COMPARISON OF DNA-PROFILING AND CLASSICAL BLOOD GROUPING IN CRIMINAL CASES

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INTRODUCTION

It was the purpose of this study to compare data from DNA-profiling and classical blood grouping applied to stains and other biological specimens related to criminal cases. Data relating to more than 850 stains were reviewed. Correlations and discrepancies of the classical analyses and the DNA analyses will be discussed.

METHODS AND DATA

DNA-profiling was carried out on *Hinf* I restricted DNA using the VNTR probes MS1, MS31, MS43a and YNH24 [1,2]. With blood stains and tissues the classical markers were: ABO, PGM1, ACP1, GC, HP, GM and KM. With stains with semen/vaginal secretion the markers were ABO, secretor (Lewis a and b), PGM1 and GC, with saliva ABO and secretor and with hairroots PGM1. The analyses were carried out according to the routine procedures of the laboratory. The counts of sperm cells were recorded on a scale ranging from 0 to 4. The results of the screening for phosphatase were recorded on a scale from 0 to 3. The study comprises 863 stains and biological specimens related to 399 criminal cases (Table 1).

RESULTS AND DISCUSSION

DNA-profiles were obtained from approximately two thirds of the stains - except for saliva stains (Table 1).

TABLE 1 - NUMBER OF STAINS AND DNA-PROFILES

STAIN	Number of stains	Number of DNA-profiles	Percent
Blood	321	193	60
Semen/vaginal secretion	511	340	67
Tissues	9	7	78
Saliva	20	5	25
Hair roots	2	1	50
Total	863	546	63

Classical systems

The rate of success of the classical blood-grouping systems with blood stains and stains with semen/vaginal secretions is given in Table 2.

TABLE 2 - SUCCESS RATE OF CLASSICAL SYSTEMS

	BLOOD			SEMEN/VAGINAL SECRETION		
System	Stains	Conclusive results	Percent	Stains	Conclusive results	Percent
ABO	286	165	58	483	358	74
SECRETOR	-	-	-	481	328	68
PGM1	297	252	86	279	96	34
ACP1	271	213	79	-	-	-
GC	291	237	81	144	31	21
HP	256	203	79			
GM	222	208	94			
KM	206	189	92			

The frequencies q of the classical type profiles comprising up to 7 markers varied from 10^{-6} to 1 (inconclusive) for blood stains. For stains of semen/vaginal secretion where only 4 markers were used the frequencies ranged from 10^{-4} to 1. The distributions of the frequencies are given in Fig. 1.

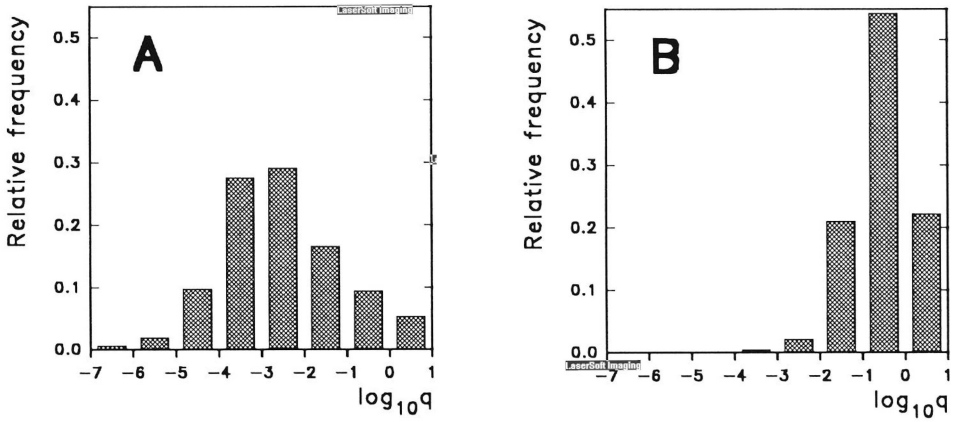

FIG. 1 - DISTRIBUTIONS OF THE $\log_{10}$ FREQUENCIES OBTAINED WITH CLASSICAL SYSTEMS
A. Blood stains. B. Stains with semen/vaginal secretions.
Inconclusive results were scored in the interval 0 - 1.

DNA-Profiling

The number of conclusive classical analyses was correlated to the success rate of the DNA-analysis. For blood stains and stains of semen/vaginal secretion the success rate of the DNA analysis was recorded according to the number of conclusive classical systems (Table 3). On the average 60 - 80 % of the DNA-profiles were complete with bands for 4 probes.

TABLE 3 - SUCCESS RATE OF DNA-PROFILING AS A FUNCTION OF THE NUMBER OF CLASSICAL ANALYSES WITH CONCLUSIVE RESULTS.

Conclusive classical systems	BLOOD Number	Success rate Percent	SEMEN/VAGINAL SECRETION Number	Success rate Percent
Not carried out	1	100 %	25	40 %
0	17	29 %	107	40 %
1	20	20 %	49	65 %
2	31	45 %	242	71 %
3	23	48 %	74	75 %
4	40	53 %	14	86 %
5	43	65 %	-	-
6	67	72 %	-	-
7	79	77 %	-	-

The correlation of the count of sperm cells and the success rate of the DNA-analysis was high. Also the score of the phosphatase screening was correlated with the count of cells (Table 4). In 3 cases DNA-profiles were obtained with stains without sperm cells. These stains exhibited positive phosphatase tests.

TABLE 4 - CORRELATION BETWEEN COUNTS OF SPERM CELLS AND DNA RESULTS
Sperm cells were scored on a scale from 0 to 4 and phosphatase on a scale from 0 to 3.

Sperm cell scores	Number of stains	Number of DNA-profiles	Success rate DNA-analysis	Phosphatase scores
4	104	89	86 %	2.8
3	96	79	82 %	2.8
2	125	75	60 %	2.5
1	99	35	35 %	1.9
0	30	3	10 %	1.5

The consistency of DNA-analysis and classical typing

For 467 stains results were obtained with DNA-analysis as well as with classical typing. For 394 of these stains a match with a person in the case was recorded. With these stains 1245 classical typings were performed. In 32 of these typing results a disagreement in relation to the corresponding blood sample was observed: In 18 blood stains GM3 (16) or KM (2) could not be detected. In 6 semen/secretion stains A or B were unexpectedly detected, and in 7 stains the presence of A, B, O or Lea were expected but not detected. In one stain the GC subtype 1F and 1S disagreed in the stain and in the corresponding blood sample. In one case a GC variant could not be detected in the stain.

REFERENCES

1. Eriksen B, A Bertelsen and O Svensmark. Statistical analysis of the measurement errors in the determination of fragment length in DNA-RFLP analysis. *Forensic Sci. Int. 52 (1992) 181-191.*
2. Eriksen B and O Svensmark. DNA-profiling of stains in criminal cases: Analysis of measurement errors and band-shift. Discussion of match criteria. *Forensic Sci. Int. 61 (1993) 21-34.*