Chapter 11

The Impact of Intergenerationally-Transmitted Fertility and Nuptiality on Population Dynamics in Contemporary Populations

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Overview: There are intergenerational continuities in contemporary fertility, mortality and partnership behaviors due to genetic and environmental factors. If persistent, these would be expected over time to lead to a proportionate increase in those with a higher than average propensity to reproduce, and consequently to lead to higher population growth (or lower decline) than would otherwise be the case. We use three scenarios of fertility transmission to investigate the differences in long run population dynamics under models of intergenerationally correlated fertility and partnership behaviors:

(1) fertility is not heritable;
(2) daughters' fertility is partly correlated with mother's fertility;
(3) daughters have the same fertility propensity (fecundability) as their mothers.

Positive correlations increase population growth rates substantially, even though the correlation coefficients between completed fertility of mothers and daughters may be modest with the assumptions of these models. This suggests that large samples are required to detect such effects in historical populations, and that the widely-held assumption that fitness was not heritable is questionable. The demographic regime is based on that of England and Wales from 1750 to 2050 and so covers typical long-term experiences of now-developed societies as they moved from pre-transitional to contemporary patterns of below-replacement level cohort fertility. The methodology is based on microsimulation of full kinship networks based on the Berkeley SOCSIM program.

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1. Introduction

A standard result in demographic analysis is that given two initial populations with different rates of growth, no matter how small the advantage, the one with the higher value will come to dominate numerically the lower one and the population eventually becomes effectively homogeneous and consists only of the higher growth population (e.g. Keyfitz 1985, Section 1.4). Of course, there must be some mechanism that transmits the rate of growth between generations, whether genetic, environmental or an interaction of the two, and presumably these mechanisms remain unchanged over time if the rate of growth does so also. A similar result – that any population with an enduring advantage in reproductive success will come to dominate numerically - is found in Mendelian genetics, namely Fisher's fundamental theorem of natural selection (Fisher, 1930) which states that any trait correlated with fitness should have a heritability[1] of zero, essentially for the reason set out above. On the other hand, observational studies show that there can be very large variability in fitness: for example, species such as the sage grouse in which more attractive males have hugely greater reproductive success in mating, producing the so-called 'lek paradox' (Boyce, 1990; Pomiankowski & Moller, 1995). The status of Fisher's fundamental theorem of natural selection has been considerably elucidated in recent years (Price, 1972; Edwards, 1994; Frank 1988), and two main sets of explanations for persistent variability in fitness have been advanced, those to do with a host-parasite 'arms race' (Hamilton & Zuk, 1982) and the role of genetic mutation (Kondrashov, 1988; Houle, 1998).

Fertility is a major component of fitness and it is therefore plausible that it should not be an inherited trait in the sense above, at least under a number of restrictive conditions. Empirical analysis of (human) historical populations has shown that the correlation of fertility between generations is close to zero. However, studies of more recent populations have indicated that there is now a correlation coefficient value of about 0.2 averaged across a number of different studies (Murphy, 1999). More specific studies based on kinship behavior genetic models and twin studies have found a relatively strong heritable component of fertility and related behaviors, including nuptiality and marital breakdown in more recent periods (McGue and Lykken, 1992; Dunne et al, 1997; Kohler, Rodgers, and Christensen, 1999; Rodgers and Doughty, 2000; Kirk et al, 2001): for a good summary of recent work, especially in relation to Fisher's fundamental theorem, see Rodgers, Hughes et al (2001).

There are a number of reasons why the superficially incompatible results for historical and recent/contemporary populations differ[2]. These include