The ESSEN-MÖLLER Method

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If a method is known by a person's name, as is the case with the Essen-Möller method (1), one can wonder where exactly lie the author's merits that justify such an allocation. In my opinion Essen-Möller has three merits:

1. introducing the frequencies X and Y as biostatistical parameters;
2. recommending a W-value indicating the plausibility of paternity - and not using a likelihood ratio;
3. weighting each hypothesis by a neutral prior plausibility.

I shall discuss the importance of these three merits in turn:

The first merit: For each possible hypothesis in a case of disputed parentage, a corresponding family tree can be set up. In the simplest case the X pedigree represents the null-hypothesis: "The man is the child's father"; the Y pedigree represents the counter-hypothesis: "Another man is the child's father".

The W_X-probability of the null-hypothesis and/or the W_Y-probability of the counter-hypothesis can be obtained by comparing the respective frequencies of the two family trees:

$$W_X = \frac{f(X)}{f(X)+f(Y)}\ ,\ W_Y = \frac{f(Y)}{f(X)+f(Y)}.$$

In a case from Dr. Hirtz, Oldenburg, the child Th has three siblings; these, however, have not been fathered by the plaintiff, but by an unknown man or even different unknown men.
This results in four family trees for the X-hypothesis "The plaintiff is Th's father" and as many as ten for the Y-hypothesis "An unknown man is Th's father". Comparison

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of the cumulated frequencies for X and Y calculated by using our "kinship program" (2) shows that

W_X = 97,6%: indicating that it is "very likely" that the plaintiff is the father of Th, and

W_Y = 2,4%: indicating that the paternity of an unknown man is "very unlikely".

After rejecting hypothesis Y we compared the 4 X-frequencies one with the other and came to the conclusion that - with a probability of 90% - either the children Ma and Na are full siblings or that each of the 4 children has a different father.

In another case (from Professor Henn, Innsbruck) the question was whether or not three sisters have the same father. Here, there is one X-hypothesis,

"All three sisters have the same father",

and are four Y-hypotheses:

"Sisters 1 and 2 are full sisters"
"Sisters 1 and 3 are full sisters"
"Sisters 2 and 3 are full sisters"
"All three sisters are half-sisters".

On the basis of other evidences the fourth Y-hypothesis may be excluded.

The following X and Y frequencies are calculated:

$$f(X) = 8.343\ 10^{-31}$$

$$f(Y_1) = 6.185.000\ 10^{-31}$$

$$f(Y_2) = 0.035\ 10^{-31}$$

$$f(Y_3) = 0.035\ 10^{-31}$$

$$\Sigma f(X,Y_1,Y_2,Y_3) = 6.193.410\ 10^{-31}$$

If $f(X)+f(Y_1)+f(Y_2)+f(Y_3) = 100\%$, then

$W_X = 0{,}13\%$
$W_{Y_1} = 99{,}86\%$ } Sisters 1 and 2 have the same father;
$W_{Y_2} = 0{,}005\%$
$W_{Y_3} = 0{,}005\%$ } sister 3 has a different father.

These examples emphasize that the serostatistical information is derived from pedigree frequencies; these are related to the hypotheses that have been set up in the respective case. Furthermore it can be seen that 2-hypotheses cases can be solved quite easily by means of a formula where the sum $f(X)+f(Y) = 1$. Multiple hypotheses cases, however, may require summing of hypotheses which may result in more than two plausibilities of kinship - e.g. in a "two-men" case there are three plausibilities of paternity: one for the defendant, one for the witness and one for an unknown man (3).

By defining the X and Y frequencies Essen-Möller paved the way to solving two-hypotheses as well as multiple-hypotheses cases.

The second merit: A likelihood ratio $\frac{Y}{X}$ (Essen-Möller) or $\frac{X}{Y}$ (Gürtler, 4) is suitable for simple 2-hypotheses but not necessarily for multiple-hypotheses cases. If, however, probabilities are used (as recommended by Essen-Möller) every imaginable hypothesis can easily be allotted an individual probability.

Unlike likelihood ratios, probabilities are familiar notions in anybody's daily life. Thus lawyers and participants in a lawsuit have a clearer idea of the value of the evidence if W-values are used instead of the rather esoteric likelihood ratios.

Regardless of whether a W-value concerns a normal case, a deficiency case, an incest case, a sibling case or any other, of whether this W-value has been obtained from the findings for a few or numerous genetic systems and of whether the probability of exclusion for non-fathers is

high or low: a W-value always corresponds to the plausibility of the X-hypothesis in one hundred equivalent cases, provided

a) that the files contain prior to the blood group opinion as many cases with a correct null-hypothesis as cases with an incorrect one;
b) that adequate genetic frequencies were used in obtaining W.

The third merit: In a given case each hypothesis is not only related to a certain family-tree frequency but also to a prior plausibility. The latter can easily be included in the computation of probabilities of the hypotheses.

In a two-hypotheses case the following formulas are valid:

$$W_X = \frac{f(X) \cdot aprW_X}{\left[f(X) \cdot aprW_X\right] + \left[f(Y) \cdot aprW_Y\right]} ;$$

$$W_Y = \frac{f(Y)\ aprW_Y}{\left[f(X) \cdot aprW_X\right] + \left[f(Y) \cdot aprW_Y\right]} .$$

To avoid prejudice Essen-Möller recommended using only neutral prior plausibilities irrespective of the nature of the case in question. Thus one assumes that in all imaginable cases the realistic prior plausibilities are approximately equal. However such an assumption may be unjustified for at least the following three groups:

a) in cases where the mother was a prostitute at the time of conception,
b) in cases where the mother is non-commercially promiscous,
c) in cases of questionable bipaternity.

The observations of Dr. Weber/Cologne (5) indicate that a neutral prior plausibility is justified in prostitute cases.

In cases of non-commercial promiscuity this cannot be assumed as easily. As no adequate statistics are available for these cases, the Court should be recommended to accept biological paternity only at $W \geq 99{,}73\%$. By analogy this applies to cases of questionable bipaternity (6); superfecundation is so rare that its plausibility must be at least $W = 99{,}73\%$ to be accepted as proved.

For reasons of neutrality of the "utility" principle - i.e. equality before the law - Essen-Möller recommended neutral and standardised priors. Realistic prior plausibilities are frequently higher or lower than these. Thus W-values in reality represent orientation data and not absolute data.

It is possible to obtain a realistic plausibility from a given W-value by including a realistic prior value. However the latter should only be used in exceptional cases. Usually it suffices - especially in cases of promiscuity or questionable bipaternity - to aim for the highest W-value possible so as to eliminate doubts arising from a low realistic prior.

Most German experts as well as those in other German-speaking countries have regarded Essen-Möller's W-value as the most valuable of all possible serostatistical parameters for at least the past twenty years. In 1966 a survey was conducted among 111 German experts (7); 75% replied, and of these 80% used the Essen-Möller plausibility. Only one used the exclusion probability. In another survey conducted this year - 19 years later (8) - 98,5% of the respondents use the Essen-Möller plausibility. Only one regards the exclusion chance as sufficient.

It is unlikely that the practice of twenty years and more - which has moulded the practice of justice in this field right up to the German Supreme Court - will change in Germany in the future. The serostatistical probability of kinship will continue to be determined in accordance with the principle of Essen-Möller, and in this form will be reflected in the Court's judgements.

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