The slave trade, death, and misery were inseparable long before abolitionist writers took up the slave trade as a subject in the late eighteenth century. Throughout the historiography there has been widespread recognition that Africans entering the trade died not only during the middle passage but during the process of enslavement and travel in the interior, on the African littoral awaiting shipment, and after arrival in the Americas. Europeans directly involved in the traffic were at risk in the last three of these four phases of transition between life in Africa and life in the Americas, and tended to die at rates comparable to their human cargoes. In the shipboard phase, and probably also in other stages of the journey, mortality in the slave trade normally exceeded that in other long-distance population movements. In the nineteenth century this differential widened as rates on other long-distance routes fell (Cohn, 1984; Eltis, 1984; Grubb, 1987; Klein, 1978; McDonald and Shlomowitz, 1989, forthcoming). To date, most explanations have focused on morbidity and mortality

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on board ship; data on the preembarkation phases are no more available to us today than to the abolitionists 150 years ago. For shipboard mortality, overcrowding on the ship, psychic shock, and violence have not fared well as explanations in the work of the last two decades, although the interplay between the first two and resistance to disease suggests further consideration. The present study focuses on shipboard mortality, but it is based on a large and complex dataset. It begins with a discussion and preliminary analysis of the nineteenth-century data. This is followed by a review of the various hypotheses on mortality in the slave trade.

The nineteenth-century data on shipboard mortality in the slave trade are taken from 1,757 voyages scattered through the period 1811 to 1867 and covering all branches of the Atlantic traffic except those to the African offshore islands. Of this total, 999 have formed the subject of three earlier studies of shipboard mortality, though in none of these studies are all 999 analyzed at once. Moreover, the British Foreign Office records from which most of the data are drawn have yielded additional information and corrections for about one-quarter of the data included in these earlier studies. Thus, for example, of the 999 observations used by earlier authors, approximately 500 have information on voyage length, whereas the present dataset has 765 with both mortality and voyage length recorded. Furthermore, several studies have treated Klein’s 1825–30 sample and Curtin’s 1817–43 sample as separate (e.g., Cohn and Jensen, 1982), whereas in fact almost all of the Rio de Janeiro data in the latter are also in the Klein set. The present dataset thus integrates previous datasets for the nineteenth century and adds new data. Some of these new records are for slavers that did not in fact complete the transatlantic crossing. After 1807 British cruisers captured about fourteen hundred slave ships and escorted them to British ports on the African coast. The five hundred that had slaves on board were forced to disembark their slaves, and the latter were given their freedom. The major disembarkation point was Sierra Leone, but because of wind and current conditions, the voyage from most major slaving areas to Sierra Leone was similar in length to a voyage to the Americas. Such voyages are treated as “transatlantic” for the purposes of
analysis here. Overall, the data constitute a large sample, perhaps between a fifth and a quarter of the total number of slaving expeditions which carried slaves in the transatlantic traffic after 1810, and some of the gaps in the tables that follow are there not because the data are missing, but because of a lack of voyages. Despite the size of the sample, there is, however, some potential bias in the data arising from the fact that they were collected at a time when the traffic was subject to increasingly intense scrutiny both officially and unofficially.

British officials suspected slave traders in Bahia, Brazil, of falsifying mortality returns for voyages arriving at Bahia between 1815 and 1830. Their suspicions were confirmed by a study of mortality in these years on captured slave ships bound for Bahia from Bight of Benin ports but diverted to Sierra Leone after capture. Although voyage length and presumably care of the slaves at the hands of the prize crew were no different from those of completed voyages to Bahia, mortality as a percentage of slaves embarked was almost twice as high on those ships diverted to Sierra Leone (Chamberlain to Canning, 13 Mar. 1824, 27 Aug. 1824, 11 Dec. 1824 [GB, FO 84/31]; Pennell to Canning, 21 Feb. 1826, 27 Feb. 1826, 24 Oct. 1826 [GB, FO 84/57]; Pennell to Dudley, 10 Aug. 1827 [GB, FO 84/71]; Gordon to Canning, 8 Dec. 1826 [enc.] [GB, FO 84/56]). The reason for this downward bias was limitations imposed by the 1815 Anglo-Portuguese treaty on the number of slaves carried in Portuguese ships, which Portuguese captains attempted to circumvent by underreporting deaths. It would seem wise, therefore, to eliminate from the sample those ships arriving at Bahia between 1815 and 1830. Yet the same bias is not apparent among slave ships reporting to the Rio de Janeiro customhouse. Mortality as a percentage of slaves embarked appears consistent with equivalent rates from the pre-1811 period as well as with data from the few Rio-bound ships captured and taken to Sierra Leone. As Rio ships, unlike their Bahian counterparts, rarely traded in zones prohibited by the 1815 treaty, it is quite possible that fear of British scrutiny and therefore the need to falsify the returns was much lower in Rio de Janeiro than in Bahia. Whatever the explanation, the present analysis proceeds on the assumption that underreporting of deaths at Rio de Janeiro was not of great significance.

Mortality patterns may be elucidated using two measurements
that have been widely adopted in the recent literature: the mortality rate, or the ratio of slaves died to slaves embarked; and the death rate, or the ratio of the mortality rate to voyage length in days. In the nineteenth century, mortality did not vary systematically with voyage length on most routes, and, within given routes, voyage time did not change significantly from 1811 to 1867 (though in the nineteenth century as a whole voyages were shorter than in earlier centuries) (Eltis, 1987: 133–135; Cohn, 1985: 690). Thus, for several of the issues at hand, which of these rates is used does not affect the interpretation offered. As data are more abundant for mortality rates than for death rates, much of the analysis is carried out with the former. After we eliminate the Bahia data, there are 1,579 records of mortality rates, including a subset of 765 records of death rates.

The results of analyzing the death-rate data were published a few years ago (Eltis, 1984). Here the focus is on the larger set of data from which mortality rates may be calculated. We begin with an examination of trends over time. Figure 1 shows time profiles for mortality as a percentage of slaves embarked, which are derived from polynomials in year of embarkation for those branches of the traffic where the data are adequate. For all regions together a seventh-degree polynomial was used and was significant at the 1 percent level. For Brazil South the polynomial was of the fifth degree and for West Central Africa it was of the third degree. Both of these profiles are significant at the .01 percent level, and in all cases the use of polynomials of a higher order added nothing to the profiles. The trend line for the traffic as a whole shows a pronounced upward movement during this half century, with the steepest increase occurring in the 1830s. The last decade of the traffic saw mortality running at two or three times that of the 1810s. In both West Central Africa and Brazil South (the latter drawing most heavily on the former), on the other hand, the secular upward trend did not get underway until the late 1820s, though the subsequent increase was fairly rapid. In all cases, substantial fluctuations between years are apparent, with rates in the years 1820–22, 1839–42, and 1849 running at between 50
percent and 250 percent greater than the decadal average in each of the areas covered by the time profiles.

Further geographic disaggregation of trends over time is possible with five-year instead of annual groupings of mortality rates. Table 1 shows the results of a regression-based analysis of variance of five-year mean mortality rates for major regions of embarkation. The limits of these regions are as follows: Upper Guinea is the coast north and west of Cape Palmas, though almost all observations are for a region stretching one hundred miles on each side of Sierra Leone; the Bight of Benin ranges from Cape Three Points up to but not including the Rio Nun, though very few left the Gold Coast; the Bight of Biafra extends from the Rio Nun to Cape Lopez, inclusive; and the Congo North extends from Cape Lopez to the mouth of the Congo. Angola is defined as the remainder of the West Coast and excludes the Congo River. South East Africa includes all export points on the East Coast; in practice, all observations fall between Sofala Bay and Mombasa. Table 2 provides the results of the same procedure carried out for slaves arriving at major regions of disembarkation.
Table 1  Mean mortality rates of slaves on transatlantic slave ships: Major regions of embarkation, 1811–67 (n=)

<table>
<thead>
<tr>
<th>Quinquennium</th>
<th>Upper Guinea</th>
<th>Bight of Benin</th>
<th>Bight of Biafra</th>
<th>Congo North</th>
<th>Angola</th>
<th>South East Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1811–15</td>
<td>0.033 (2)</td>
<td>0.043&lt;sup&gt;a&lt;/sup&gt; (86)</td>
<td>0.135&lt;sup&gt;a&lt;/sup&gt; (9)</td>
<td>0.049 (62)</td>
<td>0.067 (77)</td>
<td>0.135&lt;sup&gt;b&lt;/sup&gt; (13)</td>
</tr>
<tr>
<td>1816–20</td>
<td>—</td>
<td>0.099 (22)</td>
<td>0.105 (2)</td>
<td>0.067 (81)</td>
<td>0.073 (39)</td>
<td>0.208&lt;sup&gt;c&lt;/sup&gt; (22)</td>
</tr>
<tr>
<td>1821–25</td>
<td>0.097 (8)</td>
<td>0.110&lt;sup&gt;a&lt;/sup&gt; (37)</td>
<td>0.272&lt;sup&gt;c&lt;/sup&gt; (18)</td>
<td>0.047 (42)</td>
<td>0.078 (142)</td>
<td>0.209&lt;sup&gt;c&lt;/sup&gt; (79)</td>
</tr>
<tr>
<td>1826–30</td>
<td>0.078 (3)</td>
<td>0.188&lt;sup&gt;c&lt;/sup&gt; (38)</td>
<td>0.038 (124)</td>
<td>0.067 (207)</td>
<td>—</td>
<td>0.118&lt;sup&gt;c&lt;/sup&gt; (88)</td>
</tr>
<tr>
<td>1831–35</td>
<td>0.149&lt;sup&gt;a&lt;/sup&gt; (3)</td>
<td>0.056 (16)</td>
<td>0.111&lt;sup&gt;b&lt;/sup&gt; (40)</td>
<td>0.177&lt;sup&gt;c&lt;/sup&gt; (6)</td>
<td>0.145 (2)</td>
<td>—</td>
</tr>
<tr>
<td>1836–40</td>
<td>0.144&lt;sup&gt;b&lt;/sup&gt; (12)</td>
<td>0.061 (22)</td>
<td>0.140&lt;sup&gt;c&lt;/sup&gt; (30)</td>
<td>0.059&lt;sup&gt;b&lt;/sup&gt; (3)</td>
<td>0.203&lt;sup&gt;c&lt;/sup&gt; (13)</td>
<td>0.234&lt;sup&gt;c&lt;/sup&gt; (16)</td>
</tr>
<tr>
<td>1841–45</td>
<td>0.120 (3)</td>
<td>0.037 (16)</td>
<td>0.050 (1)</td>
<td>0.122&lt;sup&gt;c&lt;/sup&gt; (5)</td>
<td>0.125&lt;sup&gt;c&lt;/sup&gt; (34)</td>
<td>0.273&lt;sup&gt;c&lt;/sup&gt; (4)</td>
</tr>
<tr>
<td>1846–50</td>
<td>—</td>
<td>0.058 (31)</td>
<td>0.063 (5)</td>
<td>0.170&lt;sup&gt;c&lt;/sup&gt; (16)</td>
<td>0.102&lt;sup&gt;a&lt;/sup&gt; (24)</td>
<td>0.006 (1)</td>
</tr>
<tr>
<td>1851–55</td>
<td>—</td>
<td>0.081 (5)</td>
<td>0.0 (1)</td>
<td>0.327&lt;sup&gt;c&lt;/sup&gt; (3)</td>
<td>0.248 (1)</td>
<td>0.177&lt;sup&gt;c&lt;/sup&gt; (4)</td>
</tr>
<tr>
<td>1856–60</td>
<td>—</td>
<td>0.083 (8)</td>
<td>—</td>
<td>0.164&lt;sup&gt;c&lt;/sup&gt; (28)</td>
<td>0.150&lt;sup&gt;a&lt;/sup&gt; (2)</td>
<td>0.477&lt;sup&gt;c&lt;/sup&gt; (3)</td>
</tr>
<tr>
<td>1861–67</td>
<td>—</td>
<td>0.230&lt;sup&gt;b&lt;/sup&gt; (3)</td>
<td>—</td>
<td>0.076 (12)</td>
<td>0.019 (2)</td>
<td>—</td>
</tr>
</tbody>
</table>

Note: In the regression analysis, the dependent variable is mortality as a percentage of slaves embarked and the independent variables are five-year groupings of regions of embarkation, with Congo North, 1816–20, omitted. In the resulting equation the intercept is thus Congo North, 1816–20 (t statistic 6.0). \( R^2 = 0.262; n = 1,577. 

<sup>a</sup>Significantly different from Congo North mean, 1816–20, at the 20 percent level.

<sup>b</sup>Significantly different from Congo North mean, 1816–20, at the 5 percent level.

<sup>c</sup>Significantly different from Congo North mean, 1816–20, at the 1 percent level.
Table 2  Mean mortality rates of slaves on transatlantic slave ships: Major regions of disembarkation, 1811–67 (n=)

<table>
<thead>
<tr>
<th>Quinquennium</th>
<th>Caribbean</th>
<th>Brazil North</th>
<th>Bahia</th>
<th>Brazil South</th>
</tr>
</thead>
<tbody>
<tr>
<td>1811–15</td>
<td>0.215 a</td>
<td>—</td>
<td>0.043 c (95)</td>
<td>0.066 c (147)</td>
</tr>
<tr>
<td>1816–20</td>
<td>0.026 a</td>
<td>—</td>
<td>0.158 (1)</td>
<td>0.090 c (142)</td>
</tr>
<tr>
<td>1821–25</td>
<td>0.208 c (22)</td>
<td>0.145 (17)</td>
<td>0.154 (15)</td>
<td>0.109 a (257)</td>
</tr>
<tr>
<td>1826–30</td>
<td>0.153 (37)</td>
<td>0.095 a (35)</td>
<td>0.139 (21)</td>
<td>0.070 c (402)</td>
</tr>
<tr>
<td>1831–35</td>
<td>0.103 a (62)</td>
<td>—</td>
<td>0.064 (2)</td>
<td>0.307 b (2)</td>
</tr>
<tr>
<td>1836–40</td>
<td>0.134 (66)</td>
<td>0.226 a (3)</td>
<td>0.078 (6)</td>
<td>0.197 b (19)</td>
</tr>
<tr>
<td>1841–45</td>
<td>0.042 b (7)</td>
<td>0.115 (11)</td>
<td>0.042 b (8)</td>
<td>0.133 (29)</td>
</tr>
<tr>
<td>1846–50</td>
<td>0.102 a (6)</td>
<td>0.181 (2)</td>
<td>0.056 b (15)</td>
<td>0.119 (28)</td>
</tr>
<tr>
<td>1851–55</td>
<td>0.095 a (8)</td>
<td>—</td>
<td>0.131 (2)</td>
<td>0.133 (3)</td>
</tr>
<tr>
<td>1856–60</td>
<td>0.171 a (41)</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1861–67</td>
<td>0.096 (17)</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Note: In the regression analysis, the dependent variable is mortality as a percentage of slaves embarked and the independent variables are five-year groupings of regions of disembarkation, with the Caribbean, 1836–40, omitted. In the resulting equation the intercept is thus the Caribbean, 1836–40 (t statistic 9.95). \( R^2 = 0.111; \) \( n = 1,577. \)

aSignificantly different from Caribbean mean, 1836–40, at the 20 percent level.
bSignificantly different from Caribbean mean, 1836–40, at the 5 percent level.
cSignificantly different from Caribbean mean, 1836–40, at the 1 percent level.

Taken together, the two tables suggest the source of the secular increases in mortality apparent in Figure 1. Table 1 indicates that long-run increases in mortality occurred on ships leaving only two of the African regions which embarked significant numbers of slaves in the nineteenth century. Although the slave trade ended at or before midcentury in Upper Guinea and the Bight of Biafra, and variations from one quinquennium to another within all regions are significant, only from Congo North and Angola did the rate clearly rise during the century. In the early period, rates were comparable to those on ships leaving the Bight of Benin. After the 1830s, rates were comparable to those experienced in the Bight of Biafra, consistently the region with the worst mortality record.

The pronounced secular rise over time in the aggregated data in Figure 1 is thus a comment on the preponderance of West Central Africa data in the present dataset. This preponderance results in some bias in the all-African trend. West Central Africa supplied about 48 percent of the slaves shipped after 1810 but 57 percent
of the mortality records on which this discussion is based. After 1850, however, the regional distribution of the present sample and of those actually shipped was very similar. Calculation of a weighted mean mortality for all Africa based on the true share of West Central Africa before 1850 suggests that the actual all-regions time profile would lie about two-thirds of a percentage point above that shown in Figure 1 (the observed mean mortality for all regions for 1811–50 is 9.36 percent of those embarked; the corrected mean, 10.0 percent).

Table 2, on the other hand, shows that ships arriving at only one of the four major American importing regions experienced increasing mortality as the century progressed. This region, Brazil South, always drew on the two West Central African regions for the largest share of its imports. Of the American regions that did not experience increasing mortality over time, one, Bahia, had consistently lower mortality than other regions. This region drew very few slaves from Congo North and Angola and relied almost exclusively on the Bight of Benin. The other, the Caribbean (mainly Cuba), had consistently higher mortality than other importing regions. It drew heavily from the Bight of Biafra in the early part of the century and then gradually switched during the 1830s and 1840s to West Central Africa. The point here, as noted below, is that the Bight of Biafra always experienced mortality rates higher than those of other African regions. The slave trade from the Bight of Biafra trailed off just as the mortality rate from West Central Africa, which replaced the Bight of Biafra, began to rise sharply. The constant high Caribbean rate over time was thus largely a result of the Caribbean’s switching from one high-mortality exporting region to another. The strong implication here is that the primary source of fluctuations in the nineteenth-century slave trade must be sought in Africa rather than in slave trader strategies, shipping routes, or other hypotheses taken up below.

The key question is the interaction between regions of embarkation, disembarkation, and time. Again, there was no African region in the nineteenth century where significant numbers of ships from all major American regions traded at the same time. Only for West Central Africa in the quinquennium 1826–30 are there sufficient records for a test of significance for rates on ships sailing for two different American regions. The two regions are Brazil North and Brazil South, and, as we have argued above, the difference in mean mortality for each region in the Americas is not
Table 3 Mean mortality rates on transatlantic slave ships bound for the Caribbean: Major regions of embarkation, 1811–67 (n=)

<table>
<thead>
<tr>
<th>Quinquennium</th>
<th>Upper Guinea</th>
<th>Bight of Benin</th>
<th>Bight of Biafra</th>
<th>West Central Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1811–15</td>
<td>0.048 (1)</td>
<td>—</td>
<td>0.164 (3)</td>
<td>0.375 (2)</td>
</tr>
<tr>
<td>1816–20</td>
<td>—</td>
<td>—</td>
<td>0.052 (1)</td>
<td>—</td>
</tr>
<tr>
<td>1821–25</td>
<td>0.123 (5)</td>
<td>0.054 (5)</td>
<td>0.308 (12)</td>
<td>—</td>
</tr>
<tr>
<td>1826–30</td>
<td>0.078 (3)</td>
<td>0.092 (7)</td>
<td>0.177 (27)</td>
<td>—</td>
</tr>
<tr>
<td>1831–35</td>
<td>0.149 (3)</td>
<td>0.057 (13)</td>
<td>0.103 (39)</td>
<td>0.168 (7)</td>
</tr>
<tr>
<td>1836–40</td>
<td>0.141 (12)</td>
<td>0.055 (16)</td>
<td>0.145 (28)</td>
<td>0.068 (4)</td>
</tr>
<tr>
<td>1841–45</td>
<td>0.061 (2)</td>
<td>0.043 (4)</td>
<td>—</td>
<td>0.032 (1)</td>
</tr>
<tr>
<td>1846–50</td>
<td>—</td>
<td>0.047 (3)</td>
<td>0.076 (4)</td>
<td>0.270 (1)</td>
</tr>
<tr>
<td>1851–55</td>
<td>0.083 (8)</td>
<td>—</td>
<td>—</td>
<td>0.155 (2)</td>
</tr>
<tr>
<td>1856–60</td>
<td>0.230 (3)</td>
<td>—</td>
<td>—</td>
<td>0.163 (30)</td>
</tr>
<tr>
<td>1861–67</td>
<td>—</td>
<td>—</td>
<td>0.068 (14)</td>
<td>—</td>
</tr>
</tbody>
</table>

Note: The dependent variable is mortality as a percentage of slaves embarked and the independent variables are five-year groupings of regions of embarkation, with the Bight of Biafra, 1836–40, omitted. In the resulting equation the intercept is thus the Bight of Biafra, 1836–40 (t statistic 6.9), $R^2 = 0.233; n = 263$.

*Significantly different from W. C. Africa mean, 1856–60, at the 20 percent level.

_bSignificantly different from W. C. Africa mean, 1856–60, at the 5 percent level.

_cSignificantly different from W. C. Africa mean, 1856–60, at the 1 percent level.

significant. Among ships arriving at the same American region from different African regions, the evidence is more complete. Table 3 shows the results of another regression-based analysis of variance of mortality on board Caribbean-bound ships distributed by pairings of regions of embarkation and five-year periods. The statistically significant lower rates for the Bight of Benin in all periods are particularly striking. Table 4 shows the results of a similar regression on ships sailing to Brazil South from three separate African regions. This time, Congo North is defined to include Ambriz, and Angola is broken down into Luanda and Benguela. Once more, despite the rise in mortality from both Congo North and Angola after 1830, it is the distinctiveness of the patterns for each African region that is most striking. Before the rise in mortality after 1830, Congo North usually experienced lower rates than Angola.*

There is a possibility that these differences between African regions are the result of other variables, such as voyage length and ship size. Galenson (1986: 43–47) finds that for a small sample
Table 4  Mean mortality rates on transatlantic slave ships bound for Brazil South: Major regions of embarkation, 1811–67 (n=)

<table>
<thead>
<tr>
<th>Quinquennium</th>
<th>Congo North a</th>
<th>Luanda and Benguela region</th>
<th>South East Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1811–15</td>
<td>0.041 b</td>
<td>0.069 (70)</td>
<td>0.146 d (12)</td>
</tr>
<tr>
<td>1816–20</td>
<td>0.070 (81)</td>
<td>0.073 (39)</td>
<td>0.208 d (22)</td>
</tr>
<tr>
<td>1821–25</td>
<td>0.039 b</td>
<td>0.080 (116)</td>
<td>0.207 d (78)</td>
</tr>
<tr>
<td>1826–30</td>
<td>0.040 c</td>
<td>0.071 (135)</td>
<td>0.118 d (86)</td>
</tr>
<tr>
<td>1831–35</td>
<td>—</td>
<td>0.182 (1)</td>
<td>—</td>
</tr>
<tr>
<td>1836–40</td>
<td>0.191 d</td>
<td>0.248 d (4)</td>
<td>0.206 d (9)</td>
</tr>
<tr>
<td>1841–45</td>
<td>0.160 c</td>
<td>0.135 d (19)</td>
<td>0.365 (1)</td>
</tr>
<tr>
<td>1846–50</td>
<td>0.110 c</td>
<td>0.173 d (7)</td>
<td>0.006 (1)</td>
</tr>
<tr>
<td>1851–55</td>
<td>0.333 (1)</td>
<td>—</td>
<td>0.199 c (2)</td>
</tr>
</tbody>
</table>

Note: The dependent variable is mortality as a percentage of slaves embarked and the independent variables are five-year groupings of regions of embarkation, with Congo North, 1816–20, omitted. In the resulting equation the intercept is thus Congo North, 1816–20 (t statistic 7.3). $R^2 = 0.285; n = 1,025$.

aCongo North defined as Ambiz to Corisco Bay, inclusive.
bSignificantly different from Congo North mean, 1816–20, at 20 percent level.
cSignificantly different from Congo North mean, 1816–20, at 5 percent level.
dSignificantly different from Congo North mean, 1816–20, at 1 percent level.

of ships in the 1720s the interregional differences in mortality disappear after controlling for these two variables, and that death rates, or mean deaths per day on the voyage, increase considerably with ship size. Galenson’s interpretation of this result is that larger ships enhanced the possibility of embarking slaves with infectious diseases. Because the mean tonnage of slave ships increased in the period 1811–67 and varied between regions (Eltis, 1987: 127–132), the possibility that ship size affected the interregional differences noted above cannot be ignored. In the present dataset there are 179 records with information on mortality, voyage length, and tonnage. A regression was run with death rate, defined as the average daily mortality rate per thousand slaves, as the dependent variable and tonnage as the independent variable. The results follow (the standard error and t statistic are in parentheses):  

$$\text{Death rate} = 2.206 + 0.003638 \times \text{Tonnage} \quad n = 179$$  

(0.466) (0.001732)  

(4.74) (2.1)  

$R^2 = .02$
The tonnage coefficient was significant at 0.05, and evaluating it at the mean suggests that an increase in ship size of one hundred tons was consistent with a 12 percent increase in mean daily mortality. Yet variations in ship size cannot really explain either interregional differences or variations over time. The region consistently with the highest mortality, the Bight of Biafra, supplied smaller ships than the neighboring regions of the Bight of Benin and West Central Africa. Moreover, after the mid-1840s larger ships traded in both the Bight of Benin and West Central Africa, but only in the latter region was there a pronounced rise in mortality.

A variety of conditions at the point of enslavement and in the immediate pre-embarkation period may have influenced mortality. The search for the key influences may be narrowed somewhat by using the enlarged dataset in conjunction with other data. Export volumes had little influence over mortality rates, at least at the aggregate and regional levels. A comparison of Figure 1 with a series of slave exports quickly demonstrates that mortality fluctuated independently of the level of departures from Africa. Regressions of mean annual and quinquennial rates on the relevant export figures yielded no significant results. The very high aggregate export volumes in the 1820s and, for West Central Africa, in the 1840s may have resulted in the opening up of new slave catchment areas farther inland and in the purchasing of weaker slaves by transatlantic traders on the coast, but if so, there was no consistent impact on mortality. In other words, there is no evidence that, in this period at least, high traffic levels merged hitherto distinct disease zones and as a consequence forced up mortality.

Yet epidemiology and related factors were clearly important. It is possible to test for seasonal variations with a monthly distribution of mortality as a percentage of slaves embarked. Once more, a regression-based analysis of variance procedure was used. Table 5 shows the mean monthly rates for six African regions, with Luanda and Benguela again treated as separate regions. For all six, the range of monthly mortality is considerable, running in the worst months at double or triple that of the months with the lowest rates. Indeed, if the mortality for the best months had held for the rest of the year, Africans on most slave trade routes would have died at rates much closer to those suffered by contemporary European migrants in the North Atlantic. The best explanation for these variations seems to lie in supply conditions in Africa. Before
Table 5  Indexed mean mortality rates on transatlantic slave ships, 1811–67

<table>
<thead>
<tr>
<th>Month of embarkation</th>
<th>North of equator</th>
<th>South of equator</th>
<th>South East Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bight of Benin</td>
<td>Bight of Biafra</td>
<td>Congo North</td>
</tr>
<tr>
<td>January</td>
<td>338(^a) 15</td>
<td>149 12</td>
<td>183(^a) 39</td>
</tr>
<tr>
<td>February</td>
<td>255 21</td>
<td>117 13</td>
<td>221(^b) 32</td>
</tr>
<tr>
<td>March</td>
<td>385(^b) 19</td>
<td>109 8</td>
<td>185(^a) 40</td>
</tr>
<tr>
<td>April</td>
<td>305(^a) 24</td>
<td>126 14</td>
<td>128 22</td>
</tr>
<tr>
<td>May</td>
<td>145 19</td>
<td>176(^a) 6</td>
<td>176 18</td>
</tr>
<tr>
<td>June</td>
<td>173 15</td>
<td>60 5</td>
<td>124 21</td>
</tr>
<tr>
<td>July</td>
<td>193 15</td>
<td>68 9</td>
<td>165 17</td>
</tr>
<tr>
<td>August</td>
<td>480(^c) 17</td>
<td>174(^a) 11</td>
<td>109 18</td>
</tr>
<tr>
<td>September</td>
<td>265 17</td>
<td>92 14</td>
<td>131 31</td>
</tr>
<tr>
<td>October</td>
<td>223 24</td>
<td>140 13</td>
<td>129 25</td>
</tr>
<tr>
<td>November</td>
<td>241 23</td>
<td>62 6</td>
<td>98 30</td>
</tr>
<tr>
<td>December</td>
<td>100 14</td>
<td>100 12</td>
<td>100 29</td>
</tr>
</tbody>
</table>

Actual rate in base year 0.0237 0.1292 0.0483 0.0480 0.0515 0.1565

Note: The dependent variable is mortality as a percentage of slaves embarked, and the independent variables are monthly groupings of mortality. One regression equation for each region of embarkation has been estimated, with December omitted in each case. In the resulting equations the intercept is thus December. \( R^2 \leq 0.12; n = 1,315. \)

\(^a\)Significantly different from December at the 1 percent level.

\(^b\)Significantly different from December at the 5 percent level.

\(^c\)Significantly different from December at the 20 percent level.
we develop this point further, however, it is useful to evaluate the nineteenth-century experience as presented here and in Eltis, 1984, against the backdrop of competing hypotheses on the causes of mortality.

III

The different hypotheses advanced in the literature to explain why slaves died on the middle passage may be grouped for convenience into seven categories. While differences among these are often matters of emphasis rather than of substance, each category suggests a different pattern of mortality.

One major feature of all long-distance travel before this century was the prevalence of epidemics. If they were major causes of death in the slave trade, we might anticipate some distinctive trends in the data. First, there would be sharp year-to-year differences in annual mortality within the same African region as well as variations in a given year. Second, voyage length might be expected to influence epidemic mortality in several ways. As the epidemics most likely to affect slaves, for example, smallpox, went through two or more cycles of infection on the voyage, deaths as a ratio of those embarked should have risen with voyage length; moreover, if this phenomenon were widespread, the ratio should have increased constantly with voyage length. In other words, given the conditions on board ship and the short incubation periods, epidemics would break out before the final stages of a voyage and would not be more likely to occur on voyages of unusual length. The upward shift in mortality which several scholars have noted in voyages of unusual length would be less likely to show up in branches of the traffic or time periods dominated by epidemics. Similarly, death rates (or mean deaths per day) should have been constantly high throughout the voyage. Third, groupings of voyages susceptible to epidemics should have exhibited a positively skewed distribution of mortality, however defined. Even where epidemics were prevalent, only a minority of ships were affected. The median mortality might be expected to be far below the mean. One implication is that if two African regions experienced widely different mean mortalities and we expect epidemics to explain the differences, then the distribution of the ships with the lowest mortality in the two regions—say, the
lowest three quintiles—should be similar. Ships which remained untouched by the epidemic would form the majority in both cases. Finally, given the greater potential for infection, a larger cargo should have increased the possibility of epidemics. Thus, as noted above, ship size should vary directly with mortality.

Nineteenth-century evidence and some data from earlier years provide some support for the epidemic explanation. Figure 1, Table 3, and the accompanying discussion suggest significant differences in mortality over time within the same African region, and it is conceivable that the rising secular trend in West Central Africa is rooted in a resurgence of epidemics. In the eighteenth century also, big year-to-year fluctuations in mortality in the French trade are apparent, and death rates increased with ship size both in the nineteenth century and on British ships in the 1720s (Klein and Engerman, 1979; Stein, 1980; Galenson, 1986: 43–45). Yet comparisons of the distribution of mortality among regions seem in the end to devalue the epidemic approach. Differences between high- and low-mortality regions are broadly based in that all ships from the former experienced the higher rates, not just the minority of ships that we would normally expect to be affected by epidemics (Elitis, 1984). Also, data taken from the logs of ships in the English trade of the 1790s suggest a time profile that is not consistent with epidemics (Steckel and Jensen, 1986).

Factors controlled by the slave trader make up the second explanation of mortality to be considered here. If these factors were dominant forces and slave traders responded to well-organized and -integrated markets on both sides of the Atlantic, we would not expect great variations in prices among African ports. There would thus be little reason for slave trader treatment of slaves to vary among regions and as a consequence little difference in the mean or the distribution of mortality among African regions in a given time period, especially in the long run. In fact, however, differences among regions were quite pronounced both in the nineteenth century and earlier. Following Cohn and Jensen (1982), we would also expect to find a kink in the relationship between deaths per slaves embarked and voyage length. Slave dealers varied provisioning and slaves-per-ton ratios in response to relative slave prices, according to this approach. A heavy concentration of deaths might be expected as provisions ran low in
the later stages of voyages of unusual length, and mortality and voyage length should be highly correlated at some point past the average journey length. Again, however, the nineteenth-century data show little evidence of an upward shift in mortality late in the voyage (Eltis, 1984), and none at all in the English trade of the 1790s, which provides the best data for testing for such a phenomenon (Steckel and Jensen, 1986).

Slave prices did, of course, vary over time. Specifically, during the nineteenth century slave prices in Africa declined, while those in the Americas climbed markedly (Eltis, 1987). According to Cohn and Jensen (1982), this would result both in more crowding of slaves on board ships and in better provisioning. They argue that as the effect of the former was to increase mortality and the impact of the latter was to reduce it, the net effect of an increased price spread on mortality is indeterminate. However, if it can be shown that there was no secular trend towards “tight packing” in this period, then the model might be questioned. At the very least, in the absence of such a trend we might expect mortality to fall as a consequence of the higher prices and resulting improved provisioning. Again, the nineteenth-century data do not support this hypothesis. Mortality, however defined, did not decline in any region during the century but underwent a strong secular increase on ships leaving West Central Africa. This was at a time when the gap between prices in Africa and prices in the Americas was increasing and during a period when slave-per-ton ratios first increased and then declined (Eltis, 1987). It is hard to conceive of any slave trader strategy which would account for all these trends at once.9

A third hypothesis is that the volume of exports was a major determinant of mortality, either because the slave traders took slaves that might normally have been rejected or through the epidemiological consequences of breaking into new provenance zones. In the latter case, new pathogens would be introduced into the pool from which slaves were drawn (Curtin, 1968; Miller, 1988: 140–153, 432–443), and mortality should vary directly with exports. It is of course possible that the pressure of a constant level of exports over a period of years would depopulate a given region and lead to expansion into new regions and thus to higher mortality. But the former relationship seems more likely, and the absence of any relationship between exports and mortality would
suggest that for the nineteenth century, at least, this hypothesis should be set aside.

A fourth hypothesis, psychic shock or stress, would lead to a different pattern again. As there is no obvious reason for the force of this factor to vary either over time or among regions of embarkation, we might expect mortality to vary little with these variables. The pronounced regional and monthly variations are thus not easily explained by such an approach. There were some years in all regions as well as some months in every year and region when shipboard mortality was almost as low as that on the North Atlantic migrant route. Why would the stress of forced departure have a variable impact?

A fifth hypothesis peculiar to the nineteenth century is the impact of British attempts to suppress the traffic. Cruisers may have caused overcrowding, long confinement of slaves to baracoons when food was short, and the shipping of slaves at high-risk periods both of the day (e.g., at night) and of the year. The ebb and flow of cruiser activity is well defined in the historical record, and we would expect mortality in those regions and periods affected to have both increased and become more evenly distributed across ships. This impact was certainly widely accepted by those involved in suppression, and both victims and erstwhile rescuers questioned the naval strategy on humanitarian grounds. Africans who witnessed “the aggravated sufferings and mortality amongst the slaves before embarkation, which they attributed entirely to our armed interference,” wrote Captain H. B. Young to the secretary of the Admiralty Board on 16 July 1850, “cannot apprehend the motive on our part” (GB, Adm. 123/173). To those opposed to the cruiser squadron in the British Parliament during the 1840s, the navy was responsible for the increased mortality which emerges from Figure 1 (cf. Yule, 1850).

Yet the naval impact was probably not major. Although blockades were imposed against individual ports in all regions of Africa, slave traders’ use of the American flag, the sheer size of the coast, and British commitments elsewhere meant that they were impossible to maintain for complete regions or for extensive periods. If they had been, of course, the slave trade would not have lasted as long as it did. Their effectiveness, except perhaps in the 1860s, was essentially local and temporary. In addition, the secular increase in mortality was confined to West Central
Africa, whereas sporadic blockading occurred everywhere. Even in Congo North and Angola, moreover, the major increase in mortality occurred in the 1830s, before the British had established even a significant naval presence in the area, much less hunger- and disease-inducing blockades of major shipping points. Perhaps mortality would have been marginally lower in the absence of the Royal Navy, but any major effect, such as a change in the direction of the trend line, must have been confined, if it happened at all, to the very last years of the traffic in the 1860s. Significantly, it was in these years that mortality declined.

The remaining two hypotheses for mortality center on Africa and overlap with each other to a greater extent than do the first five explanations considered. It is possible that African conditions at the point of enslavement—in the nineteenth century often a considerable distance inland—determined mortality. These conditions might be military, political, or climatic, and their effect disruptions of food supplies and disease. In this case, we might expect major differences among regions of embarkation and over time within the same African region, preferably correlated with the historical record of major political, military, and climatic events. In addition, mortality should have been similar on ships leaving the same region at the same time, and, as in the case of epidemics, larger ships might have experienced higher mortality. Furthermore, while the greater incidence of weakened and diseased embarkees associated with hinterland disruptions would lead to mortality rising with voyage length, the same is not necessarily true for death rates. Pathogenic conditions on board ship, on the one hand, and in the African coastal barracoons on the other probably differed little in the nineteenth century; thus, embarkation probably had little effect on the death rate. Food shortages in Africa, however, often meant that slave ships in the nineteenth century would carry provisions from the Americas on their outbound trip. Death rates might thus be expected to decline with voyage length if more food became available at the time of embarkation. Moreover, the distribution of mortality should be rather more normal than we would expect with epidemics. Large numbers of weakened and disease-prone slaves would have meant that fewer ships would have experienced little or no mortality. While epidemics would certainly be likely to occur in such an environment, endemic disease would be much more prevalent than usual;
mean mortality would still exceed the median, but the difference would be smaller than in the previous case. Finally, within a given time period, particularly when disruptions in the interior were at their greatest, mortality should have been greater in those months immediately preceding harvest season.

But what if conditions on the African littoral rather than in the interior were the key factors? Much of the expected behavior of mortality in the previous case might also be anticipated here, but there is an additional clue to be sought which might separate the two. Gastrointestinal infections would be more prevalent during the wet months. During these months there was a greater likelihood of contaminated water, since dysentery was endemic rather than epidemic. Such links will be more easy to test in the future with the consolidation of databases."

IV

The four most striking features of the nineteenth-century data, the large interregional and monthly fluctuations in mortality, the secular trend for West Central Africa, and the association of larger ships with higher mortality, certainly point in the direction of African conditions. Attempts to separate the two “African” approaches, conditions at the point of enslavement and conditions on the African littoral, are made difficult by their interdependence. Slaves arriving from the interior who were weakened by food shortages would obviously be more likely to succumb to the seasonal bouts of dysentery expected in the coastal barracoons and on board ship. Moreover, the expected behavior of mortality during the voyage is very similar for either explanation. While there are no strong links between mortality and voyage length, the distribution of death rates in the high-mortality regions did tend towards the normal. The only clue that helps separate the two approaches is the absence of death rates which declined with voyage length. As noted above, this would suggest that deaths were not concentrated at the beginning of the voyage. Thus food shortages on the African littoral were probably not important overall. Steckel and Jensen’s (1986) analysis of ships’ logs for the 1790s confirms this pattern.

Both the written and the statistical historical record tend to favor an interaction between these two factors as the best expla-
nation for mortality. While individual ships were still losing half
or more of their occupants to smallpox in the last years of the
trade (E. M. Archibald to Russell, 27 Sept. 1859 [enc.] [GB, FO
84/1086]; John V. Crawford to Russell, 5 Sept. 1859 [GB, FO
84/1088]), naval correspondence, several British medical inves-
tigators, and fragmentary mortality records of captive Africans
in British depots establish that, as in earlier centuries (Sheridan,
1985), dysentery was the major cause of death among deportees
from all African regions, though whether bacillary or amoebic
is uncertain. It is also clear that in West Central Africa, at least,
natives of some countries in the Congo were particularly suscep-
tible to dysentery or "maculo," which was as widespread in the
barracoons as on board ship. Indeed, the slaves "usually suffer
most shortly after being brought down from the interior [and] that
during the first three or four months after being brought down,
the greatest care is requisite" (Col. Off. to Palmerston, 17 May
1849, enc. George Brand, Loanda, 20 Nov. 1848, GB, FO 84/
779). Consistent with this are the frequent references in official
reports, particularly after 1840, to the weakened condition of the
slaves at the time of the embarkations. One typical report points
out that many of the 874 slaves on the Orion, captured two days
out from the Congo in 1859, were "very emaciated and suffering
from debility evidently the result of long journeys and little food"
(Admiralty to Russell, 8 Mar. 1860, sub enc. Alfred S. Spratt,
assistant surgeon, 30 Nov. 1859, GB, FO 84/1123). No fewer
than 146 subsequently died on the voyage to St. Helena. Indeed,
even in normal times it appears that the availability and maturity
of crops had an influence on shipboard mortality (Commander
Arthur Kellett to Buxton, 22 July 1840, in Buxton, 1834-40:
32/460-1).

Rainfall data from the 1950s (U.S. Department of Commerce,
1967) correlates poorly with the monthly pattern of mortality
shown in Table 5. The correlation coefficient is positive but
nonsignificant. It is, however, difficult to get a match between
precipitation data and the exact points of embarkation for slaves,
and the regional variability of rainfall along the coast was con-
siderable. There is even less likelihood of devising a quantitative
fit between shipboard mortality and harvest patterns in the huge
African regions that supplied the slave trade. It is nevertheless
worth noting that of the seventeen months in Table 5 with mean
mortality above the base month (excluding April in the South East African column, which has only four observations), ten are either among the wettest three months of the year or known to be in the preharvest period, when food was likely to be in short supply (see also Kiple and Higgins, forthcoming; Steckel and Jensen, 1986). In the Bight of Biafra, for example, August falls in the period of heaviest rainfall; May precedes the early yam crop in most of the region (Forde, 1946: 44–47). Moreover, the much greater mortality for all months in the Bight of Biafra relative to, say, the Bight of Benin may have much to do with the differences in precipitation between the two areas. The major Bight of Biafra embarkation points experience heavy rainfall for all but one or two months of the year. Rainfall and humidity are greater and more continuous here than in central and northern Igboland or in ports and their hinterlands in other regions. In terms of disease, the Niger and Cross delta regions provide one of the environments in the world most hostile to man.  

In Luanda, Captain Owen (1833) noted on an 1826 visit, “the sickly seasons are September and October and from January to May, when many of the inhabitants fall victim to dysentery, the most prevalent and fatal disease to which they are subject” (see also Commodore Wise to Rear Admiral Grey, 19 Feb. 1858, GB, Adm. 123/174). The period from January to May covers three of the four high-mortality months in Table 5 as well as the rainy and preharvest seasons. On the other hand, in the Bight of Benin, while the high-mortality months of March and April both are wet and fall in the preharvest period for West Yorubaland, a major source of slaves at this time, August, the worst month for mortality, is relatively dry and falls after the harvest. Clearly, there are grounds for further exploration of this issue, particularly on the crop-growing cycles in areas supplying slaves.

One obvious question raised by the monthly fluctuations is why slave traders did not avoid months or regions in which mortality was severe. A cursory inspection of Table 5 indicates that months with high mortality do not have fewer voyages than healthier months, and no apparent attempts were made to avoid trading in the Bight of Biafra, South East Africa, and, later, West Central Africa. As Galenson (1986: 46–48) has pointed out, however, slave mortality was only one of the costs faced by the slave trader, and other costs may have been lower in these
high-mortality regions. This comment seems particularly apposite for the nineteenth century, when distribution and shipping costs were increased by attempts to suppress the trade and thus when other costs, such as mortality, were relatively less important (Ellis, 1987: 125–144). In fact, slave prices were lower in high-mortality regions, and the Bight of Benin always had higher prices and lower mortality than other regions (ibid.: 264). Price data by month are not available, but nothing we have learned about the slave trade in the last two decades would suggest that the market for slaves was insufficiently organized or sophisticated to make allowance for these monthly variations.

There is nothing in these findings prima facie to explain the long-run upward shift in mortality on ships leaving West Central Africa (Figure 1). But it would seem reasonable to look for changes in long-run weather patterns, with the associated phenomena of harvest and epidemiological cycles, to explain this secular shift. It is worth noting here that the peak of nineteenth-century West African mortality, which occurred in 1857–58, coincided with a “scarcity of food, amounting almost to a famine which has prevailed in the neighbourhood of the Congo and Loanda for the last year” (Admiralty to Clarendon, 28 May 1858, enc. Rear Admiral Sir F. W. Grey, 15 Apr. 1858 [GB, FO 84/1086]). There were even reports of Africans selling themselves into slavery as well as being abandoned by the slave traders (see also Curtin, 1975). Both time-series analysis and examination of seasonal patterns across regions requires larger, more consolidated sets of data than have been used before. These will become available in the future, particularly for the eighteenth century, perhaps in conjunction with documentary evidence of drought.15

Ultimate responsibility for the deaths in the slave trade, of course, lies with the slave traders, with the plantation owners, and with consumers of cheap tropical produce, increasing numbers of whom were being spawned by Western economic growth. Without a slave trade there would have been no concentration of large numbers of people in a cramped, unsanitary environment which had little counterpart in everyday life in Africa and in which dysentery could spread quickly. Once we accept this, however,
we must turn to Africa for the factors which explain variations in mortality among regions and over time, slave trader-induced behavior, for example, provisioning strategies, and attempts to suppress the trade both had relatively minor effects on these variations. Of the African factors, epidemics were probably important insofar as they were related to long-term climatic and harvest trends. Endemic disease related to conditions on the African littoral seems more important. Hard though conditions must have been for slaves such as Osifeckunde, Samuel Crowther, and Joseph Wright (Curtin, 1967), who traveled in a caravan or moved gradually from one interior market and owner to another before entering the seaborne trade, such conditions were probably healthier than confinement in a coastal barracoon, especially in the rainy season.

Variations in morbidity and mortality on board slave ships were thus determined to a large extent by what happened prior to embarkation. The present study agrees with the assessment of medical officials at St. Helena in the 1840s that close confinement of Africans such as occurred in the shore-based establishment of slave traders or in the British depot at St. Helena was almost as deadly as slave ships. Slaves entering the hold of a slave ship were more likely to be weakened and infected than those fortunate enough to avoid this fate. But as non-Africanists might remind themselves, Africa was clearly not one place, and infection and malnutrition varied over regions and, of course, time. Preembarkation inspection of human cargoes reduced mortality on other long-distance routes in the nineteenth century (McDonald and Shlomowitz, 1989; Shlomowitz, 1989). Thus if the slave trade had lasted into the 1870s and 1880s, particularly in the absence of suppression and abolition, not only would vast extra numbers of slaves have entered the traffic (see Eltis, 1987: 139-142), but the rate at which slaves died would almost certainly have fallen. While it has been argued here that British suppressive measures probably did not increase mortality, to the extent that they disrupted the embarkation process, they might have hindered inspection procedures adopted in other voyage types and thus kept mortality from falling.

NOTES

1 Curtin (1969) used 812 of the voyages, records of which appeared originally in an 1845 parliamentary paper (vol. 49, pp. 593-633). A further 100 of
these records are used in Northrup, 1978. Finally, Klein and Engerman (1975), using Rio de Janeiro newspapers, came up with 87 records of voyages which could not be found in the British records, as well as additional information on voyages that were to be found in the latter. These data have been consolidated and, with the exception of the Klein additions, all the data used here come from British and U.S. official records and newspaper reports, with most of them derived from the FO 84 series in the British Public Record Office. For a discussion of these sources see Ehitis, 1987.

2 Tests were made for statistically significant differences in the mean daily mortality rates on board ships sailing to African destinations after being captured by British and U.S. cruisers, as opposed to those which completed their journey to the Americas. There were sufficient data for tests between captured and successful ships in nine separate combinations of African and American regions, grouped into five-year periods. Only two showed differences significant at the 5 percent level. Most of these cells contained only small subsamples, which were subject to extreme values, some of which were due to the sort of natural disaster which was more likely to occur on a transatlantic journey. Accordingly, the tests were rerun after eliminating those ships that lost a third or more of their slave cargo. Only one of these cells displayed differences at 10 percent significance or less, and in most of the cases the null hypothesis could not be rejected at the 50 percent level.

3 A similar set of time profiles appeared in Ehitis, 1987: 266. However, they were based on death rates computed with voyage lengths that for about half of the records included in the profiles were estimated rather than observed. Several scholars have pointed out the inappropriateness of this procedure, and the profiles here are recalculated on the basis of mortality as a percentage of slaves embarked, that is, without reference to voyage length.


5 As ships from many nations carried slaves in the slave trade and were measured according to different rules and units of measurement, tonnages in the present dataset have been converted to British registered tons of the 1786–1835 period.

6 For the 1811–67 period, slave ships for which mortality rates can be computed averaged 193 tons in the Bight of Biafra (n = 84; st. dev. = 83.3), 243 tons in the Bight of Benin (n = 114; st. dev. = 139.1), and 288 tons in West Central Africa (n = 138; st. dev. = 174.1). Differences are significant at the 5 percent level.

7 Much higher $R^2$ (up to 0.4) and t statistics were obtained by adding dummies for regions of embarkation, but this is only to be expected in view of the earlier findings on regional differentials in mortality rates. For slave exports see Ehitis, 1987: appendix A.

8 Table 5 is superficially similar to Table D.1 in Ehitis, 1987: 267. However, as explained in note 3, the basis of Table 5 is mortality as a percentage of slaves embarked, whereas that of Table D.1 is death rate, or mortality divided by an estimated voyage length.
9 Steckel and Jensen (1986) clearly establish that increases in the slaves-per-ton ratio during the loading process increased mortality. Once the slaves-per-ton ratio reached 1.5, however, the addition of further slaves was not associated with increases in the death rate. As almost all slave ships carried cargoes in excess of this density, this factor cannot explain variations in shipboard mortality.

10 Steckel and Jensen (1986) found that mortality increased as embarkation proceeded. In the eighteenth century and earlier, the slave ship would acquire slaves gradually over several weeks. However, in the nineteenth century it became standard practice, as a result of suppressive measures, to assemble the slaves on shore before embarking them en masse, often in a few hours.

11 Kiple and Higgins (forthcoming) argue that slaves died chiefly from dehydration generated by several factors, including nutritional deficiencies, insufficient water supplies on board, and dysentery. For anyone familiar with the many nineteenth-century descriptions of slaves on board ship, this is a convincing hypothesis. Given the number of potential causes of dehydration, however, this still leaves open the question of variations in mortality with which the present paper is chiefly concerned.


13 For two of many similar cases see the Nova Especulacuo in Admiralty to Palmerston, 27 July 1850 (enc.) (GB, FO 84/826) and the Industriosso in Admiralty to Palmerston, 17 Oct. 1851 (enc.) (GB, FO 84/866). See also Col. Off. to Palmerston, 8 Oct. 1849, enc. Patrick Ross, 14 Aug. 1849, fol. 15 (GB, FO 84/780).

14 For a survey of the historical epidemiology of West Africa see Kiple and King, 1981. John Adams (1822) claimed in an earlier period that the lbo “have delicate constitutions. . . . Dysentery, to which they seem particularly liable . . . makes dreadful havoc among them.” Poorer nutrition may also explain part of the observed mortality differential. The stature of slaves embarking in Bight of Biafra ports was below that of their counterparts from other regions, though the complex process of genetic adaptation to African environments could also have been important. See Eltis, 1982.

15 The 1830s, which appear to be a critical decade in the time series in Figure 1, receive relatively little attention in two recent surveys of the historical ecology of West Central Africa (Miller, 1982; Dias, 1981).

16 Colonial Office to Palmerston, 27 Nov. 1849, enc. “Dr. Vowell’s Report,” fols. 175–215; “Dr. C. H. Rawlins Report,” fols. 217–250 (GB, FO 84/780). Shlomowitz (1989) has shown that mortality declined on British ships transporting African recaptive slaves to the West Indies from Sierra Leone,
St. Helena, and Rio de Janeiro between 1848 and 1861, while at the same
time, at least before 1851, mortality in the recaptive slave depots, also
operated by the British, remained high.

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