

Forensic Statistics and Graphical Models (1)

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<http://www.math.leidenuniv.nl/~gill/teaching/graphical>

Forensic Statistics

- Distinguish criminal investigation and criminal prosecution (exploratory vs. confirmatory?)
- Prosecution: a statistician is called by the court to use his scientific expertise to inform the court of the evidential value of certain evidence
- Dogma: the statistician should report the likelihood ratio
 $\Pr(\text{Evidence} \mid \text{Prosecution}) : \Pr(\text{Evidence} \mid \text{Defence})$

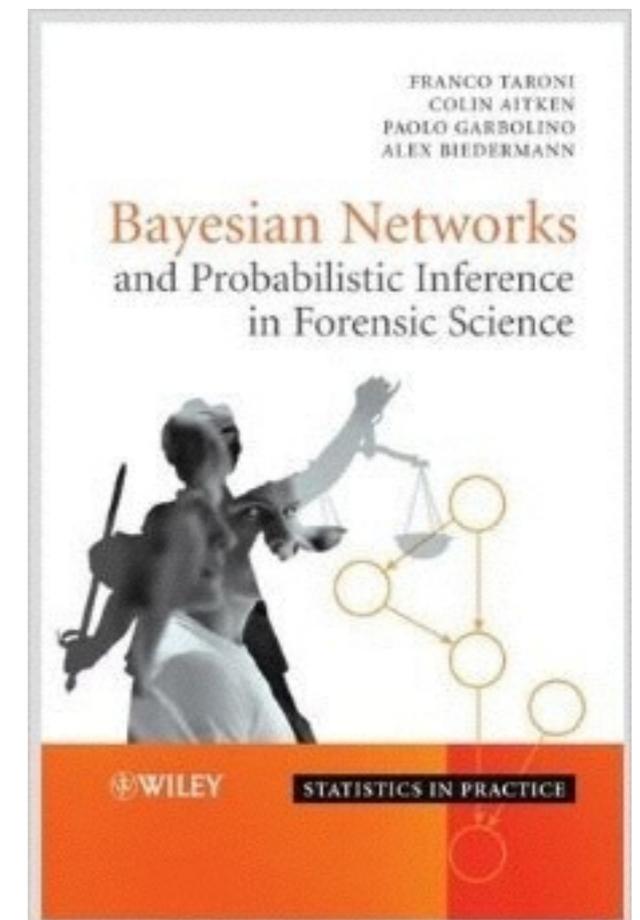
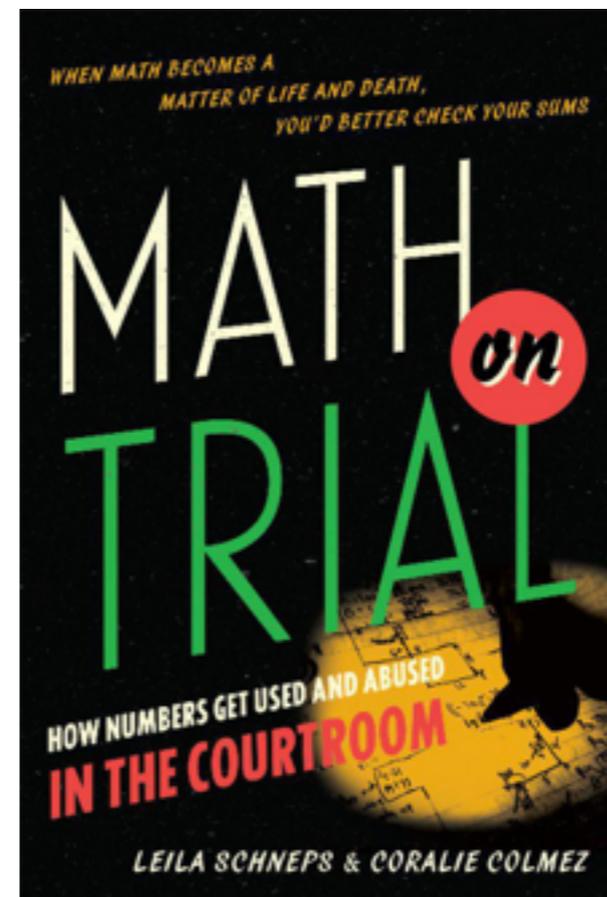
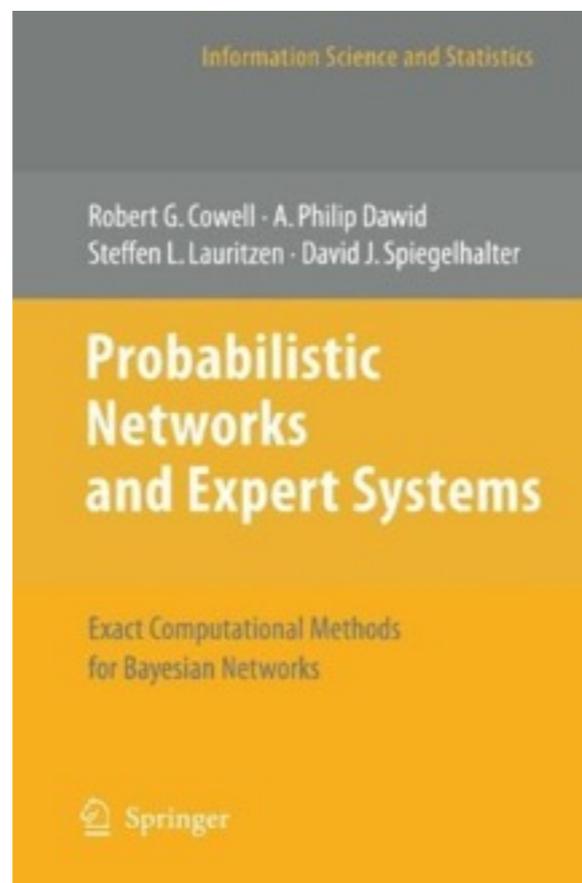
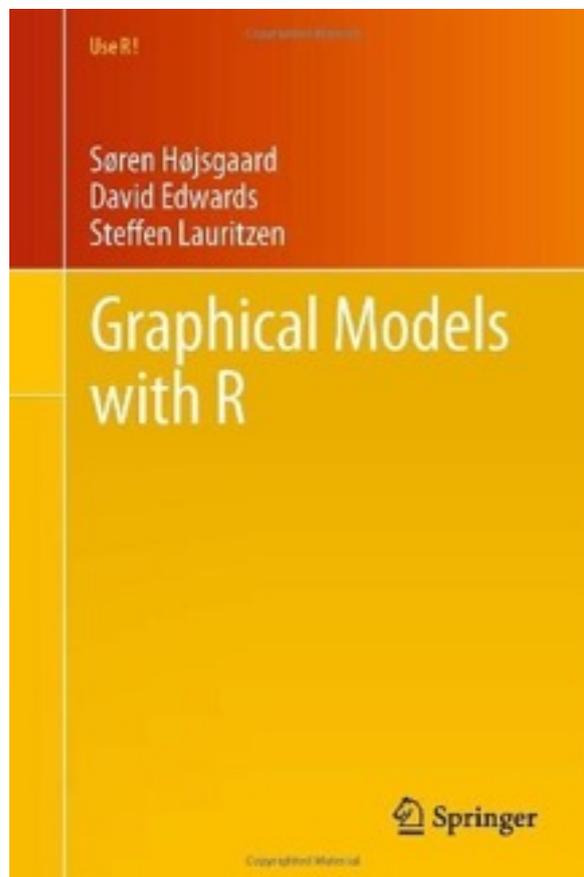
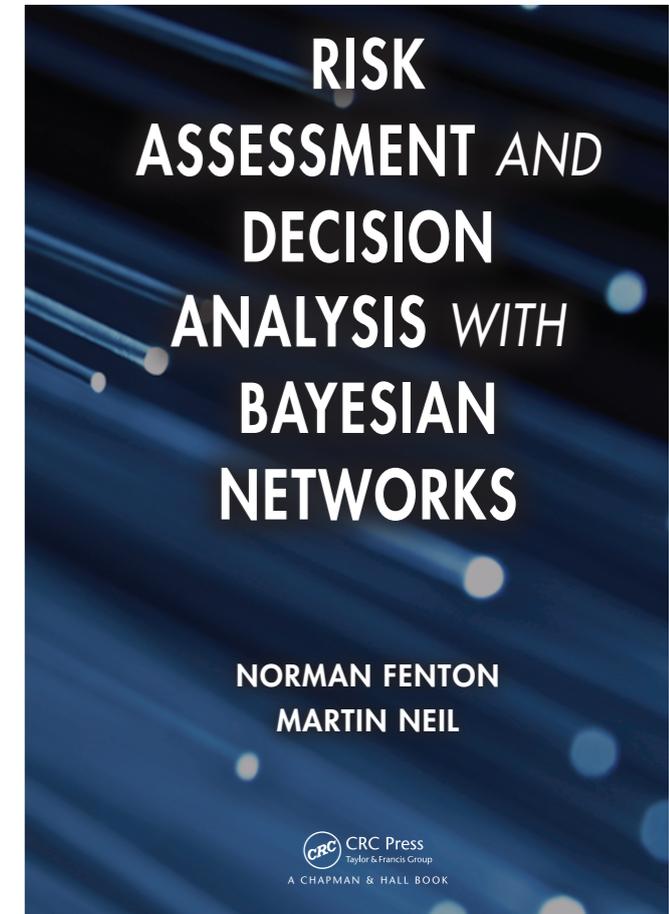
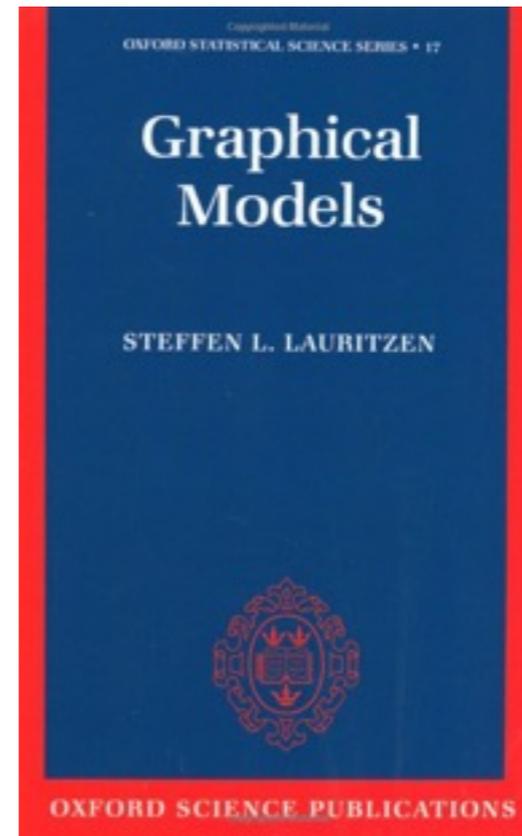
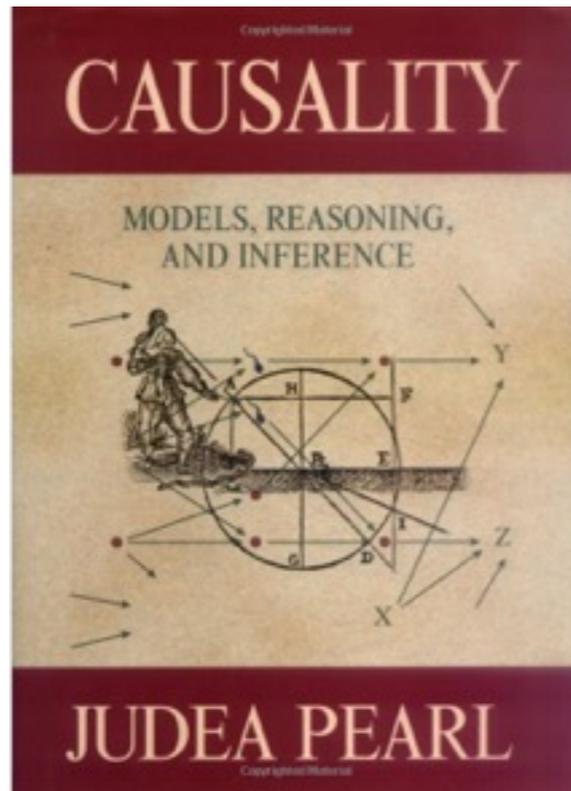
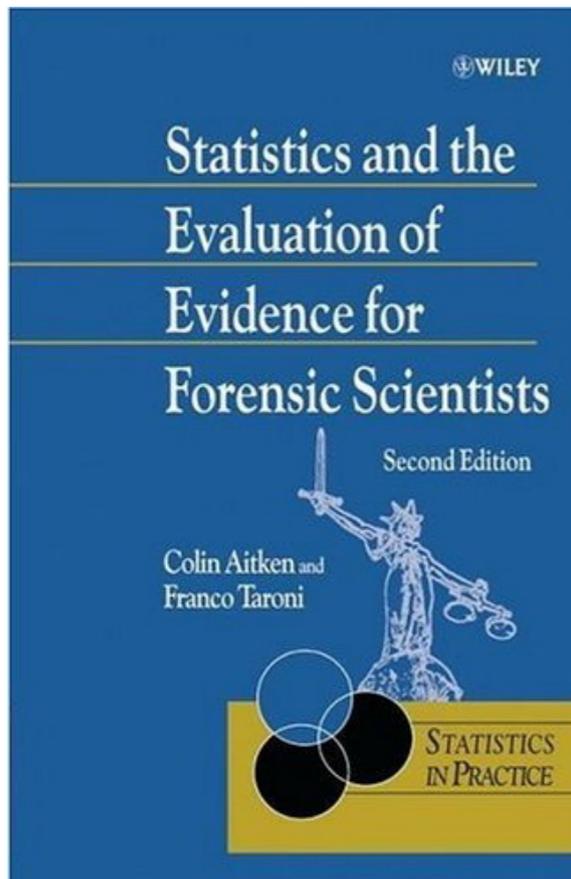
Graphical Model

- Directed acyclic graph (DAG)
- Vertex v : random variable X_v
- Arrows : (direct) statistical dependence
- With vertex v we associate a conditional probability table $p(x_v \mid x_{\text{pa}(v)})$
 - $\text{pa}(v)$: graph parents of vertex v
- Joint distribution: $p(x_1, \dots, x_n) = \text{Prod}_v p(x_v \mid x_{\text{pa}(v)})$

Graphical Models

- Visualise and communicate complex dependence structures
- Graph algorithms for rapid and accurate probability computations
- Free software: Hugin Lite, GeNIe, R, ...

Literature



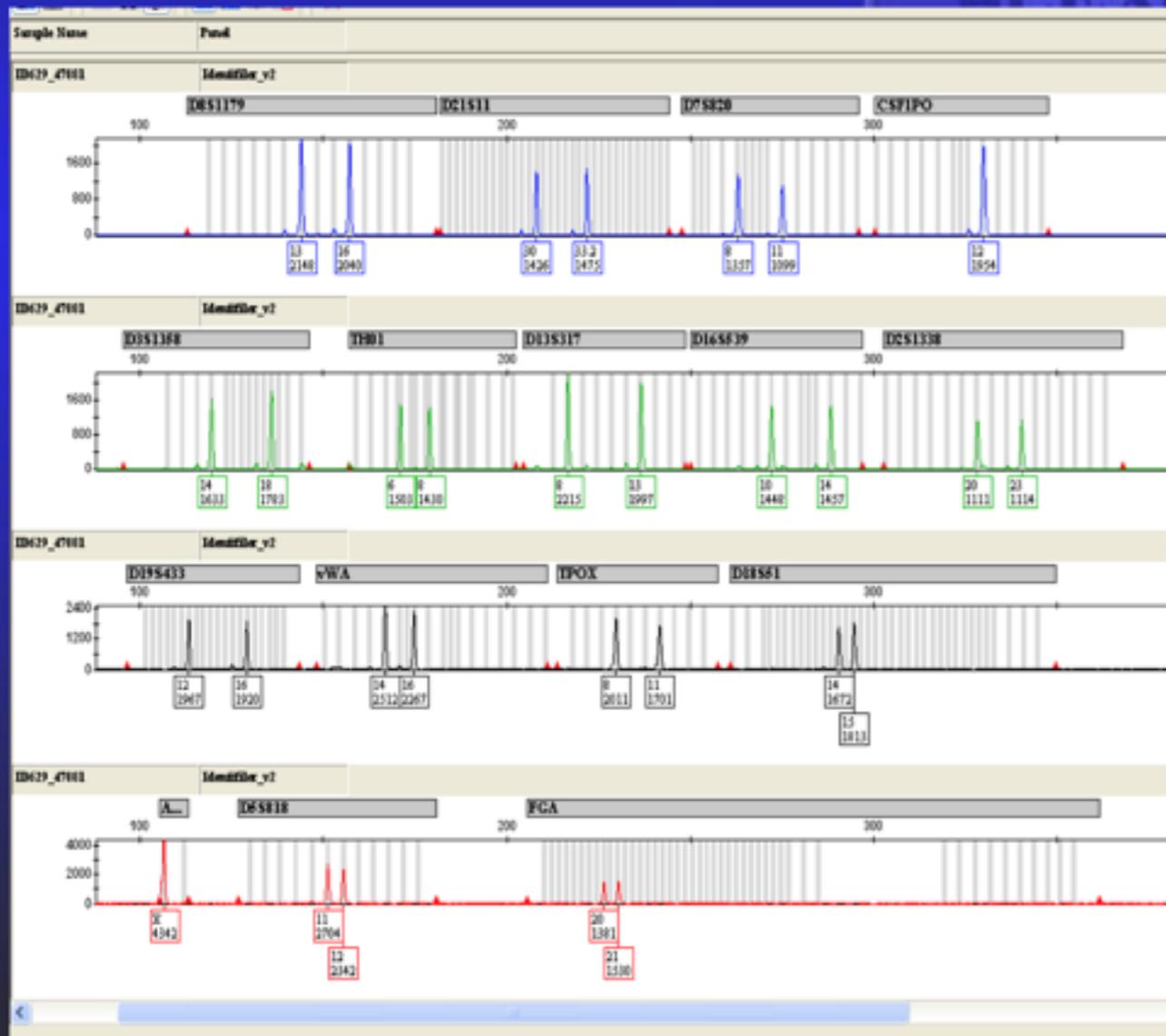
Meredith Kercher murder

Perugia, 1 November 2007

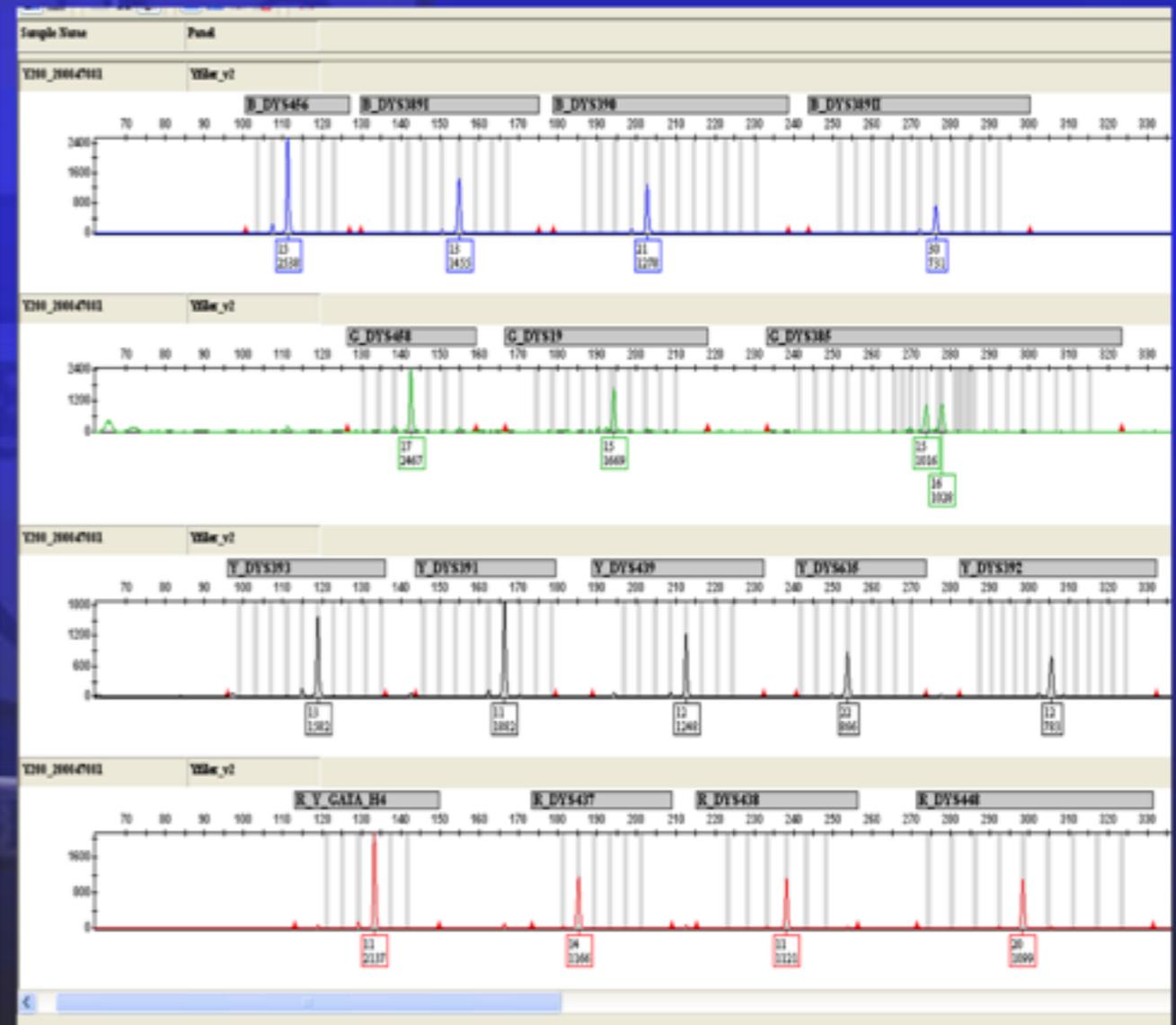
- Suspects:
 - Rudy Guede
 - Raffaele Sollecito
 - Amanda Knox

Y-chromosome DNA profile vaginal sample victim matches (?) Guede

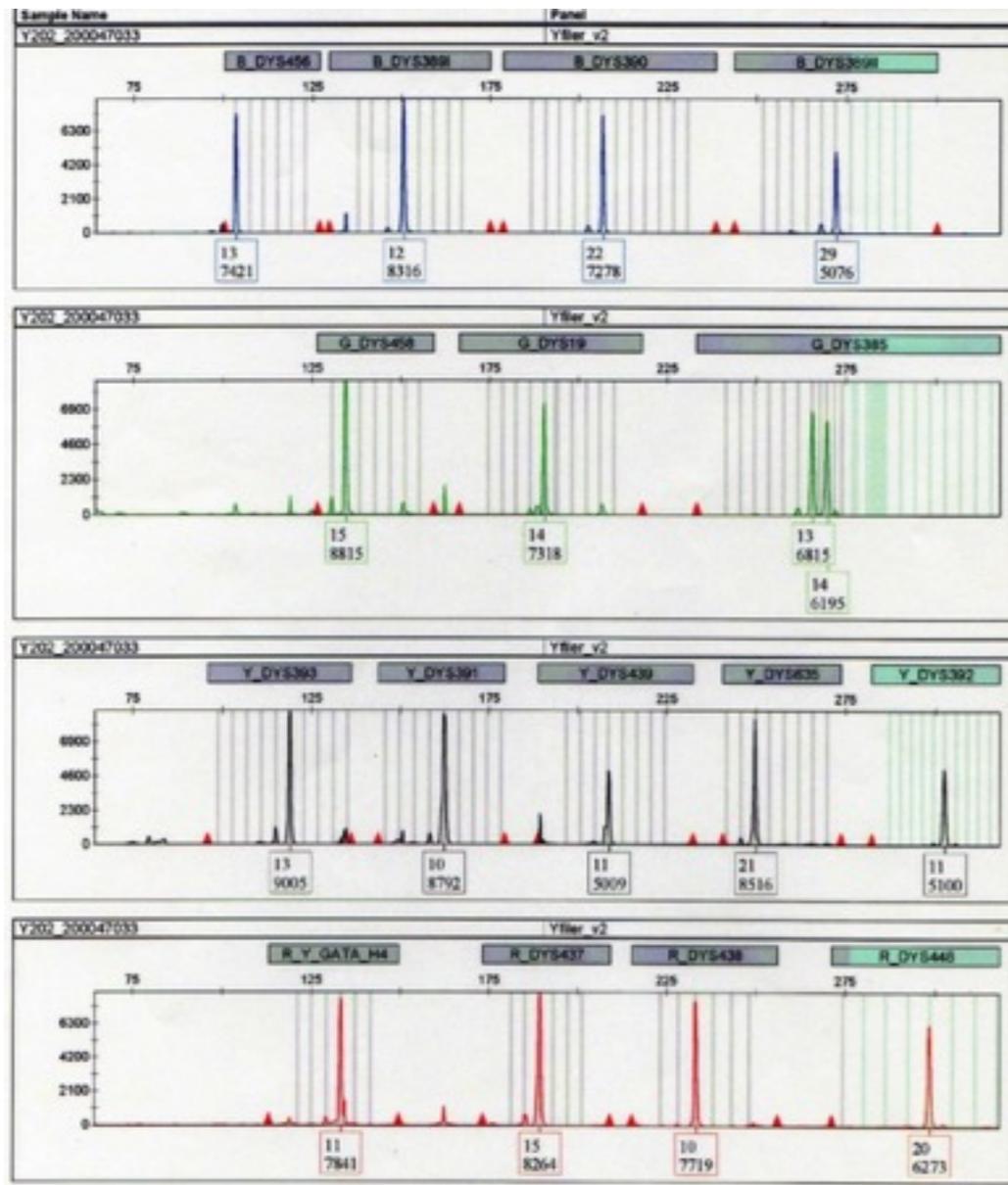
profilo VITTIMA



profilo Y-STR GUEDE



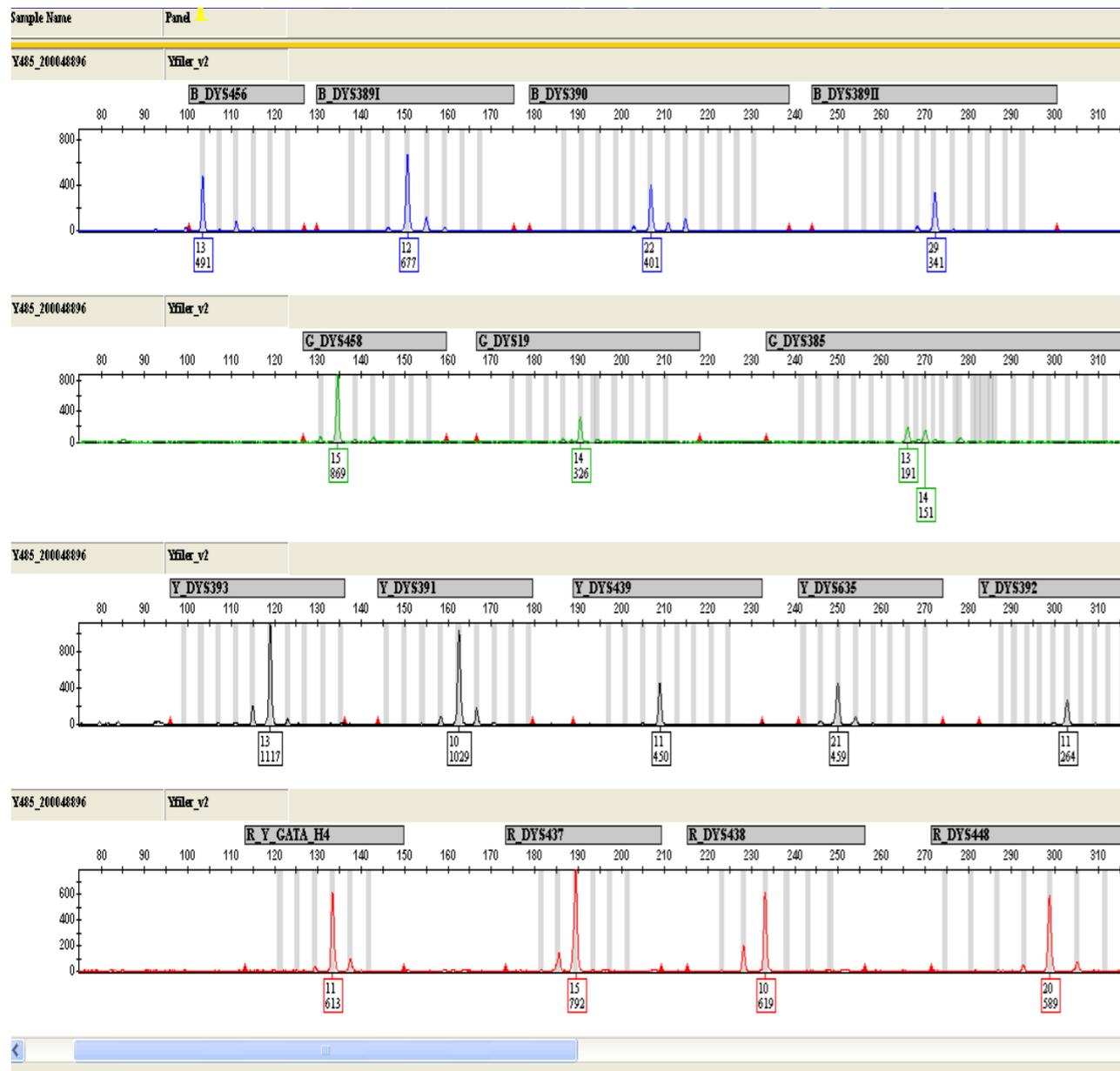
Y-chromosome DNA profile bra-clip matches Sollecito



DYS456	13
DYS389I	12
DYS390	22
DYS389II	29
DYS458	15
DYS19	14
DYS385	13-14
DYS393	13
DYS391	10
DYS439	11
DYS635	21
DYS392	11
GATAH4	11
DYS437	15
DYS438	10
DYS448	20 21

Sollecito's profile

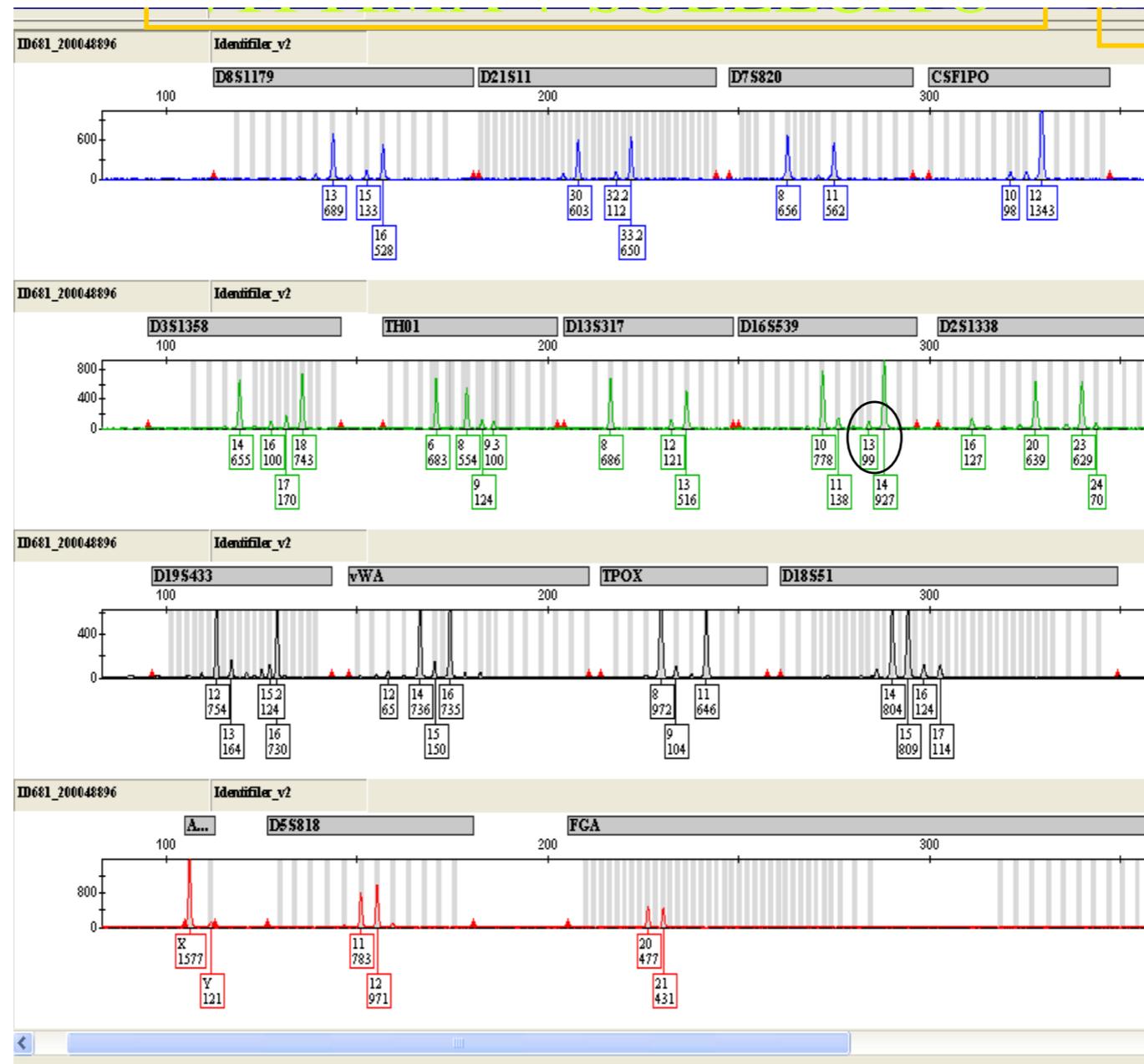
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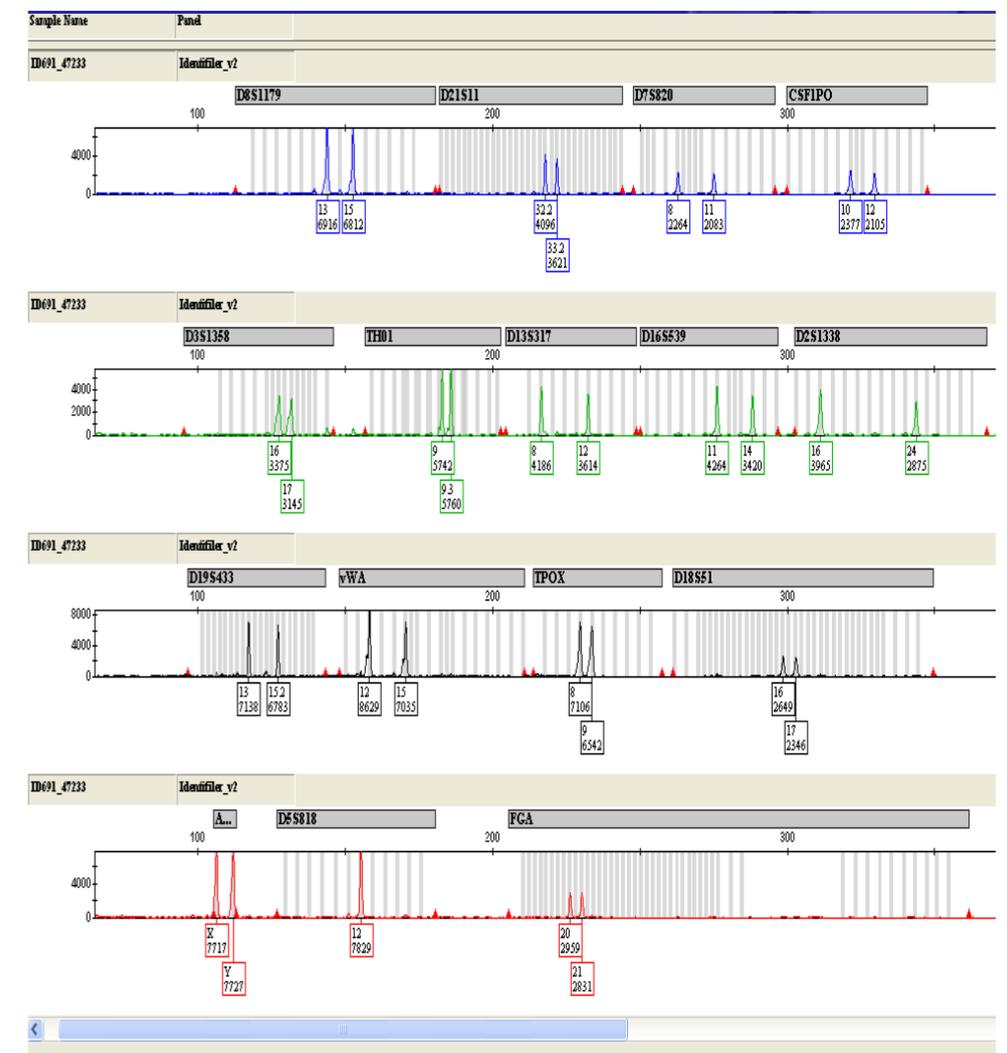
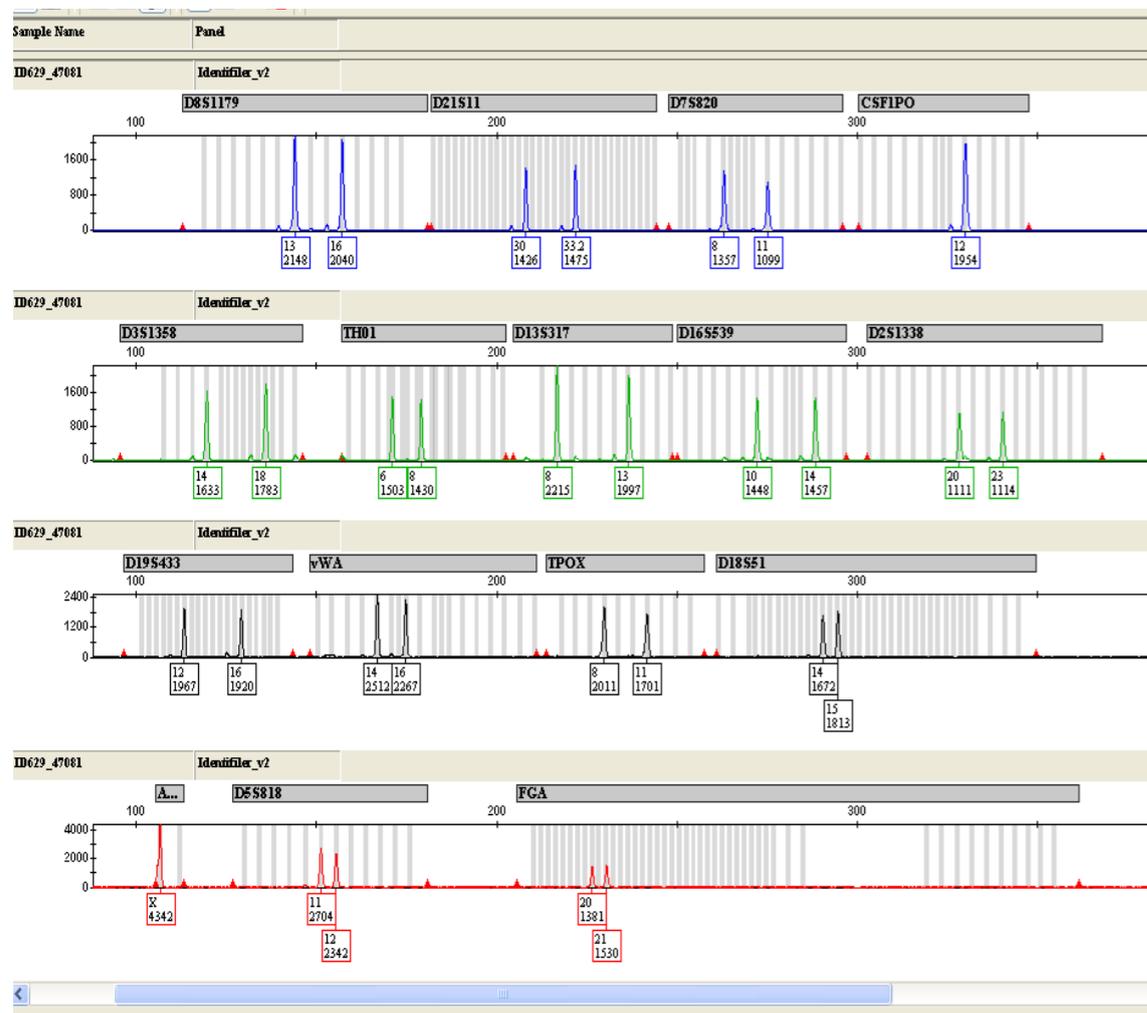
Left: profile from Bra clip trace (right: Sollecito's profile)

Autosomal DNA profile bra-clip matches Sollecito+victim



profile bra-clip trace

Autosomal DNA profile bra-clip matches Sollecito+victim



Reference profiles. Left: victim; Right: Sollecito

Y-chromosome data-base, N=12727

Supplementary data to the following publication
 # Roewer L, Croucher PJ, Willuweit S, Lu TT, Kayser M, Lessig R,
 # de Knijff P, Jobling MA, Tyler-Smith C, Krawczak M. 'Signature of
 # recent historical events in the European Y-chromosomal STR haplotype
 # distribution.' (2005) Hum Genet. 2005 Jan 20;
 # LINK: <http://dx.doi.org/10.1007/s00439-004-1201-z>

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pop	dys19	dys389i	dys389ii	dys390	dys391	dys392	dys393
Albania 12	12	13	30	24	10	11	13
Albania 12	12	13	30	24	10	11	14
Albania 13	12	13	30	24	10	11	13
Albania 13	13	13	29	23	10	11	13
Albania 13	13	13	29	24	10	11	14
Albania 13	13	13	29	24	11	13	13

Hum Genet (2005) 116: 279–291
 DOI 10.1007/s00439-004-1201-z

ORIGINAL INVESTIGATION

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 Peter de Knijff · Mark A. Jobling · Chris Tyler-Smith
 Michael Krawczak

Signature of recent historical events in the European Y-chromosomal STR haplotype distribution

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Abstract Previous studies of human Y-chromosomal single-nucleotide polymorphisms (Y-SNPs) established a link between the extant Y-SNP haplogroup distribution and the prehistoric demography of Europe.

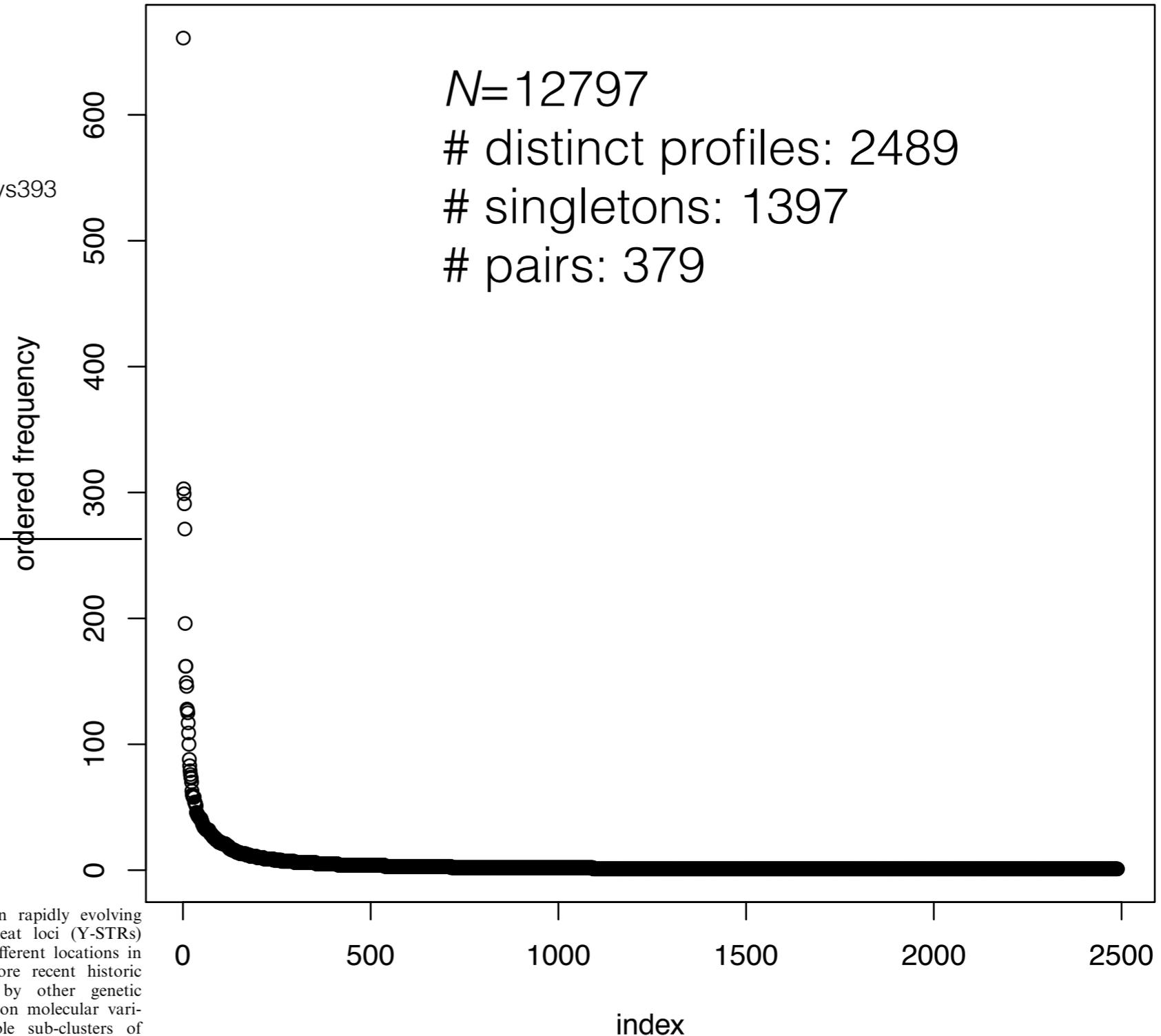
By contrast, our analysis of seven rapidly evolving Y-chromosomal short tandem repeat loci (Y-STRs) in over 12,700 samples from 91 different locations in Europe reveals a signature of more recent historic events, not previously detected by other genetic markers. Cluster analysis based upon molecular variance yields two clearly identifiable sub-clusters of Western and Eastern European Y-STR haplotypes, and a diverse transition zone in central Europe, where haplotype spectra change more rapidly with longitude than with latitude. This and other observed patterns of Y-STR similarity may plausibly be related to particular historical incidents, including, for example, the expansion of the Franconian and Ottoman Empires. We conclude that Y-STRs may be capable of resolving male genealogies to an unparalleled degree and could therefore provide a useful means to study local population structure and recent demographic history.

L. Roewer and P.J.P. Croucher contributed equally to this paper.

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“white” European males, 7 loci
 Data base YHRD.org (2005)