the basis of inscriptions recording age at death.[14] The data comprise 813 persons from Egypt, 2,345 persons from Asia, Greece, and Illyricum (hence-

[14]J. C. Russell, *Late Ancient and Medieval Population* (*Transactions of the American Philosophical Society* N.S. 48.3 [1958]) 25–29. This book, although almost entirely unknown to Roman historians, offers by far the most demographically sophisticated analysis ever made of the funerary inscriptions; I continue to rely on it throughout the present article. Russell's 14 life tables are summarized in my Table VI. Russell drew the Egyptian life table from M. Hombert and C. Préaux, "Note sur la durée de la vie dans l'Égypte gréco-romaine," *Chronique d'Égypte* 39/40 (1945) 139–146; it should be noted that the data in this life table have been smoothed (though crudely), something that is untrue of Russell's other 13 life tables. K. M. Weiss (above, n. 8) 42–43 doubted the demographic plausibility of Russell's results, for reasons that appear similar to those outlined below.

forth: Asia etc.), and 1,111 males from Iberia. The figures given in parentheses are Russell's estimates after compensating for underrepresentation of infants.

I have already discussed the clear connection between my Life Table and the Keszthely-Dobogó data. The Intercisa and Brigetio figures, by contrast, bear a close relationship, not to those from Keszthely-Dobogó, but rather to those from Egypt, Asia etc., and (less obviously) Spain. In the data from Intercisa/Brigetio, Egypt, and Asia etc., life expectancy is about 31–32 years at age 5, and it then declines, at a slow but fairly uniform pace, until it reaches about 12.5–14 years at age 65; life expectancy at this later age is about 40–42% of that at age 5. The life expectancy of Spanish males aged 5 is somewhat higher (37 years), but the series ends in close proximity to the other three adjacent populations; life expectancy of Spanish males aged 65 is about 35% of that at age 5. The contrast with the first two columns is apparent.

This unrealistically small decline in life expectancy is a common feature of life tables derived from funerary inscriptions. For Russell's 14 populations, life expectancy at age 65 is never less that 34.5% of that at age 5, and the geometric mean of the 14 percentages is 46.8%.

Two phenomena are mainly responsible for this unrealistic aspect of the life tables derived from funerary inscriptions. The first is that the funerary data consistently overrepresent the number of very old decedents (especially those aged 80 and over). This overrepresentation appears to result from a tendency to exaggerate the age of older decedents,[15] and from a concomitant tendency to include the decedent's age on the gravestone if he or she was "unusually" old at death. The inevitable outcome of the phenomenon is that life expectancy at age 65 is always much higher than would be realistic. Russell's 14 life tables give a life expectancy at age 65 in a range from 10.3–17.7 years. The mean is about 13.7 years, with a standard deviation of plus or minus 2.1 years; the median is 12.8–13.0 years. Values this high were not obtained until the modern era; in the Coale-Demeny Model West tables, a life expectancy of 13.7 years at age 65 is associated with a life expectancy at birth of 67.5 years for females, and 71.2 years for males.[16] From ages 65 onward, the life expectancy figures in Russell's 14 populations march very closely together; for ages 65–80, their means are consistently about twice as high as the equivalent values in my Life Table, and the standard deviation regularly corresponds to only about 15–17% of

[15]Age exaggeration is a fairly universal problem in demographic data derived from respondents; cf. *Manual III: Methods for Population Projections by Sex and Age* (U. N. *Population Studies* 25 [1956]) 14. On age exaggeration in the Roman funerary inscriptions, see K. Hopkins (below, n. 20) 249. Life tables tend to give excessive weight to older ages: N. Keyfitz and W. Flieger (above, n. 2) 129–130.

[16](above, n. 4) 21 and 24, respectively.

TABLE V

Comparison of Mortality—$q(x)$—in Selected Populations

Age	Intercisa/ Brigetio	Egypt	Asia, Greece, Illyricum	Spain (Males)	Rome (Females)	Africa (Males)
5	.0847	.0705	.0799	.0288	.1533	.0366
10	.0560	.0830	.0603	.0450	.1311	.0428
15	.1081	.1092	.0941	.0922	.2372	.0587
20	.1539	.1658	.1816	.1440	.3079	.0847
25	.1543	.1674	.1803	.1355	.3073	.0851
30	.1561	.1690	.1896	.1383	.2964	.0880
35	.1706	.1724	.1913	.1321	.2909	.0890
40	.1918	.1797	.2055	.1374	.2728	.0960
45	.1994	.2017	.1735	.1373	.2407	.0969
50	.2250	.2196	.2113	.1703	.2390	.1104
55	.2319	.2377	.1954	.1733	.2338	.1168
60	.2370	.2565	.2500	.2277	.2402	.1480
65	.2465	.2660	.2531	.2543	.2648	.1693
70	.3352	.2911	.3666	.3137	.3351	.2218
75	.3044	.3335	.3624	.3408	.3581	.2574
80	.3091	.4204	.4277	.4036	.3927	.3051
Mean (20–60)	.1911	.1962	.1976	.1551	.2699	.1017
St. Dev.	.0342	.0345	.0230	.0312	.0316	.0207

Note: The $q(x)$ values reported here for ages 20 onward have been smoothed by employing five-figure moving averages.
Source: Russell (above, n. 14) 25–29.

the value of the mean. What this indicates is that the overrepresentation of older decedents is surprisingly uniform throughout the Empire.

The second phenomenon distorting the funerary data is less evident, but equally universal. In Table V, I have calculated mortality rates—$q(x)$—derived from six populations, including the Intercisa/Brigetio population, and five out of Russell's 14 regional populations. (From age 20 onward, these mortality rates are based on five-figure moving averages; I have used this method of reporting in order to reduce the effect of age-heaping on 10's.)[17] What is especially curious about these figures is that they appear to depict mortality as "stabilizing" during adulthood, especially for ages 20–60. The levels of "stabilization" do vary somewhat, but "stabilization"

[17]From the extensive recent scholarship on age-heaping, see esp. R. P. Duncan-Jones, "Age-Rounding, Illiteracy and Social Differentiation in the Roman Empire," *Chiron* 7 (1977) 333-353; "Age-Rounding in Greco-Roman Egypt," *ZPE* 33 (1979) 169–177. The consequence for the $q(x)$ figures is an undesirable seesaw effect: up on the 10's, down on the 5's. The method I have chosen to counteract this effect clarifies the central tendency of the data, at the cost of very slight misrepresentation.

itself is always present. In the Egyptian data, mortality from ages 20 to 60 fluctuates between .1658 and .2565; in the data from Asia etc., between .1735 and .2500; for Spanish males, between .1321 and .2277. The range of the Intercisa/Brigetio mortality rates for ages 20–60 is from .1539 to .2370, and the rates are in general closely comparable to those for Asia etc. The final two columns in Table V present the extremes within Russell's 14 populations. For Roman females, the mortality rates are the highest emerging from the funerary data; they range between .2338 and .3079 from ages 15–65. African males have the lowest mortality rates, ranging from .0847 to .1480 for ages 20–60.

As is evident, the level at which the "stabilization" occurs varies somewhat from population to population, as does the length of time during which it prevails; but the phenomenon occurs in all of Russell's 14 populations and can be regarded as inherent.[18] Within these 14 populations, the mean levels of "stabilization" are between .1641 and .2410 for ages 20–60. The maximum and minimum values of *q(x)* normally differ by about .08 from ages 20 to 60; the smallest difference in Russell's populations is .0257, and the largest is .1096. Needless to say, this "stabilization" is highly unrealistic. In my Life Table, *q(x)* rises steeply throughout adulthood, from .0827 at age 20 to .3278 at age 60, a difference of .2451—more than triple the average range in Russell's populations. In the Keszthely-Dobogó data, the rise is from .0591 at age 20 to .2825 at age 60. The comparable rises from ages 20 to 60 in the Coale-Demeny model are from .0838 to .2912 for females, and from .0845 to .3291 for males. Of the nine *q(x)* values in my Life Table for

[18]It is also found in the differently grouped statistics of I. Kajanto, *On the Problems of the Average Duration of Life in the Roman Empire* (*Ann. Acad. Sci. Fenn.*, Ser. 2, 153.2 [1968]). The African data (some 18,000 inscriptions) were collected by J. Szilágyi, "Die Sterblichkeit in den nordafrikanischen Provinzen," *Acta Arch. Hung.* 17 (1965) 309–334, 18 (1966) 235–277, 19 (1967) 25–29. The African data differ from other data of Roman date in that, probably because age at death is almost always given on African gravestones, the *q(x)* figures for males aged 10–34 and for females aged 10–49 look very plausible, and indeed are almost identical to those in Model South, Level 2: thereafter, however, the *q(x)* figures are increasingly affected by age exaggeration, which forces their values below those in my Life Table at an exponentially rising rate. The African data thus apparently display the effects of age exaggeration in a relatively pure form; I will return to this subject elsewhere. But the defense of the African data in J. M. Lassère, *Ubique Populus* (Paris 1977) 519–524, seems demographically naive; see also J. Reynolds *et al.*, "Roman Inscriptions 1976–1980," *JRS* 71 (1981) 121–143, at 136 n. 213. Szilágyi also published the Western European data: "Beiträge zur Statistik der Sterblichkeit in den westeuropäischen Provinzen des römischen Imperiums," *Acta Arch. Hung.* 13 (1961) 125–155, 14 (1962) 297–396, 15 (1963) 129–224. There are about 25,000 inscriptions from this area. Apart from some local pecularities, these additional data do not much alter Russell's life tables. Note that in various regional populations the female mortality rates appear to "stabilize" at a higher rate than the male mortality rates, thus giving the (probably false) impression that female life expectancy was lower than male life expectancy.

ages 20–60, usually no more than four can be fitted within any of the ranges reported in the preceding paragraph.

The apparent "stabilization" of mortality rates in Russell's populations is not easily explained; it presumably depends on a variety of cultural factors influencing the decision to include a decedent's age at death on his or her gravestone. In virtually all of Russell's 14 populations, the number of decedents aged 20–40 (and to a lesser extent also those under age 20, except for very young children) is evidently overrepresented; but those aged 50 to 70 are apparently underrepresented. This suggests that young adults were persistently favored in the decision to include age at death, doubtless owing to a sense that they had died "too young;" while older adults, who died more seasonably, were persistently not favored, presumably because their age at death was thought to be "normal," and perhaps also because age exaggeration has tended to remove them from the age-brackets where they belong. In any event, the result is clear: adult mortality rates tend to "flatten out" at some stable level, although the dimensions of this "stabilization" vary somewhat from area to area of the Roman Empire, and even between the sexes. In Rome, for example, the female *q(x)* rates oscillate between .2338 and .3079, while the male rates are at a significantly lower level, between .1908 and .2165.

Over the long run, these variations in the level of mortality "stabilization" have a considerable impact on the statistics for life expectancy. At age 65, as I observed above, the mean life expectancy in Russell's 14 populations is 13.7 years, with a standard deviation of plus or minus 2.1 years (equal to about 15% of the mean). However, as one goes upward to younger ages, the diversity between Russell's populations steadily increases, until age 20 where the standard deviation is equal to about 26% of the mean, or nearly double the percentage for age 65. At age 20, the mean life expectancy is 23.8 years, and the standard deviation is plus or minus 6.0 years; this means that most populations (in fact, 11 out of 14) have life expectancies at age 20 between 17.3 and 29.3 years. This wide range and increasing diversity are ascribable solely to the diverse levels at which adult mortality happens to "stabilize" in each of Russell's 14 populations. The varying life expectancies at age 20 are every bit as artificial and unrealistic as the varying levels of mortality "stabilization."

Nonetheless, while it is true that the level of mortality "stabilization" varies somewhat in Russell's 14 populations, it is also true that these populations possess a large degree of internal consistency. If we calculate *q(x)* in the manner referred to above (note 17), the mean of the 14 *q(x)* values remains virtually unchanged from ages 20 to 55; it oscillates between extremes of .1774 (at age 45) and .1963 (at age 50), a difference of only slightly less than twenty deaths per thousand. (Mortality actually appears to decline slightly from ages 20 to 45.) The great majority of *q(x)* values (about 72%) lie within one standard deviation. Only the African statistics for both male and females, and the Roman statistics for females, lie consistently outside this range (below and above, respectively). After age 50, the *q(x)* figures start to edge slowly but uniformly upward; the mean rises to .2227 at age 60, .3017 at age 70, and .3834 at age 80. The standard deviation from these means is always less than plus or minus .0600; furthermore, this standard deviation tends to decline both absolutely and as a percentage of the mean, which indicates that the *q(x)* rates tend to converge for older ages. Correspondingly, the diversity in life expectancies also diminishes. Thus, despite the varying cultural factors that doubtless influenced the decision to include age at death on gravestones, an underlying pattern of mortality recurs time and again throughout the funerary data. This pattern, while it is extremely unrealistic, is nonetheless interesting for what it says about the general cultural uniformity of the Roman Empire.

Russell's 14 life tables are all determined, to a considerable extent, by the two phenomena I have discussed above. Life expectancy at age 65 stands at an unrealistically high level, usually about 12-15 years. The earlier portion of the life expectancy tables, back to age 20 or so, is determined both by the high level of life expectancy at age 65, and by the level at which mortality happens to "stabilize" during adulthood. The level of adult mortality "stabilization" is also frequently related to the level of mortality during childhood (ages 5–19), in the sense that populations "stabilizing" at high levels of adult mortality tend to have high levels of child mortality also, and *vice versa*. This relationship is reasonably clear from Table V, and is confirmed by all other data.

The result might be thought of as resembling a "drawbridge" with one "fixed" end and one "free" end that can be raised or lowered. The "fixed" end is life expectancy at age 65 or so, where all of Russell's populations have closely similar values. The "free" end is life expectancy at age 20. If mortality from ages 20 to 60 "stabilizes" at a relatively low level, the "free" end is raised high up into the air, and life expectancy at age 20 appears to be considerable; if it "stabilizes" at a high level, then the "free" end is lowered and life expectancy is small. In Table VI, Russell's 14 populations are arranged in ascending order of mortality "stabilization;" as can be readily observed, life expectancy at age 20 tends to descend in close correlation to the ascent of mortality "stabilization." The coefficient of determination r^2 between the mean *q(x)* values for ages 20–60 and the life expectancies at age 20 is .951, indicating very high (negative) correlation. And since high levels of adult mortality "stabilization" tend to be associated with high levels of apparent mortality for ages 5–15 (and *vice versa*), the correlation between mean *q(x)* values and the life expectancies at age 5 is also significantly high; r^2 is .793.

TABLE VI

SUMMARY OF RUSSELL'S 14 POPULATIONS

Area	No. of Inscr.	$q(x)$—Ages 20–60 Mean	St. Dev.	Max.	Min.	Life Expect. at Age: 5	20	65
Africa, Males	6,238	.1017	.0207	.0842	.1480	46.3	37.1	16.8
Africa, Females	4,459	.1147	.0155	.1012	.1520	43.7	34.3	16.8
Spain, Males	1,111	.1551	.0312	.1321	.2277	37.0	27.5	13.0
Central Italy	892	.1845	.0233	.1634	.2402	26.5	22.7	12.8
Egypt	813	.1962	.0345	.1631	.2565	30.8	23.1	12.7
Asia *etc.*	2,345	.1976	.0230	.1735	.2500	21.2	22.7	12.4
North Italy	631	.2049	.0350	.1783	.2872	29.9	22.7	10.3
Rome, Males	4,575	.2060	.0093	.1908	.2165	22.4	20.6	14.6
Spain, Females	885	.2076	.0353	.1784	.2880	31.2	21.8	11.9
Cisalpine Gaul	927	.2084	.0249	.1779	.2478	24.9	18.9	14.2
Narbonese Gaul	422	.2088	.0122	.1875	.2277	25.7	19.8	14.5
Latium	747	.2089	.0317	.1543	.2473	21.0	19.0	17.7
South Italy	1,913	.2145	.0324	.1787	.2777	27.8	21.5	12.0
Rome, Females	3,490	.2699	.0316	.2338	.3079	20.0	14.5	12.6
Mean:		.1886	.0266	.1501	.2372	29.9	23.3	13.7
Standard Deviation:		.0426	—	.0377	.0465	7.9	6.0	2.1

Note: Values for life expectancy come from Russell's tables, and (except in the case of Egypt) are based on unsmoothed values of $q(x)$. The $q(x)$ values reported here were obtained by using five-figure moving averages.
Source: Russell (above, n. 14) 25–29.

This is the artifice underlying all of Russell's 14 life tables. Each of them displays the obvious consequence of strong cultural influences on the decision to include a decedent's age at death on his or her gravestone. Russell's life tables are all poisoned from a common well.

I began this discussion by suggesting that the Intercisa/Brigetio gravestones could serve as a "control" for the Keszthely-Dobogó skeletal evidence; but in reality the reverse must be true. The Intercisa/Brigetio data are seriously affected by the same flaws that characterize all other life tables derived from funerary data; indeed, as we shall see, the Intercisa/Brigetio data virtually duplicate all the central tendencies in Russell's 14 life tables. However, in this particular instance we can safely assume that the Intercisa/Brigetio population belongs to the same demographic pool as that found at Keszthely-Dobogó, since these communities are located only about 100 km. apart. Since the Keszthely-Dobogó cemetery furnishes data that are far more consistent with the patterns predicted by the Coale-Demeny models, it may be confidently accepted as the more reliable indicator of mortality experience in this region of Pannonia. In that case, the Intercisa/Brigetio data are valuable in a different way; they show how funerary inscriptions can misrepresent normal mortality experience.

Not only do the Intercisa/Brigetio figures distort mortality experience; also, and far more important, the results of this distortion are completely consistent with the general pattern of data yielded by funerary inscriptions from elsewhere in the Roman Empire. This emerges clearly from Chart I, in which four sets of life expectancies are plotted against age from 5 to 80. The four sets comprise two distinct pairs. The first pair consists of my Life Table and the closely related data from the Keszthely-Dobogó cemetery (cf. Tables I–II). The two curves each display a relatively steep decline in life expectancy from a high of about 37-38 years at age 5; in both cases the curve is slightly convex when viewed from above. The second pair consist of the set of life expectancies derived from the Intercisa/Brigetio inscriptions (cf. Table IV), and, closely associated, a set of life expectancies based on the mean $q(x)$ values at various ages in Russell's 14 populations. (Russell's populations are summarized in Table VI; in making these calculations, I have assumed a life expectancy at age 85 of 7.9 years, the mean of the values given by Russell.) This pair of life expectancy curves begins at a considerably lower value, and ends at a considerably higher one, than does the first pair; they are therefore more nearly horizontal. In addition, these curves are distinctly concave when viewed from above, an effect that is produced by the mortality "stabilization" from ages 20 to 60.

As Chart I also suggests, the values of life expectancy calculated from the Intercisa/Brigetio gravestones are closely comparable with the mean values of life expectancy in Russell's populations (cf. Table VI). At age 5, life expectancy is 32.7 years at Intercisa/Brigetio, 29.9 years in Russell's populations; at age 20, the figures are 24.57 and 23.3 years, respectively; at age 65, 13.74 and 13.7 years, respectively. The life expectancy figures for Intercisa and Brigetio always lie comfortably within one standard deviation from the mean in Russell's populations.

What is the significance of these patterns? The answer to this question depends to some extent on interpretation. It need not be true, of course, that underlying patterns of mortality were in fact closely similar in every region within the Roman Empire. On the other hand, we have at present no real reason to exclude this possibility, and the wisest course is perhaps to keep an open mind.[19] But since the phenomena distorting the evidence from gravestones are evidently so artificial and culture-bound, my hypothetical Life Table can at least be regarded as not inconsistent with the mortality patterns that the gravestones seem to yield; for it does not appear that *any* of these mortality patterns can be correct, and the diversity between them is largely an illusion.

But a somewhat more optimistic reading is also possible. We have seen that the Keszthely-Dobogó population could be regarded as an example of the theoretical population described in my Life Table. Likewise, the Intercisa/Brigetio data represent a clear distortion of the Keszthely-Dobogó data; and this distortion fully corresponds with the central tendencies in funerary populations found throughout the Roman Empire. It would therefore seem reasonable to argue that these funerary populations, when allowance is made for the evident distortion in their data, fully correspond to my Life Table, and to that extent confirm its general validity for the Roman Empire.

By and large, scholars have tended to approach Roman demography by analyzing the ages given in funerary inscriptions; but for a variety of reasons this approach has not proven satisfactory.[20] Demographic analysis of skeletal remains is as yet extremely uncommon for the ancient world, despite the fact that its results are on the whole considerably more reliable.[21]

[19]On the results of so-called "differential demography" for the Roman Empire, see P. Salmon, *Population et dépopulation dans l'Empire romain* (Brussels 1974) 89–112.

[20]See my article (above, n. 1), esp. note 51. Perhaps the best introduction to the problems with the funerary inscriptions is still K. Hopkins, "On the Probable Age Structure of the Roman Population," *Population Studies* 20 (1966) 245–264. See also K. K. Ery, "Investigations on the Demographic Source Value of Tombstones Originating from the Roman Period," *Alba Regia* 10 (1969) 51–67; M. Clauss, "Probleme der Lebensalterstatistiken auf Grund von römischer Grabinschriften," *Chiron* 3 (1973) 395–417. Ery's article, which generally escaped notice in the West, criticizes the epigraphic evidence partially on the basis of his analysis of a small cemetery (52 burials) at Majs in Hungary; this cemetery's population closely resembles that at Keszthely-Dobogó; cf. K. K. Ery, "Anthropological Studies on a Late Roman Population at Majs, Hungary," *Anthropologia Hungarica* 8 (1968) 31–58, esp. 41 At page 33, however, Ery observes that this population is not entirely a "natural" one, but rather a strategic settlement.

[21]To the best of my knowledge, except for the cemetery mentioned in note 20, no other Roman cemetery has so far received a full and accurate demographic analysis—though this situation will doubtless soon alter. Skeletal data are reported for Classical Greece by J. L. Angel, "The Bases of Paleodemography," *American Journal of Physical Anthropology* 30 (1969) 427–435, at 427; and by H. V. Valois, "Vital Statistics in Prehistoric Population as Determined from Archaeological Data," in R. F. Heizer and S. F. Cook (edd.), *The Application of Quantitative Methods in Archaeology* (Chicago 1960) 186–204, at 195–204;

When further skeletal evidence is assessed, there will be additional opportunities to test the general validity of my hypothetical Life Table. In this regard, Josiah Russell, in a recent *Bulletin* of the *International Commission on Urgent Anthropological and Ethnological Research*,[22] has pointed out that the more than 2000 skeletons preserved from Pompeii offer "an unprecedented opportunity for physical anthropologists to reconstruct the age-sex and other patterns of a Roman population . . . . An allout study of the skeletal data is perhaps the greatest desideratum of ancient history today." I can only concur in this evaluation.

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for first-cent. B.C. Egypt, by W. M. Krogman, "Changing Man," *Journal of the American Geriatrics Society* 6 (1958) 246 (after Karl Pearson, 1897). In general, these data yield comparable life expectancies at birth, but substantially lower adult life expectancies; however, the data are poorly reported; cf. K. M. Weiss (above, n. 8) 106–107. G. Clarke, *The Roman Cemetery at Lankhills* (*Winchester Studies* 3 [1979]) 342, promises a forthcoming analysis of this cemetery's skeletal remains; and cf. already R. Warwick, in L. P. Wenham, *The Romano-British Cemetery at Trentholme Drive, York* (London 1968) 147–148; as well as C. Wells in A. McWhirr *et al., Cirencester Excavations* 2 (Cirencester 1982) 135–137, whose results are demographically very peculiar. The criticism of demographic anthropology in A. K. Samuel *et al., Death and Taxes: Ostraka in the Royal Ontario Museum* 1 (Toronto 1971) 11–13, is founded on an antiquated understanding of the field: see Acsádi and Nemeskéri (above, n. 5); Weiss (above n. 8) 11–12, 58–61; Ubelaker (above, n. 9); K. M. Weiss and P. E. Smouse in *DEHP* (above, n. 4) 59–73, with further bibliography; and in general D. H. Ubelaker, *Human Skeletal Remains: Excavation, Analysis, Interpretation* (Chicago 1978).

[22]"The Population and Mortality at Pompeii," *Bulletin* 19 (1977) 107–122; the quotation is from page 122. The recent discovery of some 80 skeletons in a cave near Herculaneum has raised the likelihood of significant imminent advances in our understanding of Roman demography; see the preliminary description of the remains by J. Judge, *National Geographic* 162.6 (December 1982) 687–692.