Comment on "An Association Between the Kinship and Fertility of Human Couples"

Rodrigo Labouriau[1]* and António Amorim[2]

Helgason *et al*. (Reports, 8 February 2008, p. 813) reported a positive association between kinship and fertility in the Icelandic population. We point out that the data further suggest that fertility initially increases with kinship and then decays. This is supported by another large study on the Danish population suggesting a superposition of effects of inbreeding and outbreeding depression on human fertility.

Helgason *et al*. (*1*) reported a positive association between kinship and human fertility based on comprehensive registers containing long historical series of the Icelandic population. Their results, interpreted as a manifestation of outbreeding depression, are in line with other similar findings in nonhuman populations (*2*–*4*). In parallel, we presented a positive association between fertility and marital radius (the distance between mates' birthplaces), based on a large Danish cohort (all women born in Denmark in 1954) (*5*). As a consequence of the classic Malécot theory on spatial genetic structure of populations (*5*–*9*), which states that the kinship is a decreasing function of marital radius, the results in (*5*) suggest a negative association between consanguinity and human fertility. Although the results of (*1*) and (*5*) appear to contradict each other, we argue that a closer look at both data sets reveals that this is not the case. Both studies corroborate the hypothesis that the superposed contrary forces of inbreeding and outbreeding depression have an effect on human fertility. The coincidence of the conclusions of these two independent large-scale studies suggests that this is a general phenomenon in human populations.

Although we do not cast doubt on the existence of a positive association between kinship and fertility as presented in (*1*), we remark that the relation between the mean number of children and kinship is not the same in the different periods reported. Examination of figure S2 in (*1*) reveals that the curve representing the number of children as a function of the kinship coefficient is not monotonic in the periods 1900 to 1924, 1925 to 1949, and 1950 to 1965, although the general curve obtained on the basis of all the periods together [figure 1A in (*1*)] does indeed seem to be monotonic. Here, the most striking example is the period 1950 to 1965, in which the mean number of children successively increases from the kinship interval with the lowest range (0 to 0.030518×10^{-3}) up to the interval 7.8125×10^{-3} to 31.25×10^{-3} (the reported positive association), but then the mean drops drastically for couples with kinship larger than 31.25×10^{-3}. Indeed, the mean number of children of couples with kinship larger than 31.25×10^{-3} is smaller than all the other reported means in this period and definitively much smaller than the mean for the interval 7.8125×10^{-3} to 31.25×10^{-3} (the 95% confidence interval for this interval does not include the mean for kinships larger than 31.25×10^{-3}). This is compatible with the hypothesis of a combination of effects of outbreeding and inbreeding depression on human fertility.

The Danish study (*5*) was based on the cohort of all women born in Denmark in 1954 who were alive and living in Denmark in 1969, totaling 42,165 women. This cohort was followed up to the end of 1999. The number of children born to each mother between the ages of 15 and 45 years old was determined and is referred to as fertility. The mean marital radius (MR) associated with each mother in the cohort was estimated using the distance between the centroids of the parish where she was born and the parishes where the partners with which she had children were born. The Spearman correlation between MR and fertility in the cohort was 0.38 ($P < 0.0001$), indicating a positive association. This was interpreted as evidence of the negative effects of inbreeding depression on fertility. A closer look at these data reveals, however, that the curve relating fertility and MR increases rapidly for low values of MR and tends to decrease for higher values of MR, with a maximum around 75 km (Fig. 1). Indeed, the Spearman correlation between fertility and MR is 0.083 ($P < 0.0001$) for the observations with MR smaller than 75 km and is –0.049 ($P < 0.0001$) for the observations with MR larger than 75 km. These results are also compatible with the hypothesized effect of a combination of inbreeding and outbreeding depression on human fertility.

Both studies attempt to control the possibility of spurious associations due to effects of socioeconomic factors, although using different arguments. The argument in (*1*) relies on the assertion that the Icelandic population is "one of the most socioeconomically and culturally homogeneous societies in the world," while our argument in (*5*) is based on conditional analyses given key socioeconomic indicators available for each mother in the cohort.

Here, we present an additional conditional analysis using the Danish data, including the following key socioeconomic indicators: education, family income, urbanicity, mother's age at first birth, and six variables representing proximity to kin [maternal radius, i.e., distance between mother's and child's birthplace; paternal radius; and presence of each grandparent in the child's birth parish or neighboring parish [see supporting online material (SOM)]. The distribution of information among these socioeconomic factors, together with MR and fertility, was characterized using graphical models (*5*, *10*–*12*) (see also SOM text) (fig. S1). The most relevant feature of this representation is that the conditional correlations between MR and fertility, given the socioeconomic indicators above, are 0.086 and –0.048 ($P < 0.0001$) for MR values smaller and larger than 75 km, respectively. According to the theory of graphical models (*5*, *10*, *11*), this implies that MR carries information on fertility that is not already contained in the other variables. Therefore, the associations found in the unconditional analyses are not a mere artifact due to effects of the socioeconomic factors mentioned above.

Both (*1*) and (*5*) suggest that human fertility often increases with kinship until a maximum and then decays as the kinship increases further. The pictures obtained resemble simulations performed in (*13*) under general genetic scenarios

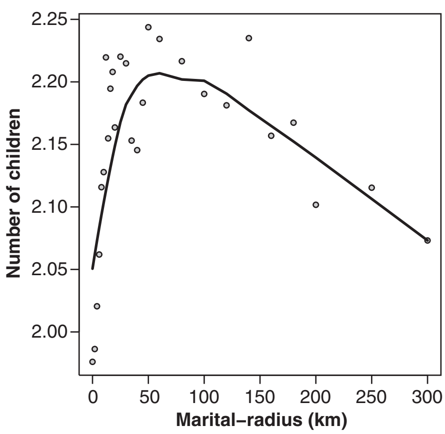

Fig. 1. Mean number of children for different intervals of marital radius observed in the Danish cohort of all women born in 1954 (and a Lowess nonparametric regression curve adjusted to the points with weights proportional to the number of observations of each interval).

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where inbreeding and outbreeding depression act simultaneously. Although the results discussed here are expected from the theory of inbreeding and outbreeding depression (*2–4*, *13*), they are hard to document in human populations. Reliable, sufficiently large human data sets, as in the two studies discussed here, are uncommon. Moreover, it is difficult to eliminate the possibility of spurious associations due to effects of socioeconomic factors unequivocally. A future challenge will be to discern which of the many possible mechanisms underlying inbreeding and outbreeding depression are in play.

References and Notes

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Supporting Online Material

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SOM Text
Fig. S1
References

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