METHODS OF FORENSIC SCIENCE

VOLUME II

Edited by **FRANK LUNDQUIST**

Head of the Division of Biochemistry and Biophysics, University Institute of Forensic Medicine (University of Copenhagen) Copenhagen, Denmark

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VOLUME II

ADVISORY BOARD

Introduction to the Series

The use of scientific methods—physical and chemical—in forensic medicine and crime investigation is steadily increasing and gaining in importance throughout the world.

In a number of cases the methods are well known from other branches of science, but for forensic purposes special modifications of the procedures are generally required in order to give results which are acceptable to legal authorities as proof of some specific point. In other cases the methods are designed exclusively for forensic use.

A large part of the literature regarding this rapidly expanding field is scattered throughout journals and books which are not readily available in most libraries. The forensic scientist, when placed before a new problem, often has extensive work to perform before he is able to decide on a method suitable for the solution of that specific problem. The need is growing, therefore, for a publication in which forensic scientists, toxicologists, police laboratory technicians, analytical chemists, and others may find authoritative and up-to-date descriptions of methods which have proved valuable in actual forensic practice.

The present series of volumes, *Methods of Forensic Science*, is designed to meet this need. Each volume will consist of several chapters. Each chapter will be contributed by one or more outstanding scientists and will include a short review of the subject followed by a detailed description—based on personal experience—of the procedure recommended by the author(s) for the particular purpose. When a chapter is out-dated or new and important methods have appeared, it is the intention to include chapters on aspects of the same subject, covering the latest developments. In this way it is hoped to provide a useful, self-modernizing handbook for forensic laboratory work.

In a series of this kind, in which chapters from many and varied fields of investigation are included, a certain heterogeneity in the arrangement of the matter and in the style is probably unavoidable. It is hoped that this will not detract seriously from the usefulness of the work.

Copenhagen, Denmark FRANK LUNDQUIST

Authors

Dr. Steffen Berg
Department of Criminology, Bavarian Bureau of Criminal Investigation, Munich, Germany

W. J. Cadman
Laboratory of Criminalistics, Orange County Sheriff's Department, Santa Ana, California

Dr. A. Dyfverman
Government Laboratory for Forensic Chemistry (Statens Rättskemiska Laboratorium), Stockholm, Sweden

Jean Gayet
Criminalistic Division of the Police Scientific Laboratory, Lyon, France

Dr. K. Henningsen, M.D.
The Serological Department, University Institute of Forensic Medicine, Copenhagen, Denmark

E. Martin
Director of the Criminalistic Departments of the Public Prosecutor's Office of Basel-City, Switzerland

Prof. P. Moureau
Institute of Pathology, Department of Legal Medicine, University of Liège, Belgium

Prof. Dr. F. Schleyer
Institute of Forensic Medicine, University of Bonn, Bonn, Germany

Dr. A. H. Witte
Forensic Science Laboratory, Ministry of Justice, 's-Gravenhage, Holland

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An Analytical Technique for Determining the Origin of Unidentified Paper

E. MARTIN, *Director of the Criminalistic Department, Public Prosecutor's Office, Basle, Switzerland*

I. Introduction

The examination of documents, certificates and paper securities, and above all the task of tracing the origin of counterfeit bank-notes, present considerable problems in criminal investigation. The difficulties become immense when one has no clue at all as to the individuals responsible, or even as to the country in which the counterfeit was produced. It is of

course possible to examine its composition and the method of production. The results are interesting and may throw light on the materials and technical processes used. But for detecting the counterfeiters the information is of no value unless one has or can obtain materials for the purpose of comparative examination.

The materials used by the counterfeiter of documents, securities and bank-notes are mass-produced in a great number of paper mills and distributed daily to an even greater number of retail traders and other users. This makes it extremely difficult to obtain the proper materials for comparative testing.

Prompted by the progress and refinements made in modern physical and chemical techniques of investigation, and recognizing the grave consequences of counterfeiting, we turned our attention to this problem with the main objective of finding out whether the place of manufacture of a given paper can be determined by analytical means.

A thorough preliminary study was made of the materials and technology of papermaking. It was found that there are different manufacturing formulae for the various types of paper which are kept a close secret. The consumption of water is heavy, and it differs widely in purity and in content of inorganic substances from one mill to the next according to the local geological conditions. In some cases chemical purification or precipitation of undesirable substances is necessary.

Our next step was to establish a series of test methods for analysing paper, in order to see whether the standard qualities from a mill exhibit, besides their known features, other constant or varying chemical or physical characteristics which are peculiar to the paper and the mill and can be turned to account in an investigation.

The test methods developed for this purpose, and the results obtained with known paper samples of Swiss manufacture, are described in this article.

II. Test Methods for Paper Analysis and Test Results

General Observations

We used 92 qualities of paper which were kindly provided by Swiss papermakers. Of each quality, we were given several standard samples which had been manufactured at different dates, and in addition samples from the beginning, middle and end of several different batches. The

material included writing, printing, drawing, bookbinding and cover papers, Japanese vellum and straw vellum, all of different composition and weight. Each sample was accompanied with exact details of the quality, date of manufacture and weight.

The samples were used to obtain information on a number of questions relevant to the investigation of criminal forgeries:

1. Can paper qualities be qualitatively and quantitatively analysed and compared with exactitude, and does the composition of a paper change from the beginning to the end of a single batch?
2. Does the composition of a standard type of paper, made at intervals in the same mill, remain the same or do changes occur?
3. Can trace elements be detected which would indicate the nature of the water used in papermaking?

Preliminary experiments were necessary in order to devise tests suited to our special needs, in particular microscopical techniques which would require only very small samples that could be used for several tests. We first studied the methods described in the technical literature on papermaking and testing. These tests, developed partly by paper scientists and partly by technicians, are many-sided. The main objectives are to improve the quality of the product, to discover the causes of faults in manufacture, to assess the efficiency of papermaking processes, and to increase the papermaker's skill and knowledge. However, fairly large samples are needed for most of these tests, while in our field, for example in the investigation of counterfeit notes and forged documents, we have to work with used, worn paper which often is printed on both sides. Moreover, we have found that the papers we examine, due to the printing process and the presence of ink, differ from unused paper of the same type in regard to air permeability, gloss, handle, rattle, weight, ash residue, and other physical properties. These differences are misleading and make comparative evaluation extremely difficult.

With these considerations in mind we only adopted the tests which appeared to us to meet the special conditions and requirements of criminal investigation, namely those for determining the weight per square metre, the ash residue, the macroscopical determination of the composition and the degree of beating.

In addition, we devised some new, slightly modified analytical methods which provide valuable information on the nature and amount of certain substances in paper, and which we find are characteristic of one or more products of the paper mill concerned. These additional analytical tests are:

1. A method of preparing clean samples for microchemical examination.

2. A spectrographic method of examining and identifying the inorganic substances in paper.
3. A chromatographic method of determining the alkali metals and alkaline earth metals in paper.

Further, we investigated possible methods of identifying the trace elements in spring or subsoil water. More especially, we tried to find out whether there was agreement between the content and proportions of these substances in the water supply of the paper mill and in the paper qualities made in the mill.

1. Quantity, Condition and Preparation of Paper for Analysis

At least 1–2 g of each paper under investigation is required for the various tests. In normal papers this weight corresponds to the size A5 (8.22 in. × 5.78 in.). The more paper available, the more often the tests can be repeated and the higher the degree of accuracy.

As counterfeit currency is generally printed on both sides and is often soiled and worn, we had to find a way of obtaining clean fibres for the microchemical tests. If we have a number of the counterfeit notes, one or two of them are reserved for this purpose. Both sides of the note are covered with overlapping strips of one-inch Scotch Electrical Tape No. 5. On one side the tape and top layer of paper are cut through with a scalpel in strips about $\frac{3}{4}$ in. wide. A corner of the tape is lifted and the tape, with the

Fig. 1. Application of adhesive tape on printed paper.