Grant Program: USC Social Sciences Grant Program  
Grant Title: Paleodemographic and Paleogenomic Analyses of the Medieval Black Death  
Amount of Award: $20,000

Project Description  
This project combines molecular and paleodemographic analyses in an investigation of the Black Death (c. 1344-1351) and subsequent medieval plague epidemics using skeletal samples from London cemeteries. The Black Death was one of the most devastating epidemics in history, as it killed tens of millions of Europeans (i.e. 30 – 50% of the population) and had widespread and long-lasting demographic, social, and economic repercussions. The Black Death was one of the most important emerging diseases faced by our species, and it can provide an invaluable model of how emerging diseases affect human populations and how an emerging pathogen and its host evolves following initial emergence. The goal of the ancient DNA portion of this project is to investigate how medieval plague, which was caused by the bubonic plague bacterium *Yersinia pestis*, affected human genetic variation. Data from a temporal series of medieval London cemeteries will potentially reveal how plague mortality influenced human genetic variation associated with immune function and disease susceptibility. The objectives of the paleodemographic portion of the project are to assess: 1) temporal changes in plague mortality patterns, 2) variation in risks of mortality during medieval plague outbreaks, 3) the factors that contributed to the emergence of the Black Death, and 4) the effects of Black Death mortality on the demographic and health conditions of the surviving population. This project has the potential to reveal more about the cause and demographic and health consequences of medieval plague than any other study to date, and more generally, it will generate data that can eventually be used to test models of the evolution of disease virulence and the co-evolution of humans and important emerging pathogens.

Summary of Accomplishments  
Funding from this grant was used for travel expenses associated with several weeks of data collection from two pre-Black Death cemeteries curated at the Museum of London during the summer of 2012, and to pay for ancient DNA analyses conducted at McMaster University. The ancient DNA analyses are currently in progress, and I am awaiting final results from my collaborators at McMaster. With respect to the first and second objectives of the paleodemographic portion of my project, I am determining whether young children and men faced higher risks of death in the second outbreak of medieval plague in 1361 compared to the Black Death and if overall mortality levels were lower in the later plague, as suggested by historical documents. For the analysis of sex patterns of mortality, I am modeling sex as a covariate affecting a model of adult mortality. I have gathered all the relevant data for these analyses and am currently estimating hazard model parameters. Preliminary results indicate that females faced elevated risks of mortality compared to males during the 1361 plague. These results run contrary to contemporary reports written at the time of the Black Death that suggest males died in higher numbers than females; however, such documentary data might have been
biased by higher numbers of men in the original, at risk population. The results from my analysis might reflect the disproportionate effects of early 14th-century famine and animal murrains on female health in England. Further analysis of the skeletal data and assessment of historical documents will help to resolve this. For the analyses of differential age patterns and levels of mortality, I plan to model time period (Black Death vs. 1361 plague) as a covariate affecting a parsimonious model of mortality across the lifespan.

With respect to the third paleodemographic objective, I am comparing skeletal data from two pre-Black Death time periods, 1000-1200 vs. 1200-1300 AD, to determine if demographic patterns were deteriorating right before the epidemic occurred. I am assessing pre-Black Death trends in mortality by modeling time period as a covariate affecting a baseline hazard of mortality. I am also examining trends in survivorship by estimating Kaplan-Meier survivorship functions for the two time periods. Preliminary analyses suggest declines in survivorship and increased mortality in the later period. With respect to the fourth objective, I examined differences in survivorship and mortality risk between the pre- and post-Black Death populations of London by applying survival and hazard analyses and controlling for temporal changes in birth rates. I have also begun assessing temporal trends in health by examining pre- and post-Black Death patterns of skeletal lesions and stature. In general, the results of these analyses have indicated improvements in survival, mortality, and health following the Black Death.

**Description of Products**

I incorporated the findings obtained from this project into an NSF proposal (with me as PI) requesting funding for data collection from a large cemetery from London, St. Mary Spital, that became available to researchers in 2012 and which contains both pre- and post-Black Death skeletal assemblages. My NSF proposal was awarded funding, and the funding period is 2013-2016. From the combined data collected using the USC Social Sciences grant and the NSF grant, I have produced several journal articles and conference presentations, as detailed below. I am also incorporating the data into an NSF proposal for a collaborative project with faculty at the University of Louisville that will be submitted in Spring 2015.

**Journal Articles**


**Conference Presentations**

