

Supporting Information

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SI Materials and Methods

Demographic Data *The cohort.* The Lutheran Church has kept census, birth/baptism, marriage, and death/burial registers of each parish in Finland since the 17th century, covering the whole population of the country for tax purposes. By using these registers, it is possible to follow the reproductive and marital details of each individual from birth to death because the whole population practiced the Lutheran religion, and everyone who died (in most cases also including stillborn and infants who died before baptism) was recorded in the book of deaths. Migration rates were low, and in most cases the parish migration registers allow the life events of those moving away from the natal parish to be determined. We used demographic data collected from four geographically separate populations: one inland parish (Ikaalinen) and three coastal parishes (Hiittinen, Kustavi, and Rymättylä). For analysis, all individuals born between 1760 and 1849 were chosen ($n = 7,476$). From this cohort, we restricted the analysis to individuals with complete records for sex, survival, marriage, and reproductive events. During the study era, the main source of livelihood was farming, supplemented by fishing in coastal areas (1, 2), and the populations experienced high child mortality and fertility because of the lack of modern medical care and contraceptive methods. Diseases such as smallpox, along with infection, were the major causes of childhood mortality (3).

Mating success. We used marriage number as a proxy to measure the mating success. This approximation seems reliable in these populations for two reasons. First, the number of mating partners before being married was probably low because of the strict social norms of sexuality. For instance, although children born outside of marriage were recorded in the church registers along all of the other births, only 0.26% of unmarried women had registered children in our dataset. Second, extrapair copulation rates are also expected to have been low for the same socio-cultural reasons, and, indeed, given the serious punishments dealt to those accused of adultery in the study society (4), it is unlikely that extrapair paternities would have exceeded the current worldwide mean of 3% for populations with high paternity certainty (5). Such low levels of extrapair paternity are insufficient to bias our results qualitatively. For more information, see ref. 6.

Reproductive success. We measured the reproductive success as the reported number of children produced during the entire life of individuals. Because this number of children was computed for all born individuals, this measurement includes both a survival and a fecundity component and therefore corresponds to an estimate of the lifetime reproductive success of individuals. In the context of measuring opportunity for selection, this reproductive success measurement enables us to define different fitness components during the life cycle without crossing from one generation to the next, which precludes confounding selection and inheritance and can be easily related to formal evolutionary theory (7).

Social class. Previous studies have shown that social class induced differences in survival and reproductive success in these populations (8). We therefore studied social class effects on opportunity for selection. We grouped individuals into two categories of socio-economic status depending on whether they came from a landowning or a landless father (landowners vs. landless). Although parental and offspring social class could differ, inheritance of social class was moderately high in these populations (8), and this procedure allowed us to overcome two important constraints in our analysis. First, it enabled us to attribute a social class to every individual, even those who died before adulthood. Second, it enabled us to compare opportunities for selection

between social classes throughout successive episodes of selections occurring during the life cycle (e.g., it did not change with marriage).

Statistical Methods. Statistical analysis was performed with R 2.10 (<http://www.R-project.org>).

Opportunity for total selection. The estimate of the opportunity for total selection was obtained by computing the variance in number of offspring produced by all born individuals divided by the square of the mean, which is strictly equivalent to compute the variance in the relative number of offspring (i.e., the total number of offspring divided by its mean). To do so, we selected all individuals that had been successfully followed from birth to death. The 95% confidence interval ($CI_{95\%}$) of the opportunity for total selection was assessed by bootstrap. We generated the bootstrap distribution by resampling observed data with replacement and computing opportunity for total selection on these samples 10,000 times. Then we identified opportunity values between the 2.5 and the 97.5 percentiles of the bootstrap distribution. We used the same procedure for estimates of the opportunity for total selection, split by sex and social class.

We then compared opportunity for total selection between sexes and between social classes by using permutation tests. To do so, we compared observed ratios of opportunity for total selection ($I_{\text{male}}/I_{\text{female}}$ and $I_{\text{landowners}}/I_{\text{landless}}$) with those expected under the null hypothesis (i.e., opportunities do not differ between sexes and between social classes). The ratios expected under the null hypothesis were computed from data obtained by sampling the observed data without replacement and allocated at random the sex and the social class in accordance with the observed frequency of the four groups (male landowners, female landowners, male landless, and female landless). This data shuffling was performed 10,000 times to create empirical distributions of each ratio under the null hypothesis. We then calculated P values for the observed difference between sexes and between social classes by measuring the proportion of the null empirical distribution that gave a ratio equal to or more extreme than the observed ratio or its inverse (it therefore corresponds to bilateral tests). For an introduction to bootstrap methods and permutation tests, see ref. 9.

Episodes of selections. Because selection may change in magnitude and direction during the life cycle, we broke down the opportunity for total selection into four multiplicative components of fitness following refs. 7, 10. The four sequential episodes of selection defined were survival to reproductive age (w_1), mate access (w_2), mating success (w_3), and fertility per mate (w_4). All variance and covariance computations are described in the appendix of ref. 10.

We modeled the influence of sex and social class on the probability of (i) surviving, (ii) marrying, and (iii) remarrying by using logistic regressions considering sex, social class, and their interaction as covariates. For the three models, the interaction between sex and social class was not significant. Effects of the covariates were estimated by likelihood ratio tests using the *Anova* function provided by the package *car* (<http://CRAN.R-project.org/package=car>).

The effects of sex and social class on the different components of relative fitness were analyzed by permutation tests as described in the previous section.

Opportunity for sexual selection. We estimated the opportunity for sexual selection by using two different methods. We first computed the variance in number of marriages divided by the square of the mean, which is strictly equivalent to compute the variance

in relative total number of marriages (i.e., the total number of marriages divided by its mean). To do so, we selected all individuals that had survived to reproductive age (age 15 y), including those who did not marry. Second, we computed the opportunity caused by the combination of the episodes w_2 and w_3 (mate access and mating success) in the analysis of episodes of selection. To do so, we collapsed these two episodes of selection following the computation described at the end of the appendix of Arnold and Wade (10). We applied the same methods as those presented above to produce confidence intervals in the opportunity for sexual selection and to analyze the effects of sex and social class.

Relationship between mating and reproductive success. To compute standardized Bateman gradients, we computed the slope of the linear regressions of relative reproductive success (the total number of offspring divided by its mean) on the relative mating success (the total number of marriages divided by its mean). This computation was performed on the subsample of individuals who survived to reproductive age to remove covariance between mating and reproductive success that was attributable to early mortality. Note that performing the same analysis on the whole sample led to higher Bateman gradient values ($\beta_{SS} = 0.85$, $CI_{95\%} = 0.83\text{--}0.87$), indicating that our results are conservative in this respect. $CI_{95\%}$ values were computed by bootstraps as previously described. Here, because the analysis involves two variables, we generated the bootstrap distribution by resampling the pairs of mating and reproductive success values. Differences between sexes and between social classes were analyzed by permutation tests as previously described.

Effects of data selection on the estimate values. Our cohort was initially composed of 7,476 individuals. To provide reliable estimates

of the reproductive success of individuals, we included only individuals with complete records for marriage and reproductive events ($n = 5,923$). This procedure can engender a departure from randomness in the sampling of individuals. In particular, individuals dying young were more likely to be characterized by complete records than individuals dying later or those that could have migrated or been lost from church records during adulthood. As a consequence, this data selection may have biased our assessment of survival rates and also biased our estimates of the opportunity for total selection. Consequently, we evaluated the potential bias induced by this data selection by comparing opportunity for selection because of survival to adulthood in both our sample of 5,923 individuals and in the entire dataset. In the complete cohort, the opportunity for selection because of survival equals 0.58 ($CI_{95\%} = 0.55\text{--}0.61$), suggesting that restricting the analysis to individuals with complete records induced an overestimation of the opportunity for total selection of 9.8%. When the selection bias is taken into account, survival to adulthood explained 25.4% of the total variation in fitness and therefore remains the largest fitness component, along with fecundity per mate (w_4).

Although our data selection procedure engenders a slight overestimation of the opportunity for total selection through the overestimation of early mortality, the decomposition of variance in fitness must be carried out on a unique dataset. Consequently, excluding individuals with incomplete life history reports was necessary to provide reliable estimates of all other episodes of selection and in particular to obtain accurate estimates of the opportunity for sexual selection.

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