



Y chromosomal clue successfully facilitated the arrest of Baiyin serial killer

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The Baiyin serial murders, or called Gan-Meng 8.05 serial murders, has been considered to be the most infamous among the major criminal cases since 1949. Between May 26, 1988 and February 9, 2002, 11 women including an 8-year-old girl were found gagged, raped, and murdered, often by slitting their throats, and some of their bodies were mutilated brutally, resembling the infamous “Jack the Ripper” killings that occurred in London more than one hundred years ago. Nine of these 11 murders took place in Baiyin District of Baiyin City in the northeast of Gansu Province (Fig. 1a) and the remaining two murders occurred at Kundulun district of Baotou city, 675 km north-east of Baiyin City, in Inner Mongolia Autonomous Region (Fig. 1b). The criminal suspect preferred to pick the women dressed in red, followed them home, and then raped and killed them bloodily. Consequently, the Baiyin serial murders aroused much fear in Baiyin city where women were even afraid to walk alone in the streets.

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Until Baiyin serial killer was arrested on August 26, 2016 at a grocery store in Baiyin City almost three decades after the first murder, police in Gansu Province has been under great pressure from the public and themselves. During this period, they have made strenuous efforts to seek the clues to Baiyin serial murders. According to the evidences from footprint, fingerprint, and DNA (drawn from seminal stains and body fluids) left by the killer in each murder, police confirmed that these murders were committed by the same individual. Uselessly, hundreds of thousands of local male inhabitants in Baiyin city were screened for the suspect by fingerprint comparisons and DNA identifications. In addition, in 2002, an expert from China’s Ministry of Public Security has sketched a portrait of the suspect due to three eye-witnesses’ descriptions, and in 2004, the authorities put a high price for information about the murders. Unfortunately, the course of Baiyin serial murders seemed to be stalled.

An unrelated bribery investigation triggered the breakthrough unexpectedly. The relevant criminal’s Y-STR profile was highly consistent with the serial killer’s, albeit their autosomal STR genotypes were discrepancy, which attracted the notice of local police immediately. Police then continued a genealogy-based fingertip search. Fingerprint and DNA information of all his male relatives were extracted simultaneously. The Baiyin serial killer, his distant nephew, was finally arrested. This time it took the police only several days to break the case. The killer is a native of Chenghe Village, which is administratively assigned to Lanzhou City, the capital of Gansu Province. Geographically, this village is about 100 km north-east of Lanzhou City and only 25 km south of Baiyin City (Fig. 1b).

Then two questions come, one is whether the Baiyin serial murders was solved only by chance, and the other is

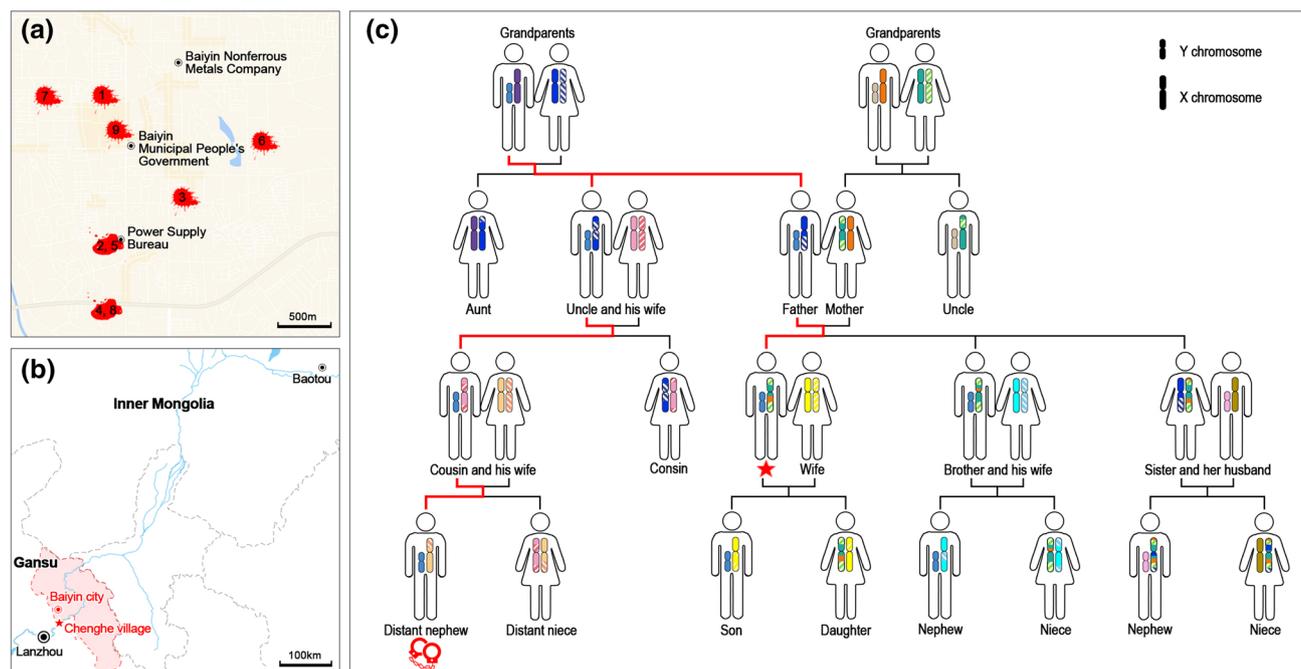


Fig. 1 The geographic backgrounds and genetic principles involved in this article. **a** Map showing the approximate locations where nine murders took place in Baiyin District of Baiyin city. **b** Baiyin serial killer come from Chenghe Village of Lanzhou City. However, this village is much nearer to Baiyin City than Lanzhou city. **c** Map exhibiting the parallel inheritance of surnames and Y-chromosomes. Ideally, men sharing a surname in a patrilineal family are expected to have similar Y chromosomes (in blue). By contrast, their autosomes and X chromosome are jumbled by recombination (in multicolor). The vital clue to the killer's identity was the Y-STR profile of his uncle (represented by pentagram). From this, all male individuals of the family were examined. Finally, the police clapped the handcuffs on the murderer

why Y-STR markers, compared to autosomal STR markers, could facilitated the Baiyin case solving shortly. For the first question, we should realize that the long-term fundamental work, such as fingerprint, autosomal STR, and especially Y-STR database establishment and their continuous updating, and considerate investigations performed by the Gansu police were crucial for breaking the Baiyin case. Admittedly, unexpected clue is a good catalyst that accelerates the progress of the Baiyin case. For the second question, the reason was attributed to the characters of Y chromosome [1]. From Fig. 1c, we can clearly see that Y chromosome is inherited paternally and completely without recombination and therefore it is the best material to mirror the paternal lineages within a large family or population at individual level; in contrast, autosomes and X chromosome are inherited from both the parents and are always jumbled by recombination, which makes it hard to identify the clear kinship among relatives more than one generation. Furthermore, the surnames similar to Y chromosomes are usually inherited from fathers [2]. Some complicated social behaviors, e.g. adoption and surname changing, will obfuscate the association between surnames and Y chromosomes, but in most cases men sharing a surname are expected to have similar Y chromosomes. Additionally, according to our previous studies including investigations of the genetic structure of different ethnic groups [1],

examination of initial colonization in East Asia [3], identification of ancient famous persons' genetic lineages [4–6], we found that East Asian Y chromosomes are more likely to generate population-specific haplotype distribution and their diversity is strongly associated with ethnic/linguistic families [1, 7, 8]. Thus, Y chromosome DNA testing not only can be used for forensic identification similar to autosomal STR, but also volunteered any further information, such as potential surname, nationality, and even biogeographic origin [9]. In recent years, we have created a specialized Y chromosome database for population genetic studies [10] and forensic applications [8, 10], through which we inferred the information about possible sources and possible living paternal relatives of the soldiers died in Myitkyina Battle [8] and Huai Hai Campaign [11], as well as the suspects and missing persons involved in several criminal cases, including the Baiyin serial murders.

The arrest of Baiyin serial killer represents the biggest success for the Y chromosomal profiling, which can trace criminals even if they have not been placed on the national DNA database then. Forensic Y chromosome DNA application is becoming a standard typing method in the near future.

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Conflict of interest The authors declare that they have no conflict of interest.

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