Y chromosomes of Jewish priests

SIR — According to biblical accounts, the Jewish priesthood was established about 3,300 years ago with the appointment of the first Israelite high priest. Designation of Jewish males to the priesthood continues to this day, and is determined by strict patrilineal descent. Accordingly, we sought and found clear differences in the frequency of Y-chromosome haplotypes between Jewish priests and their lay counterparts. Remarkably, the difference is observable in both the Ashkenazic and Sephardic populations, despite the geographical separation of the two communities.

The human Y chromosome has useful properties for studies of molecular evolution[1,2]. Except for the pseudo-autosomal region, it is inherited paternally and does not recombine. It can be used to construct patrilineal genealogy cladograms complementary to those formulated using maternally inherited mitochondrial DNA.

The phenotypic differences that exist between different communities of contemporary Jews in the world are thought to emanate, at least in part, from genetic admixture with neighbouring communities of non-Jews, during a prolonged dispersion[3,4]. The genetic basis of this diversity has been investigated using analysis of neutral DNA markers, including mitochondrial and Y-chromosome markers[4]. However, previous studies have not considered the subsets of male Jews comprising the priesthood (Cohanim). Significantly, there is no procedure other than paternal descent by which male Jews are assigned to the priesthood. Identification as a priest carries with it certain social and religious obligations which have tended to preserve this identity within Jewish communities. Based on surveys of Jewish cemetery gravestones, priests represent approximately 5% of the estimated total male world Jewish population of roughly 7 million (data not shown).

We identified haplotypes of 188 unrelated Y chromosomes using the polymerase chain reaction (PCR) applied to genomic DNA isolated from buccal mucosal swab samples from Israeli, North American and British Jews. We constructed haplotypes using first, the presence or absence of the Y Alu polymorphic (YAP) insert, thought to represent a unique evolutionary event dated to between 29,000 and 340,000 years ago[1,5]; and second, a polymorphic GATA repeat microsatellite, DYS19 (refs 6, 7). We also typed a subset of samples for the non-Y-chromosome CA-repeat polymorphism, D1S191 (ref. 8).

We determined the designation of each subject as a member of the priesthood by direct questioning. Subjects who were not sure of their designation or who identified themselves as 'Levite' (a separate junior priesthood, based on a different, less-well-defined patrilineal lineage) were not included in the current analysis.

We identified six haplotypes, whose frequencies are shown in the table (YAP^- DYS19A–E and YAP^+ DYS19, all alleles). Applying the χ^2 test to the frequencies of the Y-chromosome haplotypes distinguishes priests from the lay population. The most striking difference was in the frequency of YAP^+ chromosomes among priests compared with lay Jews. Only 1.5% of Y chromosomes among priests were YAP^+, in comparison to a frequency of 18.4% in lay Jews. In contrast, we found no significant difference in the distribution of alleles for the non-Y-chromosome locus polymorphism D1S191 (data not shown). These Y-chromosome haplotype differences confirm a distinct paternal genealogy for Jewish priests.

We further identified subjects as being of Ashkenazic or Sephardic origin. This refers to the two chief, separate communities which developed within the diaspora during the past millennium[9]. As shown in the table, the same haplotype distinction can be made between priests and lay members within each population. This result is consistent with an origin for the Jewish priesthood antedating the division of world Jewry into Ashkenazic and Sephardic communities, and is of particular interest in view of the pronounced genetic diversity displayed between the two communities[9]. This conclusion is further supported by the relative preponderance of the YAP^-, DYS19B haplotype in both populations, suggesting that this may have been the founding modal haplotype of the Jewish priesthood.

Taken together, our findings define a set of Y chromosomes of recent common origin. Differences which have accumulated in the genomic DNA of the Y chromosomes of Jewish priests during the relatively short time since the establishment of the priesthood, should be useful in defining rates and mechanisms of Y-chromosome evolution.

HAPLOTYPE FREQUENCY *F* (standard error)

Alleles		All		Ashkenazic		Sephardic	
		Cohen *n*=68	Israelite *n*=120	Cohen *n*=44	Israelite *n*=81	Cohen *n*=24	Israelite *n*=39
YAP^- DYS19	A	0.162 (0.045)	0.091 (0.026)	0.205 (0.061)	0.074 (0.029)	0.083 (0.056)	0.129 (0.054)
	B	0.544 (0.060)	0.325 (0.042)	0.454 (0.075)	0.321 (0.052)	0.709 (0.093)	0.333 (0.075)
	C	0.162 (0.045)	0.300 (0.042)	0.227 (0.063)	0.272 (0.049)	0.042 (0.041)	0.359 (0.077)
	D	0.088 (0.035)	0.083 (0.024)	0.091 (0.044)	0.111 (0.035)	0.083 (0.056)	0.026 (0.024)
	E	0.029 (0.020)	0.017 (0.012)	0.000 —	0.025 (0.017)	0.083 (0.056)	0.000 —
YAP^+ DYS19 (all)		0.015 (0.014)	0.184 (0.035)	0.023 (0.024)	0.197 (0.045)	0.000 —	0.153 (0.057)
$P\ \chi^2$		<0.001		<0.01		<0.01	

Ashkenazic, Jewish communities of northern Europe; Sephardic, Jewish communities of north Africa and the Middle East; Cohen, Priest; Israelite, lay Jew. A–E, different DYS19 haplotypes.

Scientific Correspondence

Scientific Correspondence is intended to provide a forum in which readers may raise points of a scientific character. Priority will be given to letters of fewer than 500 words and ten references.

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1. Hammer, M. F. *Nature* **378,** 376–378 (1995).
2. Jobling, M. A. & Tyler-Smith, C. *Trends Genet.* **11,** 449–456 (1995).
3. Benerecetti, A. S. S. *et al. Genetic Diversity Among Jews* (eds Bonne-Tamir, A. & Adam, A.) 45–50 (Oxford Univ. Press, New York, 1992).
4. Ritte, U. *et al. J. Mol. Evol.* **37,** 435–440 (1993).
5. Hammer, M. & Horai, S. *Am. J. Hum. Genet.* **56,** 951–962 (1995).
6. Santos, F. R. *et al. Hum. Genet.* **97,** 309–313 (1996).
7. Roewer, L. *et al. Hum. Mol. Genet.* **5,** 1029–1033 (1996).
8. Gyapay, G. *et al. Nature Genet.* **7,** 246–249 (1994).
9. Motulsky, A. G. *Nature Genet.* **9,** 99–101 (1995).