

mer did become "seasoned" to a new disease environment, but they were not particularly immune to future epidemics of typhoid, dysentery, or salt poisoning. These epidemics recurred for another reason—the annual summer invasion of saltwater up the James that contaminated the Jamestown water supply.

This close relationship between environment, disease, and mortality in 1607 Jamestown may be stated more generally for all Chesapeake estuaries. For our purposes, an estuary is an ecological unit wherein freshwater from the land is mixed with encroaching water from the sea, producing three salinity zones: a zone of freshwater, with salinity less than .5 parts per thousand; a zone of freshwater-saltwater transition (the oligohaline), with salinities of .5 to 3 parts per thousand; and a zone of salty water, with salinity above 3 parts per thousand (includes the mesohaline, polyhaline, and marine).²⁵ Sediment and fecal material entering an estuary are flushed out of its freshwater portion, temporarily trapped or plugged up by the salt incursion in the oligohaline until a large portion is eventually flushed downstream into the saltier water. Thus, pathogenic river-borne organisms are least common in the freshwater zone, maximum in the oligohaline zone, and intermediate in the mesohaline and polyhaline zones near the estuary mouth. Contamination also varies by bank side. Left bank contamination exceeds that of the right bank owing to the deflection of the salt incursion by the earth's rotation. This geographic distribution of estuarine contamination is, in turn, directly correlated with human exposure, infection, and mortality from the pathogens of typhoid and dysentery.²⁶ Mortality also varies seasonally

25. Chesapeake estuaries are moderately stratified, i.e., turbulence by tidal action mixes underlying salty water and overriding freshwater, thus bringing salt to the water surface. The variety of estuaries is discussed in a massive compendium: George H. Lauff, ed., *Estuaries*, American Association for the Advancement of Science, no. 83 (Washington, D.C., 1967). Several articles therein are pertinent: Donald W. Pritchard, "What Is an Estuary: Physical Viewpoint," 3–5; and his "Observation of Circulation in Coastal Plain Estuaries," 37–44; M. M. Nichols and R. L. Ellison, "Sedimentary Patterns of Microfauna in a Coastal Plain Estuary," 283–288; and J. L. McHugh, "Estuarine Nekton," 581–620, which contains the salinity classification. Also see D. W. Pritchard, "Salinity Distribution and Circulation in the Chesapeake Bay Estuaries System," *Journal of Marine Resources*, XI (1952), 106–123.

26. The distribution of disease organisms within an estuary depends on their point of entry, the circulation and flushing time of the estuary, and the life expectancy of the disease organisms. Laboratory experiments show that coliform bacteria, an indicator of disease contaminants, die off rapidly to one-tenth their original population in a period of one half to two or three days. The extent of downstream contamination increases when river circulation is rapid and the pollutants are flushed downstream before

with the migrations of the salt incursion. In the oligohaline zone the probability of infection increases when the saltwater-freshwater boundary passes by; clinical symptoms and mortality lag behind during the incubation period, with a normal lag of about one week to one month. The location of this deadly boundary zone migrates with river discharge. In the Chesapeake estuaries low discharge usually occurs in summer, and the saltwater invades the estuary to its landward maximum; on the James it penetrates thirty miles to the vicinity of Jamestown, where as a result seventeenth-century mortality rates should have peaked in July and August. Highest discharge customarily comes in the spring, and pushes the saltwater to its seaward maximum; on the James the retreat is to Hog Point, where mortality rates should have peaked in April and May. Within the saltwater zone, mortality rates should have risen slightly in spring because of the proximity of the salt trap; however, this zone would have received tidal flows of fecal material throughout the summer, thus assuring summer sickness and death. Recurrent epidemics were possible when population occupied the freshwater-saltwater and saltwater zones.²⁷

Having put forward a geographic model of mortality, I hastily remind the reader of its crudity. The model coarsely subdivides estuaries into three salinity zones and hypothesizes their variable mortality. A more refined model might specify the precise concentrations of contaminants, as a function of estuarine flushing and of the transport and the life expectancies of pathogens, and the expected levels of infection and mortality. The hydrologic information for early Virginia hardly warrants such refinements.

death. Bostwick H. Ketchum, "Distribution of Coliform Bacteria and Other Pollutants in Tidal Estuaries," *Sewage and Industrial Wastes*, XXVII (1955), 1288–1296; Clarence J. Velz, *Applied Stream Sanitation* (New York, 1970), 339–379; *Wastes Management Concepts for the Coastal Zone: Requirements for Research and Investigation*, Committee on Oceanography and Committee on Ocean Engineering, National Academy of Engineering (Washington, D.C., 1970).

27. The expected timing and location of disease morbidity and mortality rest on the assumption of "average" climatic conditions and "normal" estuarine circulation, i.e., peak discharge and salt retreat in spring, and low discharge and salt incursion in late summer. Atypical weather conditions could alter the timing and location of disease incidence. The timing of epidemics is affected also by physiological factors. The increased incidence of typhoid and dysentery in later summer may have to do with increased human output of pathogens at that time. Counts of coliform bacteria in the Detroit River rose steadily in spring, reaching a peak in August; the reasons underlying this increased productivity are incompletely understood. For our purposes, this increased summer output should produce higher mortality in the landward edge of the oligohaline than on the seaward edge. Velz, *Applied Stream Sanitation*, 239–242.

The data for early Virginia afford several opportunities of testing the geographic model of mortality. For the period from 1607 to 1624, deaths may be estimated from contemporary statistics and estimates of population and immigration, which must be handled with circumspection. Figures can lie, and early Virginians regularly juggled population estimates to suit their purposes. The most probable causes of death are deduced from colonists' descriptions of the timing and symptoms of death and the reasonableness of their explanations as to the causes of death. The locations of population and of mortality derive from contemporary accounts. Particularly useful is the geographic census of the living and dead for 1623–1624.

The first question at issue is the relationship of mortality and the location of population in early Virginia. A chronological survey of the period from 1608 to 1624 reveals the recurrent deadliness of Jamestown summers. When population was concentrated in the town, mortality rates invariably rose above 30 percent; and when the population dispersed, death rates declined sharply.

The first two summers in Virginia were disastrous; the third offered the first glimmer of hope. As of October 1608 perhaps 244 colonists had come to Jamestown, and 144 of them had subsequently died.²⁸ But the death rate fell abruptly between October 1608 and the summer of 1609, when by the most liberal estimates just 21 of 130 persons died, including eleven by drowning. This anomaly of survival deserves comment.²⁹ Captain John Smith claimed credit for this success, and rightly so. Smith, though a vainglorious man, was also a sensitive ethnographer.³⁰ He carefully recorded the Indians' seminomadic

28. In December 1606, 144 colonists went to Virginia; 104 were left by Newport in June 1607; 38 to 40 survived in January 1608; 100 to 120 immigrants arrived between January and September 1608; and 60 were alive in October 1608. The mortality rate in the text is from Irene W. D. Hecht, "The Virginia Colony, 1607–1640: A Study in Frontier Growth" (Ph.D. diss., University of Washington, 1969), 68; Brown, *First Republic in America*, 55, 58–59, 68. Brown's population and immigration figures are usually accurate, and I rely on them frequently. However, his friendliness toward the Sandys administration from 1619 to 1624 and its "democratic" character leads him to minimize the mortality problem then, while he is excessively critical of mortality under the crown and under Thomas Smythe.

29. Friends of Smith claimed that only 7 or 8 died out of 200. Brown shows 130 alive in October 1608; 11 drowned in mid-January, and not more than 109 survived. Arber and Bradley, eds., *Travels and Works of Captain John Smith*, I, 154–157; Brown, *The First Republic in America*, 70–71; Philip L. Barbour, *The Jamestown Voyages under the First Charter, 1606–1609*, Hakluyt Society Publications, 2d Ser., CXXVII (Cambridge, 1969), II, 411.

30. The full story of Smith's ecological and ethnographic sensitivity and his application of this knowledge remains untold. Arber and Bradley, eds., *Travels and Works of*

economy and undoubtedly understood its survival value. In the spring the Indians congregated along the James estuary, subsisting on marine life while they planted their crops of corn, pumpkins, beans, and so forth. As summer approached, the tribes dispersed into smaller groups, residing usually on a hill with a fresh water spring, yet near the river where they gathered fish, oysters, and crabs. By dispersing, the Indian bands avoided the deadly estuarine zone, while exploiting scattered edible plants and animals during this leanest of seasons. But survival had its price. The scattered bands were politically and militarily weak. They sniped at their vulnerable, sick, and weak English enemies, but a summer war of attrition was impossible. As this flux in Indian power eluded most Virginians, they were terrified by late summer. Percy fully expected annihilation in 1607, and he marveled that God had saved them by putting "a terrour in the Savages hearts."³¹ Smith saw things more clearly; the Indians were almost as vulnerable as the whites. In 1609 he dispersed his men with impunity. Smith also understood the Indians' generosity in the fall. Then they reassembled, harvested their crops, and gorged themselves. Their full bellies made them charitable, and they brought "Bread, Corne, Fish and Flesh in great plentie" to the confounded colonists.³² With the onset of winter, the Indians once again fragmented into small bands and migrated upland into their piedmont hunting grounds, where they stalked deer, bear, and other game animals. Smith's genius was in placing the puzzling Indian behavior and subsistence strategies into a coherent ecological whole. He realized that the colony's survival, no less than the Indians', depended on seminomadism, at least during the deadly summer season.

In late May 1609 President Smith scattered the Jamestown settlers into the surrounding countryside. His scheme infuriated Captain Gabriel Archer, who described more than he understood: "Howbeit when Captaine Argoll came in [about July 10, 1609], they were in such distresse, for many were dispersed in the Sauages townes,

Captain John Smith, I, 61–70; Maurice A. Mook, "Virginia Ethnology from an Early Relation," *WMQ*, 2d Ser., XXIII (1943), 101–129; Philip L. Barbour, *The Three Worlds of Captain John Smith* (Boston, 1964), 243–276. Smith can be eulogized too much. While others died in Jamestown, he explored the healthier reaches of the Chesapeake. In 1608 Smith returned to Jamestown long enough to see the summer sickness, and then he was off again. Brown, *First Republic in America*, 60.

31. "Observations by Master George Percy," in Tyler, ed., *Narratives of Early Virginia*, 22.

32. *Ibid.*

living upon their almes for an ounce of Copper a day; and fourescore lived twenty miles from the Fort and fed upon nothing but oysters eight weekes Space."³³ Smith's scheme of dispersal, though repugnant to Argall, was the wisest to date. But the scheme encountered opposition in August with the arrival of between 185 and 270 immigrants. Smith was able to dispatch a third of the colonists to Nansemond on the south side of the river in the saltwater zone and another third to the freshwater zone at the falls near the head of the James. But the rest stayed in Jamestown, assuredly against Smith's better judgment. Predictably, sickness ravaged 100 Jamestown colonists, and 50 died by October. Yet at Nansemond and at the falls, few sickened and none died.³⁴ Indian behavior had given Smith the key to life in the James estuary, but this precious knowledge was soon lost. He was relieved of the presidency in October and returned to England; with him went the schemes of seminomadism and summer dispersal. The colony once again clustered at Jamestown, and death hung heavy over the settlement.

Between Smith's departure and Thomas Gates's arrival in May 1610, the colony experienced the infamous "starving time." The accounts of hundreds starving, of cannibalism and other inhumanities, have proved irresistible. But these accounts are biased, sensationalized, and exaggerated. They have warped the death rate and its causes out of all proportion and have diverted attention from the summer epidemics. In the first place, the death toll in the winter of 1609–1610 was much less than is usually assumed. The most common error has been the belief that 490 to 500 immigrants came to Virginia in October, with just 50 to 60 surviving when Gates arrived in May 1610—meaning that over 400 died.³⁵ In fact the Virginia population in October stood at 250 or less, and after Smith departed with 30

33. Arber and Bradley, eds., *Travels and Works of Captain John Smith*, I, xcvi.

34. Staying in Jamestown during August was inconsistent with Smith's strategy, and so I conclude that his opponents were responsible for the return to the town. By summer's end 1609 the population stood at 250. Louis B. Wright, ed., *A Voyage to Virginia in 1609: Two Narratives*, Strachey's "True Reportory" and Jourdain's *Discovery of the Bermudas* (Charlottesville, Va., 1964), 83.

35. The "starving" time is embedded in Virginia's historical lore, embracing everything from AAA Guide Books to Edmund Morgan's sophisticated research. Yet another and less dramatic explanation may be suggested. Proponents of the starving time err in assuming that 490 to 500 immigrants reached Virginia before the winter of 1609–1610; only 185 to 270 arrived, finding about 109 survivors, making a total of 294 to 379. As it fits Strachey's estimate, 300 sounds about right; 50 of them died at Jamestown in August 1609 (Brown, *First Republic in America*, 97, 109, 112–113). When Gates arrived in May 1610, 100 were alive. Wright, ed., *Voyage to Virginia: Two Narratives*, 82–83, 115.

unruly youths, 220 colonists remained. At least 15 of them were killed by Indians, and 25 to 30 others returned to England, leaving 180 in the colony.³⁶ When Gates arrived in May, he found 40 men in good health, along with President Percy, at Point Comfort near the mouth of the James. And at Jamestown 60 ragged men dragged out to meet Gates.³⁷ In other words, 100 survived the winter, 15 were killed by the Indians, and 80 died from other causes.

Was starvation the cause of death? Enemies of the company and of Sir Thomas Smythe's administration placed the blame on starvation resulting from inadequate provisions. Purportedly, "famine compelled us wholly to devoure those Hoggs, Dogges and horses that weare then in the Collony," along with vermin and human flesh.³⁸ Yet there are serious inconsistencies surrounding the "starving time." Gates reported that 600 hogs were destroyed, which at conservative dressweights of 50 pounds per hog amounted to 30,000 pounds for 200 colonists or less—or about 150 pounds per capita during the seven months.³⁹ And supplemented by 500 chickens, seven horses, dogs, rats, snakes, and other vermin, the colonists' diet seems sufficient to have warded off starvation—even without human flesh.⁴⁰ Gates offered a different interpretation. He noted that Powhatan stepped up hostilities, confining the colonists to Jamestown between October and May. Some of the colonists were murdered, others fled, "and most by drinking of the brackish water of James Fort weakened and endangered, famine and sickness by all these means increased."⁴¹ Brackish water, probably contaminated with typhoid and dysentery, is implicated once again, but this time in winter. One source of salty

36. Brown, *First Republic in America*, 97, 109, 112–113. Despite his careful analysis of mortality, Brown is anxious to blame Captain Smith and the company and so he accepts the thesis of starvation promulgated in "'A Trewe Relaycon': Virginia from 1609 to 1612," Tyler's *Quarterly Historical and Genealogical Magazine*, III (1922), 264–270; "A Briefe Declaration of the Plantation of Virginia duringe the first Twelve Yeares . . ." *Colonial Records of Virginia* (Richmond, Va., 1874), 70–73; William Stith, *The History of the First Discovery and Settlement of Virginia, being an essay towards a general history of this colony* (New York, 1969; orig. publ. 1747), 108–117.

37. Percy's abandonment of Jamestown for the healthier Point Comfort site was pragmatic, but not the most heroic of gestures. Wright, ed., *Voyage to Virginia: Two Narratives*, 62–63.

38. "A Briefe Declaration," *Colonial Records of Virginia*, 71.

39. Gates's comments are excerpted in Wright, ed., *Voyage to Virginia: Two Narratives*, 99; also, Strachey's remarks, *ibid.*, 86–87.

40. Gates's hog estimate was confirmed by Smith. *Ibid.*; Arber and Bradley, eds., *Travels and Works of Captain John Smith*, I, 167.

41. The tragedy was also blamed on "idleness," perhaps the result of salt intoxication. Wright, ed., *Voyage to Virginia: Two Narratives*, 98–99.

water was, of course, shallow wells, tapping brackish aquifers contaminated by pathogens percolated downward into the ground water. Another possible source of bad water was the river, contaminated during the severely cold winter of 1609–1610. Climatologists have observed that cold temperatures and subsiding air depress rainfall. A cold, dry winter—common in many parts of the mid-latitudes during the late fifteenth and early sixteenth centuries—would have lowered river discharge and delayed the retreat of the estuarine salt incursion, fecal material, and sediment from Jamestown.⁴²

We cannot say conclusively that typhoid, dysentery, and salt poisoning were the principal causes of death in that winter; however, we can suggest that the case for massive starvation is far from proven. For instance, the mortality rate of 44.4 percent is much lower than the rate usually suggested by proponents of the “starving time.” Starvation appears dubious given the livestock available to be consumed in the winter. Moreover, the mortality rate is very similar to expected and observed rates of death from typhoid and dysentery for 1607 and 1608. Finally, winter mortality in early Virginia was rare except in extremely severe winters (for example, 1607–1608 and 1609–1610).⁴³ Cold, dry winters and estuarine hydraulics could have produced a contaminated water supply and epidemic typhoid and dysentery in the so-called starving time.

With the arrival of Lord De la Warr in June of 1610, Jamestown was retained as the colony's center. In mid-June 350 people were alive, the sickness began one month later, and 150 (43 percent) had died by

42. For 17th-century climate, see H. H. Lamb, “The History of Our Climate: Wales,” in James Taylor, ed., *Climatic Change with Special Reference to Wales and Its Agriculture*, Memorandum no. 8, University College of Wales, Aberystwyth (1965), 1–18. C. E. P. Brooks, *Climate Through the Ages: A Study of the Climatic Factors and Their Variations*, 2d rev. ed. (New York, 1970), 359–378. The extremely cold winter of 1609–1610 is noted in Brown, *First Republic in America*, 113. Salty water at Jamestown in 1609–1610 would explain the presence of water too cold to wade in for oysters, yet unfrozen because the salt incursion lowered the freezing point. “A Brief Declaration,” *Virginia Col. Records*, 71. Twentieth-century records of the James River provide evidence of winter discharge falling below late summer levels. However, salinity records are too recent and spotty to indicate a winter saltwater incursion. Virginia Conservation Commission, *Surface Water Supply*.

43. Arber and Bradley, eds., *Travels and Works of Captain John Smith*, I, 23, 98. Brown estimates that 57 of 110 colonists died between January and April 1608 and that 25 of 83 died between April and October 1608. The winter mortality of 52 percent exceeds slightly the 44 percent rate (80/180) for the cold winter of 1609–1610. Brown, *First Republic in America*, 57; Arber and Bradley, eds., *Travels and Works of Captain John Smith*, II, 398, 407, 434.

the end of the summer. By April 1611, 50 more died.⁴⁴ Colonial leaders strongly suspected the Jamestown water supply as the cause of death. Gates and William Strachey stated as much, and Gates and De la Warr, on their return to England in the fall of 1610, communicated their fears to the Virginia Company leaders.⁴⁵ Jamestown's days were numbered, or so it seemed.

The establishment of a healthier town site took time, and meanwhile the summer death continued. Thomas Dale arrived in Virginia on May 22, 1611, with 300 colonists, bringing the colony's strength to 480.⁴⁶ By mid-June, Dale had chosen a new town site—the falls at the head of the James—but building did not commence until September. The colonists spent the summer in Jamestown, with the sickness beginning in early July. A few days later Dale instituted martial law, but tough discipline did not thwart disease. At least 240 of the colonists became so sick that they could not work.⁴⁷ A death toll of about a third of the population, or 160, would be consistent with summer mortality and with later population estimates. At summer's end in 1611 the colony's population stood as follows: Dale's 320 survivors, plus 300 immigrants brought by Gates in August, all of whom were evacuated to the healthier falls site, and 62 brought by Argall in late September putting the colony total at 682—a figure just slightly below the 700 estimated for early 1612 by a Spanish prisoner at Jamestown.⁴⁸

44. Gates withdrew from Jamestown with 200 in June 1610. The 40 others at Point Comfort probably were not included in this count. The colony thus numbered 200 to 240. De la Warr arrived with 150 men, putting the colony at 350 to 390. The colonists were heartened when De la Warr announced he had provision for 400 men for one year. They would have been less cheerful if De la Warr had brought 200 to 300 immigrants, as is sometimes asserted. Wright, ed., *Voyage to Virginia: Two Narratives*, 85, 115; Brown, *First Republic in America*, 116, 128, 134–139; Richard L. Morton, *Colonial Virginia: The Tidewater Period, 1607–1710* (Chapel Hill, N.C., 1960), I, 27–28; Hecht, “The Virginia Colony, 1607–1640,” 330; “A Trewe Relaycon: Virginia from 1609 to 1612,” *Tyler's Quarterly*, 269–270.

45. For Strachey's insights, see Wright, ed., *Voyage to Virginia: Two Narratives*, 82–83; Morton, *Colonial Virginia*, I, 28–29.

46. In March 1610, 150 were alive; 30 arrived soon after, and Dale brought 300 in May 1611—a total of 480. Brown, *First Republic in America*, 138–139, 149; Ralph Hamor, *A True Discourse of the Present Estate of Virginia, and the successe of the affaires there till the 18 of June. 1614* . . . (London, 1615), 26.

47. Brown, *First Republic in America*, 149–155; Morton, *Colonial Virginia*, I, 28–31; Brown, *Genesis of the United States*, I, 506–507; Darrett B. Rutman, “The Virginia Company and Its Military Regime,” in Darrett B. Rutman, ed., *The Old Dominion: Essays for Thomas Perkins Abernethy* (Charlottesville, Va., 1964), 1–20.

48. Brown, *First Republic in America*, 156, 172; Arber and Bradley, eds., *Travels and*

Rome was not built in a day, nor was Henrico, the new town at the falls. Construction began in the autumn of 1611 and continued through winter. But the schedule was interrupted by spring planting in 1612, and full-scale settlement of the new town awaited the end of the harvest. My guess is that the majority of colonists spent the summer of 1612 at Jamestown. The mortality figures suggest as much. According to the Spanish prisoner Molina, 350 died out of a total population of 700. Molina's report appears accurate; 700 colonists seems about right for the spring of 1612. Molina, however, gives two estimates of the survivors in May 1613—either 305 or 350. The death rate for 1612–1613 was probably 50 percent or more.⁴⁹

With the establishment of Henrico and the general dispersal of population between 1613 and 1616, early Virginia enjoyed its healthiest era. By 1614 Jamestown had dwindled as the colony's center, and the population shifted toward the head of the James River. Rolfe's description of settlement in 1616 revealed that Jamestown contained just 19 percent of the colony population, and just 32.3 percent resided in both the oligohaline (Dale's Gift and Jamestown) and the saltwater (Kecoughtan). The remaining 67.7 percent occupied the freshwater zone at Henrico, Bermuda Nether Hundred, and West Sherley Hundred.⁵⁰ Mortality was rarely mentioned in the contemporary correspondence or accounts of these years, and for good reason. The population in May 1613 consisted of 305 to 350 persons, and by May 1616, 45 immigrants had arrived and 351 colonists survived.⁵¹ The mortality rate had declined sharply. Assuming no natural increase,

Works of Captain John Smith, II, 509; "Letter of Don Diego de Molina, 1613," in Tyler, ed., *Narratives of Early Virginia*, 220, 223–224.

49. As late as May 1613, Jamestown contained almost half of the colony's population and Henrico only a third. The pattern surely changed by the summer of 1613. "Letter of Don Diego de Molina, 1613," in Tyler, ed., *Narratives of Early Virginia*, 223–224; Hamor, *A True Discourse*, 32. Dale's letter of June 1614 is enlightening. Although his obligation in Virginia was complete, he believed the colony was in "desperate hazard." Abandoning her might reflect on his reputation. Perhaps, too, Dale had to endure another summer to see if the healthy year preceding (1613) resulted from his settlement policies or from dame fortune. Hamor, *A True Discourse*, 51–59.

50. John Rolfe, *A True Relation of the state of Virginia left by Sir Thomas Dale, Knight, in May last 1616* (New Haven, Conn., 1951), 33–41; Hamor, *A True Discourse*, 26–33; Charles E. Hatch, Jr., *The First Seventeen Years: Virginia, 1607–1624, Jamestown 350th Anniversary Historical Booklet*, no. 6 (Williamsburg, Va., 1957), 32–33.

51. Brown, *First Republic in America*, 220, 224, 229; Hecht, "The Virginia Colony, 1607–1640," 332. Writing in 1614 about the martial law invoked in 1611, Hamor defended Dale's measures, "for more deserved death in those daies, then do now the least punishment." Healthful conditions had marvelously reformed idle and factious Virginians! Hamor, *A True Discourse*, 27.

the Virginia population either held steady or declined at a rate of about fifteen deaths per year—an astonishing annual mortality rate of about 3.8 percent.

The marked improvement in mortality rates following the redistribution of population into healthier freshwater environments is consistent with the model used here; however, the causal role of dispersal is clouded by a simultaneous reduction in immigration. The latter explanation for declining mortality is favored by proponents of the "seasoning" thesis. They maintain that mortality rates among immigrants were very high, but fell sharply among the survivors, who were "seasoned" to the Virginia disease environment. The seasoned survivors were less susceptible (immune) to disease in future years. An alternative hypothesis, and the one favored here, maintains that seasoned colonists were nearly as susceptible as newcomers to typhoid, dysentery, and salt poisoning and that their vulnerability can be demonstrated for the period under discussion. Immigration to Virginia came to a virtual standstill in the summer of 1611. The seasoning thesis would posit a sequence of high mortality rates in that summer, the survival of seasoned colonists, and a sharp mortality reduction in the summer of 1612. In fact, we have shown that mortality remained high in both summers. Death rates dropped dramatically in 1613, after the Virginians shifted their settlements into the freshwater zone. Environment and location were the decisive factors lowering mortality between 1613 and 1616; immigration and seasoning were largely irrelevant.⁵²

The healthy era, 1613 to 1616, was the product of a lengthy and painful process of environmental learning and adjustment. The three years from 1607 to 1610 were spent enduring death and identifying its

52. Seasoning was at once a well-recognized process in Virginia and a theory of curative medicine, i.e., treatment of individuals. By exposing the individual to infection in a new disease environment, future susceptibility was reduced. The theory worked fine for self-immunizing or debilitating diseases such as malaria, bacillary dysentery, paratyphoid, but curative medicine worked miserably on non-immunizing, virulent diseases. Exposure to these diseases brought death year after year. The only effective remedy against them, at least before vaccines and antibiotics, was the preventive medicine of environmental modification or avoidance. Since Virginians were powerless to change the oligohaline, the best course was to avoid the zone. An excellent discussion of the seasoning process and the role of malaria is Darrett B. Rutman and Anita H. Rutman, "Of Agues and Fevers: Malaria in the Early Chesapeake," *WMQ*, 3d Ser., XXXIII (1976), 31–60. Blanton, *Medicine in Virginia*, 37–41; Colonel P. M. Ashburn, *The Ranks of Death: A Medical History of the Conquest of America*, ed. Frank D. Ashburn (New York, 1947), 118–123, 159–160; Duffy, *Epidemics in Colonial America*, 214–218; May, *Ecology of Human Disease*, 26.

geographic pattern and its causes. By the spring of 1610 colonial leaders had associated death with the water supply and the Jamestown environment. They persuaded the company in London of this pattern by the fall of that year. Implementation of a new settlement distribution consumed the next three years from the winter of 1610–1611 to the fall of 1613. During these years Dale reconnoitered, chose a site, began construction of Henrico, cleared land for crops, and instituted an aggressive Indian campaign. Thus, in seven years the company had perceived the solution to summer mortality, and Dale worked swiftly toward that end. But the resettlement scheme was greatly facilitated by the Indians. Dale's provocative encroachment into Powhatan's territory at the head of the James met little resistance from the chief. Perhaps Powhatan's advanced age and the capture of his daughter Pocahontas tempered his retaliation, but his mysterious behavior suggests intrigue. The chief remained incomunicado from May 1613 to March 1614, and he removed his quarters from the James to the Pamunkey River. Is it not possible that Powhatan had his hands full with the hostile Monacans on his western flank, and until they were subdued, he temporarily conceded Dale the James River head? Whatever Powhatan's motives, the English colony profited from his passivity.⁵³

When Dale left Virginia in the spring of 1616, he felt confident that the colony would endure. The mortality problem had been solved by diminishing Jamestown's importance and locating the settlements in healthier zones. With sickness and death on the wane, the healthy colonists produced a surplus of food. Trade relationships altered. Formerly the colonists begged, stole, or traded for Indian food; now the Indians came seeking the colony's corn.⁵⁴ Healthy conditions continued through the summer of 1616. There were no reports of widespread mortality, and the colony probably contained 335 to 351 colonists. But with the arrival of a new governor in the spring of 1617, all of Dale's insights were abandoned, to be painfully relearned.

53. Hamor, *A True Discourse*, 54–55; William Strachey, *The Historie of Travell into Virginia Britania*, ed. Louis B. Wright and Virginia Freund, Hakluyt Society Publications, 2d Ser., CIII (London, 1953), 105–106; Nancy Oestrich Lurie, "Indian Cultural Adjustment to European Civilization," in James Morton Smith, ed., *Seventeenth-Century America: Essays in Colonial History* (Chapel Hill, N.C., 1959), 33–60; Wesley Frank Craven, *White, Red, and Black: The Seventeenth-Century Virginian* (Charlottesville, Va., 1971), 46–50.

54. Rolfe, *A True Relation*, 36.

Governor Samuel Argall was not one to learn from his mistakes. This was the same Argall who earlier had condemned Smith's dispersal of colonists in the summer of 1609. As governor in the spring of 1617, Argall was again appalled by the state of the colony and Jamestown where "he found but five or six houses, the Church downe, the Palizado's broken, the Bridge in pieces, the Well of fresh water spoiled; the Store-house they used for the Church; the market-place, and streets, and all other spare places planted with Tobacco: . . . the Colonie dispersed all about, planting Tobacco."⁵⁵ On June 9 Argall wrote the company that he liked "James Town better than Bermudas 40 miles above it, [and] will Strengthen it."⁵⁶ Argall must have succeeded in realigning settlement, for that summer a great mortality ensued. Death struck 105 to 115 of the 415 colonists, and suddenly the mortality rate had risen from almost nil to 25 percent.⁵⁷

The realignment of settlement begun by Argall and continued under the Sandys administration was one of the principal causes of death until 1624. The hard-won knowledge of the environment and the adjustments made between 1607 and 1617 were abandoned. Between 1617 and 1623, 36 new settlements dotted the James estuary, and 13 of them occupied the oligohaline and the saltier water.⁵⁸ More important, population shifted into the lower estuary, and Jamestown was reaffirmed as chief city and center of government. The extent of realignment is revealed by the census of 1623–1624, and by the records of deaths from the massacre of March 1622, both of which help provide a more accurate picture of population distribution from 1618 to 1622 (see table 1).⁵⁹ These sources show that 72 percent of the

55. Arber and Bradley, eds., *Travels and Works of Captain John Smith*, II, 535–536, quotation is on p. 535.

56. Susan Myra Kingsbury, ed., *The Records of the Virginia Company of London*, 4 vols. (Washington, D.C., 1933–1935), III, 73.

57. *Ibid.*, 92. The mortality rate is based on the following: probably 335 (my estimate) were alive in May 1617, plus 80 brought in by Argall, or a total of 415. In May 1618 the colony contained about 400, 90 to 100 of whom had arrived between March and May 1618. Subtracting these from the 400 yields 300 to 310 alive in March 1618. Thus from May 1617 to March 1618, 105 to 115 had died. Arber and Bradley, eds., *Travels and Works of Captain John Smith*, II, 535–536; Brown, *First Republic in America*, 253–256, 260, 277; Hecht, "The Virginia Colony, 1607–1640," 333–334; Evarts B. Greene and Virginia D. Harrington, *American Population before the Federal Census of 1790* (New York, 1932), 135.

58. Hecht, "The Virginia Colony, 1607–1640," 174, 361–363.

59. "Lists of the Livinge and Dead in Virginia, Feb. 16th, 1623[4]," *Colonial Records of Virginia*, 37–60; Kingsbury, ed., *Records of the Virginia Company*, III, 565–571. The census of 1623–1624 alone gives a misleading impression of population distribution