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JAMES C. RILEY

Mortality at sea has emerged as a prominent issue in the recent literature on forced and voluntary migration from Africa and Europe in the seventeenth, eighteenth, and nineteenth centuries. Among the concerns of historians has been to establish rates of mortality among slaves being transported west and, having established those rates, to attempt to interpret them according to the experience of other migratory groups. My attention was drawn to this problem by some data presented by the Dutch mathematician, geographer, and demographer Nicolaas Struyck (1687–1769) about the experience of 17,092 people sailing on 84 vessels between the Dutch Republic and the Dutch East Indies during the 1730s (Table 1).[1] Struyck's attempt to establish mortality on these very long voyages, requiring some eight months for each half of the voyage, raises the issue of how properly to calculate seaborne mortality rates. These rates are usually stated in terms of voyages, and thus for highly variable periods of time during which the lives of seaborne travelers were at risk. While this mode of computing rates has certain strengths, a comparison of the Struyck data with other experience reveals the value of also computing rates for constant periods of time. When data on the mortality experience of Dutch sea voyagers are compared with data on the experience of other groups on an equivalent-time basis, it appears that mortality among slaves exceeded that among several other groups of voluntary and involuntary immigrants in the eighteenth century.

Among the intriguing questions concerning mortality at sea is that about the curve of experience during the voyage. Struyck reports that slower voyages experienced more deaths, but, like most sources reporting on this question, he does not reveal the trend during the course of the voyages. Several factors that are only partially time dependent influenced mortality on voyages such as these. First, one might notice a standard mortality associated with confined conditions, marginal nutrition, and shipboard hazards. For slaves the effect of these factors was compounded. Standard mortality rates were higher at sea

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NOTES

[1] Nicolaas Struyck, *Les oeuvres de Nicolas Struyck (1687-1769)*, J. A. Vollgraff, ed. and trans. (Amsterdam, 1912), pp. 361–62. Further interpretation of mortality among Dutch East India voyagers may be found in J. R. Bruijn, "De personeelsbehoefte van de VOC overzee en aan board, bezien in Aziatisch en Nederlands perspectief," *Bijdragen en mededelingen betreffende de geschiedenis der Nederlanden*, 91 (1976), especially pp. 221–24. Bruijn's data indicate an average voyage-specific mortality on the outbound passage in the period 1730–1740 of 12 1/2 per cent, which was somewhat higher than the usual rate on all outbound voyages. Per voyage experience may be followed in J. R. Bruijn, F. S. Gaastra, and I. Schöffer, eds., *Dutch Asiatic Shipping in the 17th and 18th Centuries*, 3 vols. (The Hague, 1979).

Mortality rates have been computed by dividing the number of deaths on the voyage by the population at the midpoint of the voyage (here assumed to be the beginning population less half the deaths on the voyage). Russell Menard kindly pointed out to me the need to adopt this method rather than the more commonly seen computation that divides all deaths by the beginning population. (For the Breslau and model life table populations dealt with in Table 3, this adjustment is not needed because the data given are midyear populations.)

TABLE 1
MORTALITY ON DUTCH VESSELS

At Risk	*Vessels*	*Deaths*	*Crude Death Rate per Thousand*	*Average Duration of Voyage*	*Death Rate per Thousand per Month*
Leg 1—15,889 people (Dutch ports to the Cape of Good Hope)	73	1,733	115.36	5 months	23.07
Legs 3 & 4—1,203 people (Batavia, modern Jakarta, to Dutch Ports)	11	80	68.79	8 months	8.60

Source: See footnote 1. Struyck omits mention of the second leg of this voyage.

than on land for most populations with the same characteristics. Second, long-distance voyages involved a duration effect. The best-informed assumption seems to be that duration mortality occurred in a U curve, with a high initial death rate tapering off thereafter.[2] On unusually long voyages and probably also on voyages experiencing a delayed onset disease (such as yellow fever or dysentery) that had time to appear before a voyage was completed, the second half of the U curve was felt. A third factor in mortality was the passage into new epidemiological zones, although the effects of this factor have not been examined closely in the scholarly literature.

Because the sources about mortality at sea that have been reported upon up to now do not reveal date or cause of death (except occasionally for crew members), the relative weight of the above-mentioned factors cannot yet be distinguished. Whether or not mortality at sea was highly time dependent, the time involved in voyages needs to be standardized if only to clarify what is at issue. Voyage-specific rates should be calculated, for they may be suggestive of factors behind mortality other than time. Too often in the literature, however, voyage length is not specified, and mortality on voyages of widely different lengths is compared without regard for the element of time. Unless the length of voyages is specified, and time-standardized rates are also calculated, important differences in mortality experience will be overlooked. In the present instance only voyage-specific and time-standardized rates can be calculated from Struyck's data, so that it is not possible to distinguish the effect upon mortality of standard hazards, duration factors, and passage into new epidemiological zones. But it is possible to establish by means of time-specific mortality rates a standardized means of comparing mortality in Struyck's setting to mortality in other settings.

[2] Joseph C. Miller, "Mortality in the Atlantic Slave Trade: Statistical Evidence on Casuality," *Journal of Interdisciplinary History*, 11 (Winter 1981), 388 and *passim* 385–423, argues that in ordinary voyages slaves died in largest numbers early in the voyage, after which the death rate declined. On unusually long voyages, however, the death rate again increased as food and water were exhausted. As Miller acknowledges, this interpretation of the available evidence awaits verification. In any event, the pattern of deaths within a voyage may indeed have been as Miller suggests without calling into question Struyck's observation that slower voyages had higher mortality levels. Struyck, and most historians of mortality on these voyages up to Miller, thought about death rates in voyage-specific terms. Their statements that the death rate increased when the average voyage lengthened meant that the longer a cargo of slaves remained at sea the larger would be the portion of slaves that would die. Sometimes these historians implied that the trend of the rate of loss turned upward with longer voyages. Miller's contribution is to show that higher rates for long voyages and lower rates for short voyages do not by themselves tell us anything about the trend of the rate of loss during the voyage.

On the eastbound voyage Dutch mortality was high, but it is not easy to establish just how high it was in comparison to other, similar experience.[3] At first glance the 11.54 per cent mortality on a leg of the voyage that lasted, on average, five months seems considerably higher than that experienced by slaves on French vessels taking less than seven months between their arrival on the African coast and at an American destination (Table 2). But the comparison of Dutch and African slave experience must mention that French and other slavers did not usually get a full complement of slaves very soon after their arrival on the African coast. Thus the distribution of losses drawn form the work of Robert Stein tends to exaggerate the time most slaves spent on board ship. Since the middle passage was comparatively brief, averaging only 62 days in one, 81 days in a second, and 39.1 days in another, later sample,[4] it is chiefly the coastal portion of the voyage that seems to be reflected in Table 2. If slave acquisitions were evenly distributed during the coastal portion, then Stein's coastal periods might be reduced by some two months each to reflect more closely the average time that slaves spent on board ship. If one accepts such a procedure, it becomes unclear whether slave deaths on French vessels occurred at a lower or higher rate than the worst European mortality case dealt with here (that among Europeans sailing from Dutch ports to the Cape of Good Hope) when the times on board ship were of approximately equal duration.

On the other hand, if, as Joseph Miller suggests,[5] deaths in the French slave trade were ordinarily reported for the middle passage only, then the time involved in Stein's mortality percentages would be sharply diminished. Figured now on a monthly rather than a voyage-specific basis,[6] and at what would seem to be minimum and maximum estimates of

[3] Robert L. Stein, *The French Slave Trade in the Eighteenth Century: An Old Regime Business* (Madison, 1979), p. 100; and *idem*, "Mortality in the Eighteenth-Century French Slave Trade," *Journal of African History*, 21, 1 (1980), 35–41. See also Herbert S. Klein, *The Middle Passage: Comparative Studies in the Atlantic Slave Trade* (Princeton, 1978), *passim*, especially pp. 64–71, 86–93, 160–63, 193–203, and 229–41; Johannes Postma, "Mortality in the Dutch Slave Trade, 1675–1795," in Henry A. Gemery and Jan S. Hogendorn, eds., *The Uncommon Market: Essays in the Economic History of the Atlantic Slave Trade* (New York, 1979), pp. 239–60; Herbert S. Klein and Stanley L. Engerman, "A Note on Mortality in the French Slave Trade in the Eighteenth Century," in Gemery and Hogendorn, *The Uncommon Market*, pp. 261–72; Herbert S. Klein and Stanley L. Engerman, "Shipping Patterns and Mortality in the African Slave Trade to Rio de Janeiro, 1825–1830," *Cahiers d'études africaines*, 15 (1975), 381–98; and Herbert S. Klein and Stanley L. Engerman, "Facteurs de mortalité dans le trafic français d'esclaves au XVIIIe siècle," *Annales économies sociétés civilisations* 31 (Nov.-Dec. 1976), 1213–1224.

Most students of this question report that mortality declined over time, but the available data are sporadic in time and place. Information collected by Klein, *Middle Passage*, pp. 64–68, suggests the following pattern of voyage-specific mortality among slaves:

	British	French	Portuguese
1680–1688	23.6%		
1715–1775		14.9%	
1791–1792	14.2		
1795–1811			9.3%
1810s–1840s	9.1		

[4] Postma, "Mortality," pp. 244-46; and Klein and Engerman, "Shipping Patterns," p. 386.

[5] Miller, "Mortality," pp. 400 and 403-04.

[6] In the literature on slave mortality considerable ambiguity arises because the time at issue in death rates is sometimes left vague; moreover, since the length of slave voyages tended to be reduced over time, the period of time implied in voyage-specific statements of death rates changes. This ambiguity might be ended by stating mortality rates at sea in daily, monthly, or annual rates, but of those a statement of monthly rates seems preferable. As Miller, "Mortality," has shown, daily rates are quite useful for certain purposes, and they produce more precise rates. But daily rates are very small numbers. Annual rates might be taken to imply that mortality at the extraordinary levels of sea voyages was sustained for such a long period when in fact few voyages lasted a year and most were completed

TABLE 2
SLAVE MORTALITY BY DURATION OF VOYAGE

Duration of Voyage	*Percent Loss*
Less than 7 months between arrival of ships at the African coast and at an American destination	6
7 to 9 months	13.5
Over 9 months	18.3

Source: See footnote 3.

the average time spent on board (Table 3),[7] slave deaths among the large number of people transported by Nantes slavers seem to have occurred at a higher rate than European deaths on the voyage to the Cape or among Europeans in other cases of voluntary or involuntary migration. On the assumption that reported slave deaths refer to both the coastal and the middle passage portions, the excess of slave mortality over the worst-conditions case for Europeans (leg 1 on the voyage to the East Indies) is slight (23.70 per thousand per month versus 23.07 per thousand per month). On the likelier assumption that all slave deaths reported occurred during the middle passage, the difference is substantial (52.66 per thousand per month versus figures no higher than 23.07 per thousand per month).

Another case, slaves arriving at Rio de Janeiro between 1795 and 1811, seems to cor-

in a much shorter period. Monthly rates have the advantage of providing a common measure that can readily be used for comparative purposes while preserving sufficiently large figures. Either a linear or an exponential method of calculation might, in most cases, be used:

$$\text{linear: } \frac{\text{voyage specific death rate}}{\text{number of months (30 day periods) in the voyage}};$$

exponential: $P_t = P_o\,(1\text{-}k)^t$, where P_t = survivors at end of voyage, P_o = population at beginning of voyage, t = length of voyage in months, and k = monthly probability of death.

In most cases the difference between linear and exponential rates will be quite small (e.g., minimum per month slave mortality on French vessels: linear = 23.70, and exponential = 23.74). The exponential method may be considered more appropriate because, if the probability of dying remains the same each month, the number of deaths will decline exponentially. But because the difference in result between the methods usually will be very small, in practice the linear method may be preferred. I wish to thank George Alter for explaining these distinctions to me. Monthly probabilities of death are converted to monthly death rates, which are central rates (i.e., deaths divided by the mid-month population), by the formula: $k / (1 - 1/2k)$.

Other methods of stating mortality rates remain useful. For example, in many instances voyage-specific rates will be preferred because they yield a merchant's rather than a demographer's measure of loss.

[7] Ansley J. Coale and Paul Demeny, *Regional Model Life Tables and Stable Populations* (Princeton, 1966), pp. 6 and 8 of the tables; A.G.L. Shaw, *Convicts and the Colonies* (London, 1966), pp. 116 and 363-64, for male and female (but mostly male) convicts transported to Australia; and K. G. Davies, "The Living and the Dead: White Mortality in West Africa, 1684–1732," in Stanley L. Engerman and Eugene D. Genovese, eds., *Race and Slavery in the Western Hemisphere: Quantitative Studies* (Princeton, 1975), pp. 88-89, for Royal African Company employee deaths. Male model tables have been used because shipboard populations are believed to have been predominantly male in most cases. These calculations follow a stationary population approach. For the Nantes crew mortality rates I infer an average voyage length of 81 days (2.7 months) from Stein, "Mortality," p. 37. From *ibid*, p. 41, table 8, I infer a weighted voyage-specific probability of death of 132.75 per 1000 and estimate passage times. For the coastal and middle passage taken together, note that the figure of 6 months represents an attempt to estimate average time spent on board by slaves.

TABLE 3
SEABORNE AND INLAND MORTALITY COMPARED

	Case	*Death Rate per Thousand*	
I.	*Seaborne*	*Per Voyage*	*Per Month*
	Minimum and maximum versions of mortality among slaves transported on French vessels, 1715–1778 (132.75 per thousand)		
	coastal and middle passage assumption, estimated average of 180 days	142.19	23.70
	middle passage only assumption, estimated average of 81 days	142.19	56.66
	Europeans in transit, leg 1 (15,889 and 1,733 deaths)	115.36 (5 months)	23.07
	Nantes slaver crews on the middle passage, 1715–1778	51.18 (81 days)	18.96
	Convict laborers arriving in Australia, 1788–1800 (7,385 and 743 deaths)	105.94 (191 days)	16.64
	Nantes slaver crews, coastal and middle passage, 1715–1778	130.51 (243 days)	16.11
	Europeans in transit, legs 3 & 4 (1,203 and 80 deaths)	68.79 (8 months)	8.60
II.	*Inland*	*Per Year*	*Per Month*
	Royal African Company employees, 1684–1732 (ave. 141 and 38 deaths ann.)	311.48	25.96
	Breslau, general population (34,000 and 1,174 deaths)	34.53	2.88
	Breslau, ages 15–19 (20,705 and 376 deaths)	18.16	1.51
	Coale-Demeny West model (male 15–59, $e^\circ = 27.668$)	20.73	1.73
	Coale-Demeny West model (male 15–59, $e^\circ = 32.484$)	17.85	1.49

Sources: See footnotes 1, 3, 7, and 11.

roborate the observation that, when computed on a per-month basis, slave mortality exceeded that among Europeans. In this instance the monthly mortality rate among slaves may have been about 75 per thousand.[8]

Among crews mortality rates in the Atlantic slave trade often fell below those for comparable periods of the voyage to the Cape of Good Hope. Surveying crews on 130 vessels sailing from Nantes between 1714 and 1778, Stein found that voyage-specific crew mortality increased during the century from 6.5 to 8.6 percent for coastal portions of the voyage,

[8] It is difficult to give examples of slave mortality because, on the one hand, all the relevant information is seldom given in sources where this issue is considered and, on the other hand, available data are often drawn from different periods and relate to different trade routes (and thus voyage lengths and mixtures between coastal and middle passage portions) to the point at which averages drawn from them may have very little, perhaps no, value. Klein, *Middle Passage*, p. 55, reports an average mortality of 93 per thousand among 162,225 slaves arriving at Rio de Janeiro between 1795 and 1811. That (apparent) percentage may be converted to a mortality rate of 97.54 per thousand for the average voyage. But how long was the average voyage? In Klein and Engerman, "Shipping Patterns," p. 386, an average sailing time of 39.1 days is reported for slaving ships arriving at Rio de Janeiro from several African regions between 1825 and 1830. If it is reasonable to use this average sailing time to interpret data on mortality among slaves making the passage to Rio between 1795 and 1811, the monthly mortality rate would then be 74.84 per thousand.

which grew longer, and remained constant for the middle passage (at 5 percent).[9] For early and late century, however, mortality figured at a monthly rate fell short of that reported by Struyck on leg 1 (Table 3). For the century as a whole, the rate of crew deaths averaged 13 percent, but this was for voyages averaging 243 days, significantly longer than the 150-day journey from Dutch ports to the Cape.

Among other seaborne groups, it is known that eighteenth-century European immigrants to North America died at a voyage-specific rate of 15 to 20 percent, and sometimes more, on crossings averaging four to five months, and that during 1776–1780 British troops sent to the West Indies suffered losses averaging 11 percent. Among troops being transported at sea, voyage-specific mortality rates ranged from 12-20 per thousand for Europeans going into the Mediterranean and temperate zones to 486-668 per thousand for those going to West Africa.[10]

When compared to inland populations in the same period, all these rates show the hazards of sea travel, whether forced or voluntary. As he gathered data on Europeans dying on voyages to and from the East Indies, Struyck may have had in mind similar data collected by a near contemporary, the English astronomer and mathematician Edmund Halley, concerning mortality in Breslau between 1687 and 1691.[11] Breslau's population, however, was neither stationary nor free from migration. As Halley and Struyck realized, it only approximated the stationary sample needed for mortality investigations, although it approximated such a sample more closely than any other large body of general population data collected during the seventeenth or eighteenth century. As a check against the mortality patterns suggested by the Breslau data, Table 3 incorporates mortality rates derived from the Coale-Demeny West model life tables for males at two life expectancies (e°) near those which it is reasonable to suppose Breslau residents, and Europeans in general, experienced in the late seventeenth and early eighteenth centuries. In the same table those mortality rates are compared with selected populations moving into new epidemiological zones.

In the small city of Breslau which, Halley believed, represented a typical mortality experience for European populations, 1,174 deaths were reported among an estimated 34,000 inhabitants (midyear population). Comparing a general population with groups composed chiefly of males aged 15-40 (slaves) or 15-59 (Europeans in transit to and from Batavia) would underestimate the difference in mortality between those groups. Thus Table 3 seeks to show mortality rates for all Breslau inhabitants, Europeans in transit, and model life table males, and to distinguish among those groups by age. Of Breslau inhabitants aged 15-59 mortality averaged about 1.82 percent per annum. On the first leg of the Dutch voyage to Batavia, the rate was over fifteen times greater (on a monthly basis). Similarly the Dutch rate was over thirteen times greater than the mortality rate for the model male population with a life expectancy at birth of 27.668 years.

By reporting the experience of several seaborne and inland populations in the seventeenth and eighteenth century, Table 3 offers an approximate hierarchy of mortality rates. In it are made clear the great risks encountered by all groups venturing on long-distance sea voyages in that period, the greater risks assumed by anyone venturing into a new epidemiological zone, and the still greater risks forced upon slaves.

[9] Stein, "Mortality," pp. 36-37 and pp. 40-41.

[10] Klein, *Middle Passage*, pp. 69-71 and p. 236.

[11] Edmund Halley, *Degrees of Mortality of Mankind*, Lowell J. Reed, ed., (Baltimore, 1942), p. 6. Breslau's age structure is not known, so it is not possible to correct Halley's estimates. Struyck discusses Halley's work in *Les oeuvres.*