

Original Article

Low nonpaternity rate in an old Afrikaner family

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Abstract

Extrapair paternity is a crucial parameter for evolutionary explanations of reproductive behavior. Early studies and human testis size suggest that human males secure/suffer frequent extrapair paternity. If these high rates are indeed true, it brings into question studies that use genealogies to infer human life history and the history of diseases since the recorded genealogies do not reflect paths of genetic inheritance. We measure the rate of nonpaternity in an old Afrikaner family in South Africa by comparing Y-chromosome short tandem repeats to the genealogy of males. In this population, the nonpaternity rate was 0.73%. This low rate is observed in other studies that matched genealogies to genetic markers and more recent studies that also find estimates below 1%. It may be that imposed religious morals have led to reduced extrapair activities in some historic populations. We also found that the mutation rate is high for this family, but is unrelated to age at conception.

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1. Introduction

Genealogies drawn up from church records, birth certificates, and death notices are useful to identify founders of diseases (Austerlitz & Heyer, 1998; Hayden, Hopkins, McCrae, & Beighton, 1980; Heyer, Tremblay, & Desjardins, 1997; Heyl, 1970; Torrington & Viljoen, 1991); to identify disease-causing genes (Karayiorgou et al., 2004; Vezina et al., 2005); to quantify the parameters that shape human life histories (Lummaa, 2007; Voland, 2007); to determine the genetic heritage of individuals (Greeff, 2007); to estimate mutation rates of forensically important DNA markers (Heyer, Puymirat, Dieltjes, Bakker, & deKnijff, 1997; King & Jobling, 2009a; Pollin et al., 2008); and, as noted by King & Jobling (2009b), for fun. A weakness in genealogical hypotheses is that they can be incorrect due to unrecorded adoptions or extrapair paternities. A number of initial studies argued that extrapair paternity rates may be as high as 5% or even 10% (Baker & Bellis, 1995; Macintyre &

Sooman, 1991). This means that after 12 generations, only 54% ($=0.95^{12}$) or even as few as 28% ($=0.9^{12}$) of males will be genetically related to the original male founder. Looking back in time, it can be shown that, with an extrapair paternity rate of p , a fraction

$$C = \frac{1}{2^n} \sum_{k=0}^n \binom{n}{k} (1-p)^k, \quad (1)$$

of ancestors n generations ago will be correctly identified. This would mean that as many as 40% of ancestors 10 generations ago, identified using genealogies, will be incorrect (Fig. 1A).

However, Anderson (2006) has shown that while extrapair paternity rates are indeed high in cases where paternity is contested (29.8%), it is substantially less in general, in the order of 1.7%. Similarly, Voracek, Haubner, and Fisher (2008) showed that more recent studies found significantly lower estimates and an average of 3.1% extrapair paternity. These estimates would reduce the number of potentially misidentified ancestors substantially to 8% in 10 generations (Fig. 1B). It is also clear that the rates

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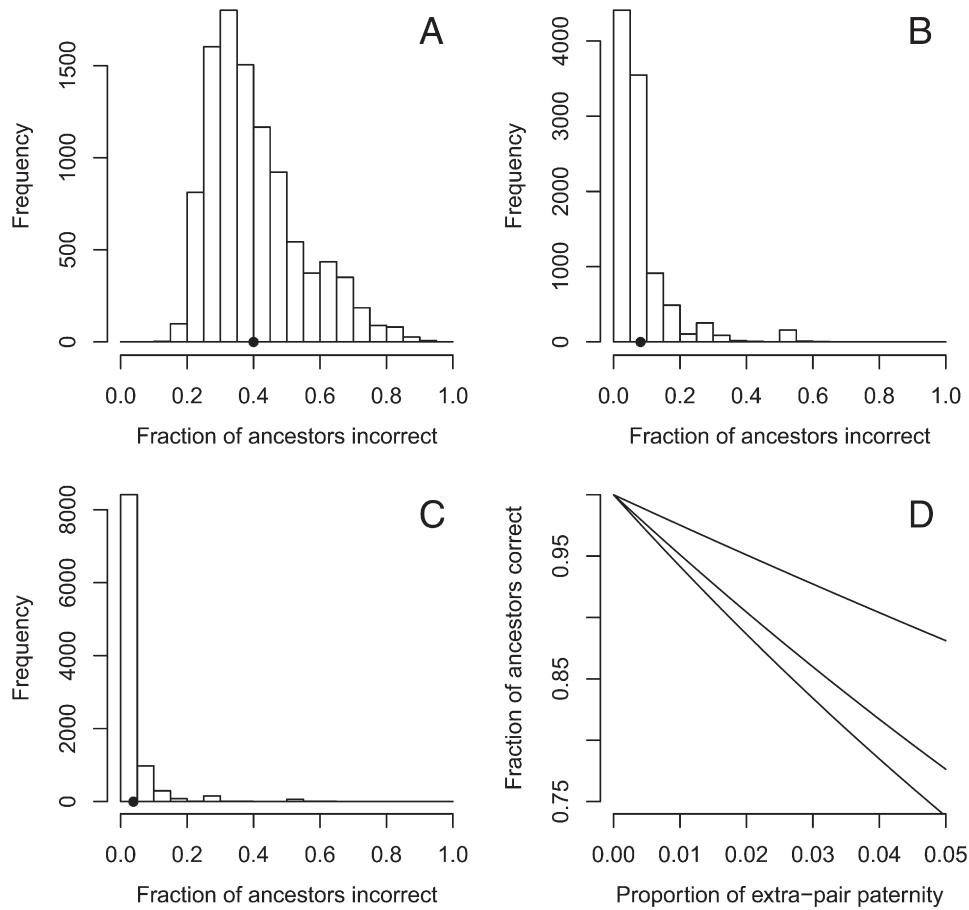


Fig. 1. Influence of extrapair paternity on accuracy of genealogies. Distribution of the expected fraction of ancestors in the 10th generation, identified by genealogy, which is actually incorrect if extrapair paternity is 10% (A), 1.7% (B), and 0.75% (C). These distributions were obtained from 10,000 simulations in R. The filled circles indicate the means. (D) The expected fraction of ancestors that are correctly identified given a rate of extrapair paternity. From top to bottom for 5, 10, and 12 generations.

vary from population to population, with culture and specifically social norms regarding extramarital sex playing an important role (Anderson, 2006; Bellis, Hughes, Hughes, & Ashton, 2005).

The Afrikaner population of South Africa descends mostly from Dutch, German, and French immigrants. Afrikaners have a well-recorded ancestry (De Villiers & Pama, 1966) and a vibrant genealogical community (Genealogical Society of South Africa: <http://www.eggsa.org/Familia-index/general.htm>; Genealogical Institute of South Africa: <http://www.gisa.org.za/site/node/3>), so it is potentially a rich field for doing family reconstitution from old records (Voland, 2007). The crucial question is how faithful the Afrikaner couples were to each other? During the 1980s, in cases where paternity was contested, 22% of South African Caucasians (i.e., including non-Afrikaans-speaking people) were excluded as fathers (Du Toit, May, Halliday, Schlaphoff, & Taljaard, 1989). This is the sixth lowest value of 31 studies worldwide (Anderson, 2006). Data recorded during 2007 for 72 Afrikaans-speaking Caucasians where paternity was contested also gave 22.2% nonpaternity events (A.S. Greeff & Y. Harris, unpublished data).

Despite the fact that, during the last two and a half centuries, Christianity, with its emphasis on monogamy, was seen as one of the cornerstones of the Afrikaner family and population (Giliomee, 2003), this has not always been the case. For instance, despite the fact that the population was strongly male biased, the reformed church of Stellenbosch district initially had three times more confirmed women than men (Giliomee, 2010). In the Stellenbosch of 1726, it was unusual for both members of a couple to be confirmed members of the reformed church (only 20%; Giliomee, 2010). In fact, a traveler referred to the Cape population as “an assembly of blind heathen” (Giliomee, 2010). During the first 150 years of the European settlement, there were very few European women, and illegitimate sex, especially with slaves, was far more frequent than later on (Giliomee, 2010). Female slaves were often part of the household, acting as child-minder, wet nurse, and sometimes even the mistress of the head of the house (Giliomee & Mbenga, 2007). Furthermore, the slave lodge acted as a brothel (Giliomee & Mbenga, 2007), suggesting frequent illegitimate sex at the Cape of Good Hope.

While these sexual activities of men could not have gone unnoticed, the children thus produced normally defaulted to

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