Bonaparte Software For DNA Identification assists in DVI and in Missing Persons Program

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Introduction

Countries have become aware of the importance of preparedness for disaster victim identification (DVI). This DVI work is greatly facilitated by modern DNA technology. The Netherlands Forensic Institute (NFI), together with SNN at Radboud University Nijmegen, have developed new software for pedigree matching victim identification of mass fatality incidents. This software, Bonaparte, uses so-called Bayesian networks to evaluate the DNA evidence for identifications. The NFI has used the Bonaparte software in a real DNA DVI case and in the on-going missing persons program in the Netherlands.

Bonaparte software

• uses probabilistic graphical models, so-called Bayesian networks, to model statistical relationships of genetic material of relatives in a pedigree;
• uses all information from the pedigree at once (resulting in fewer false hits);
• is transparent (for example, models implemented in Bonaparte are available to users) and has been validated (K. Slooten, Forensic Science International: Genetics 5 (4) (2011) 308-315);
• allows incorporation of other factors such as mutation models, size bias correction, missing data (failed/drop-out alleles), other genetic markers, uncertain parent-child relations, etc;
• is user-friendly (automatic import of DNA-profiles, 'drag and drop' pedigree editor etc).
• carries out autosomal, Y-STR and mitochondrial DNA matches;
• is a platform independent web based system;
• can be integrated in existing infrastructure (linked to existing databases via xml) and workflow (pdf match report generation);
• has an internal database with concurrent user capability and roll back functionality (for audit purposes).

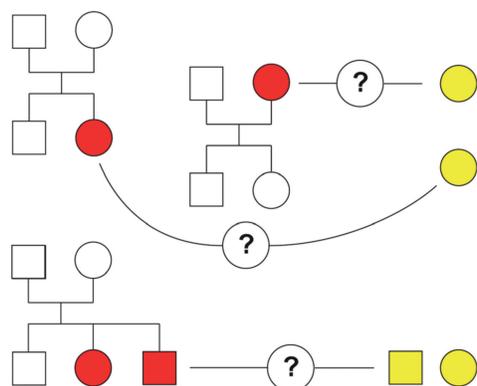Demonstration available from www.bonaparte-dvi.com

Figure 1. Matching victims to missing persons in pedigrees.

Performance in DNA DVI

On 12 May 2010 an Afriqiyah Airways flight crashed upon landing near Tripoli airport in Libya. There were 103 fatal casualties. Among the victims were a number of blood relatives. NFI was formally requested by both the Libyan authorities and the Dutch Ministry of Foreign Affairs to assist with the identification process.
• Samples: the NFI received batches with PM and AM samples from day 8 to the 25th day after the crash.
• DNA profiling: upon delivery the samples were processed. DNA profiles were obtained containing 15 autosomal loci and amelogenin using the Identifiler kit. This process took 3-4 days per batch.
• Matching and reporting: DNA profiles were entered into the Bonaparte software and the matching process was started. This matching process took only several minutes per batch. Then, matching reports were generated and were issued the same day.

The entire identification process took 36 days (figure 2). Matching with Bonaparte took a relatively short time in the whole identification process.
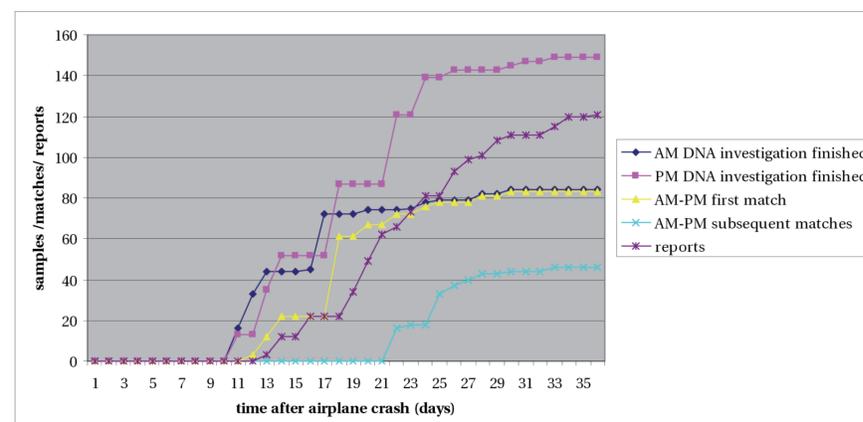

Figure 2. Results in chronological order following the crash.

Missing person program

Since April 2007 the NFI has a national DNA database for missing persons that uses CODIS software. In 2011 the database contains more than 900 DNA profiles. In addition to DNA profiles from unidentified persons and missing persons, it contains DNA profiles from relatives of missing persons.
The missing persons database is linked to Bonaparte via an in-house program to import DNA profiles. Pedigrees are automatically generated from CODIS data (figure 3). The software automatically performs direct searches, as well as indirect searches against both partial and full family trees. For all cases, exact likelihood ratios (for autosomal profiles) and/or number of mismatches (for autosomal, Y-chromosomal and mitochondrial DNA profiles) are computed. Finally, match reports can be generated on demand by Bonaparte's customized reporting modules. In this way, an advanced search strategy combined with a modern, efficient workflow is realized in NFI's missing persons program.
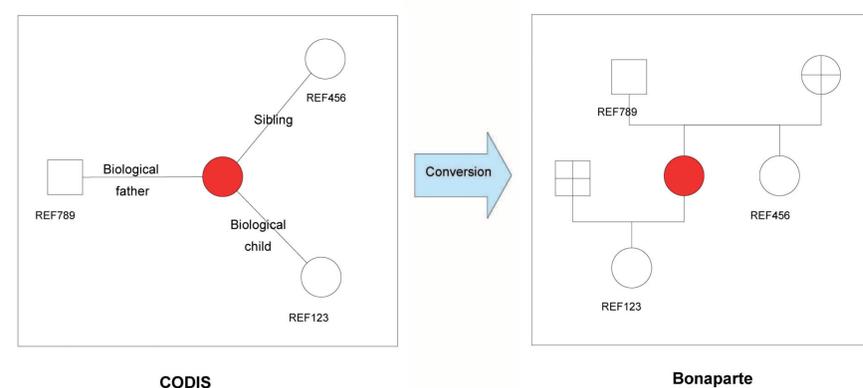

Figure 3. Automatic creation of pedigrees in Bonaparte.

Conclusion

Bonaparte software can effectively handle the identification process in case of a large disaster with many victims and it can be applied in the missing persons program.