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SCIENCE AND THE POLICE OFFICER

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To
my friend
Edward H. S. Walker

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FOREWORD.

This book is a collection of written ~~lectures~~ to police officers originally published in the Garda Review, the official journal of the Irish Free State police, and now reproduced in this form by the kind permission of Major General W. R. E. Murphy and the Directors and Editor of the Garda Review. These articles met with some success in the attempt they made to meet a definite need which is the author's excuse for reprinting them.

Science has been applied to criminal investigation for many years, although not always under its true name; and much of the misunderstanding which has arisen in regard to the relation existing between science and police work is due to this fact. On a last analysis the object of scientific training is not the mere acquisition of scientific facts. Facts are of no importance out of relation to the habit of mind which is brought to bear upon them. If it were clearly recognised that the use of science and scientific training consisted precisely in this, most obstacles which seem to separate the scientific specialist from those (like the police) who are applying their knowledge to strictly and immediately practical issues would disappear.

Having regard to the fact that in criminal investigation so much depends upon a sound system of inductive methodology, it is a surprising fact that no book on the subject has appeared in English. This book does not claim in any way to meet this requirement, but an attempt has been made in discussing the scientific problems involved to indicate the methods by which they should be interpreted, and to show in general that the method of approach to all criminal problems must be, of its very nature, scientific, however elementary and straightforward the problem may appear to be.

The book which has most clearly brought this out is the classical *Criminal Investigation* of Prof. Hans Gross. It is

almost impossible to exaggerate the importance of this contribution to the subject of scientific police. Not merely had Prof. Gross intimate and first-hand knowledge of the problems which the police were called upon to solve; he was also a scientific man who really understood what is meant by the scientific habit of mind. The scope of the book is very wide, and while from the point of view of scientific technique some parts of it are now out of date, its accuracy, having regard to the ground covered, is remarkable. It is a book which advanced students of police work all over the world recognise as being indispensable as a work of reference.

The aim of the present book is necessarily much less ambitious. It is written from the scientific point of view, and an attempt has been made to show that even every-day problems of investigation touch at one point or another the technique of the laboratory. Police officers are not alone in being to some extent distrustful of the academic point of view in the sense that it is commonly understood, but in police work, as in other departments of activity, it is important to realise that the academic point of view is not inevitably associated with academic and technical training. Even pure research generally bears at least an indirect relation to the affairs of everyday life, and it can truly be said that the study of the science of technical police, however much the caché of the laboratory and lecture room hangs about it, has been exclusively and directly devoted to practical ends.

It is thus a particular aim of this book to give an outline of those aspects of the work of the police which have occupied the attention of scientific men. In general it is true that there is no kind of specific problem in connection with criminal investigation upon which some scientific principle has not a bearing, although it is obvious that science has a closer relation to some enquiries than to others. But, on the other hand, it is also true that an enquiry which seems to turn almost entirely upon scientific evidence in the narrow sense seldom does so in fact. The interpretation of the whole

evidence, the construction of a synthesis, is a matter for the police.

This is very important. Without some knowledge of the sphere of the expert, the limitations of his technique and what it really embraces, the police are not in a position fully to co-operate with the scientific man. This has been one of the fundamental principles which has been kept in mind and out of which has grown the police school of the Continent. These schools not only give courses of higher education to the police, but incorporate within the same organisation more elementary courses for the lower ranks. The police school at Brussels under Prof. de Rechter is an example. The present work has been modelled to some extent on the elementary courses of this type which have been evolved on the Continent, where long experience has proved their value not only as an introduction to the study of scientific methods for those who propose to pursue their studies further, but to the ordinary police officer who requires a general knowledge of scientific principles underlying criminal investigation.

We are accustomed to think of the practical applications of such things as photography, the recording of finger and foot prints, as being an art rather than a science. It is true that such operations cannot be perfected without practice, but they have at the same time a scientific aspect which heightens the significance of the evidence they are able to supply. Without a knowledge of optics photography loses much of its significance; the examination of footprints involves something more than an empirical knowledge of measurement. The scientific implications of fingerprint identification is better understood, but even here there is an inclination to treat this highly complex subject empirically.

The question of the anthropometric system of identification has not received much attention in England, but its value is in some circumstances very great. As with fingerprints, anthropometry has important scientific implications; and an understanding of the principles underlying it is essential to a proper understanding of the subject. No

attempt has been made to treat the matter exhaustively from this point of view. It has been necessary as far as possible to concentrate upon practical applications; but all which has been set down in this book bears a definite relation to scientific principles and method.

The practical aspect of the more specialised branches of investigation has also been stressed. The use of the microscope is a good example of the value of manipulative skill. And while a knowledge of optics is necessary to carry out microscopic work effectively, manipulative skill is the first essential. The simpler applications of ultra-violet light are in the same category.

But it would be grave omission to exclude from such a review other more specialised matters on the grounds that they do not fall directly within the province of the police so far as the actual technique is concerned. Chapters have therefore been included dealing with forensic ballistics, forensic graphology, the chemical and biological examination of traces and stains, toxicology, and the application of psychology to reconstruction and evidence. To a greater extent than in the previous examples quoted these matters are for the specialist. This, however, would not justify their exclusion. It is no longer fashionable, as once it was, for the expert to surround his undertakings with an atmosphere of mystery; and, indeed, it comes to be held more and more than an attitude at once secretive and pontifical is a badge of the quack rather than of the qualified. A knowledge of the methods employed by experts does not presuppose a desire to usurp their functions. Such general knowledge is, on the contrary, necessary in order to make effective co-operation possible. Carey, the well-known American detective, explains in one of his books that he took steps at the beginning of his career to acquire a knowledge of toxicology and allied subjects. He had, indeed, recognised at a period when the importance of the application of scientific methods to the work of the police was not adequately realised that for the detective general knowledge of this kind was essential to the right conduct of criminal investigation.

This is not to say that in England the question of the application of scientific methods to criminal investigation has been neglected. At least in the sphere of forensic medicine and toxicology this country is no less advanced than any other, and it is a great deal more efficient than many; but there has been a tendency to segregate the expert from the ordinary police organisation, so that it is true to say that we are from this point of view behind the other large European countries in the organisation of technical police. Detection in this country has been regarded rather as an art than as a science.

That it is an art is manifestly true. It would be absurd to suggest that formal scientific methods alone suffice to solve any important problem. In this sense the scientific detective is an invention of the newspapers. But it remains true that without scientific methods of some sort many investigations could not be satisfactorily concluded at all. This has not been directly stressed in the succeeding pages. The facts are there to speak for themselves.

On the Continent this co-ordination of the science and art of detection has been achieved by the creation of university faculties in criminology, and in the formation of technical schools with university status for the training of police. In Austria many of the police in the higher grades hold diplomas in law, and the police school at Vienna is the most famous in the world. The Continent is thus more familiar with the application and uses of academic training for the police, and experience seems fully to justify these academic methods of training.

In police work, of course, as in everything else, theory is merely the foundation upon which sound practical experience can be built. No one would suggest that academic training in itself could suffice, or that a merely academic approach to any problem of criminal investigation would be of any utility.

It is for this reason that, while the theoretical background has been kept in mind, the practical aspect of the subject of technical police has been stressed. A careful distinction has

been preserved between technique which is essentially expert and specialised, and that which falls directly within the sphere of the investigating officer himself. The intention has been to show that scientific method is not only a matter for the medical man, the chemist, the physicist and the biologist.

A book of this kind necessarily suffers from many defects and omissions. It is not a simple matter to produce an elementary text-book on any subject which will meet all the demands likely to be made upon it. This is particularly true of a subject concerning which very little has been published in English. The author will welcome any suggestions for the improvement of the book and will be grateful if his readers will bring to his notice any errors that may be found in it.

SCIENCE AND THE POLICE OFFICER

INTRODUCTION.

In his book *L'Enquete criminelle et les Méthodes scientifiques*, Dr. Edmond Locard relates the following story: During the war he conducted a number of scientific men round a hospital. At the conclusion of the tour he asked each of them if he had observed a clock in one of the wards. All of them had noticed the clock and several remembered the time by it.

There was, in fact, no clock there; it was a moon-faced barometer.

If this is an extreme case it nevertheless legitimately illustrates the very important connection between science and detection. It would be well in the first place to remark that the surgeon would have made no such mistake concerning the details of an operating table, the biochemist none regarding the hydrogen ion concentration apparatus, nor would the microscopist have wrongly described an ultra-microscope had there been one there. But one and all had failed to distinguish through lack of exact observation between a clock and a barometer.

A high degree of specialisation in ~~some~~ particular branch or branches of science does not necessarily confer upon the specialist a scientific habit of mind. Dr. Locard's anecdote is evidence of this. It is of importance to observe in this connection that a group of police officers in a similar situation would not have made this mistake about the clock and the barometer. There are necessarily differences of opinion

as to the ideal method of training a police officer, but it is generally agreed that the training and work of a police officer in any civilised country almost automatically inculcates a scientific habit of mind. The youngest and most inexperienced police constable may at any moment have to apply it. An everyday example such as a street accident suffices to illustrate this. Summoned to the scene of an accident which the constable may not have witnessed himself, he will have to take note of depositions of those directly involved and of witnesses, decide as to the reliability of the statements of the principals, examine the scene for collateral evidence in support of the statement of one party or another, and report accurately and impartially upon the facts so far as he is able to ascertain them. This is fundamentally the work of a scientific man. Because, after all, the scientific method whether applied to mathematical physics, criminal anthropology, or the taking of evidence is the same; to observe and describe without personal bias, to separate fact from probability, and to concentrate upon those things relevant to any enquiry. Beyond the specialised knowledge the police officer is bound to acquire he is further trained to do this. To what extent the present training suffices is naturally a matter of opinion, but the fundamental necessity of scientific training in this sense cannot be denied and is, indeed, fully recognised throughout the civilised world.

That it has not until recently been recognised even by the police themselves that police work is essentially scientific perhaps accounts for the fact that closer co-operation does not exist between the scientific man and the detective. Even to-day a considerable amount of misunderstanding exists. It is but a few months ago that an eminent French detective had some very caustic things to say about the application of science to police work. This is very largely due to the fact that the policeman knows very little of the work of the scientist, the scientist practically nothing of that of the policeman. There is a good deal of traditional prejudice on both sides

The scientific method in connection with police work is by no means a modern invention. As long ago as 1862 an Italian detective named Domenico Cappa made a scientific study of the measurement of footprints, and he was as a matter of fact a good deal laughed at for his pains. A series of particularly brutal murders, however, had been committed in Turin and no clue to the culprits could be discovered. After the last murder Cappa succeeded where his colleagues had failed in tracing the murderers by making careful examination of the ditch where the victim was discovered and making elaborate measurements of the footprints. These he was subsequently able to compare, some time after the prints had been obliterated, with the boots of the suspects. As a result two men, Gian Battista and Antonio Garesio, were arrested and convicted of the crime. It is interesting to compare this case with the unfortunate affair of John William Hebron, tried for the murder of a policeman in Manchester in 1876. William Hebron was actually convicted upon the evidence of a footmark found in the mud which one of his boots was said to fit exactly. Many years later Charles Peace confessed to this murder and William Hebron, who fortunately was not executed, was liberated from prison and compensated. In the case of Cappa scientific methods of measurement had been employed. In the Manchester case a lack of them had very serious consequences. A later chapter will deal with the scientific measurement of footprints in detail.

Cappa was more fortunate than Detective Whicher, who might be called the second victim of the famous Kent mystery of 1860. Whicher understood the scientific principles of taking evidence, and he suspected Constance Kent from the beginning of the inquiry. His suspicions, contemptuously set aside at the time, afterwards proved fully justified by the dramatic confession of the girl. The confession, however, came too late to vindicate the reputation of the most able detective then in the Service. He died shortly after his resignation (a direct result of the severe criticism he incurred) it is said, or a broken heart. There

was never a case where scientific methods were more needed. That they were not employed is scarcely surprising at that time, but the almost incredible negligence with which the preliminary inquiry was carried out was not the least remarkable feature of this remarkable affair.

Since that time scientific methods directly or indirectly relating to the detection of crime have rapidly developed, but it cannot be said that the co-ordination of specialised scientific technique and criminal investigation in the field is really much more satisfactory than it was in 1860. The policeman and the scientific man do not yet know enough of each other's work to appreciate the importance of co-operation. This is abundantly clear when it is recalled that there exist scientific men who have stated that important investigations ought not to be in the hands of the police at all, but should be conducted by independent scientific experts. No one with even an elementary grasp of the problem is in any danger of taking statements of this kind very seriously. But that this extraordinary fallacy should also have crept into fiction in the guise of describing the so-called scientific detective as the resolver of all problems while his colleague, the policeman, is represented as little better than an imbecile, is further evidence of bias.

Public opinion, however, and much scientific opinion as well, would accept with no great confidence the findings of independent scientific experts in the matter of criminal investigation, and it would probably be right.

Theoretically, of course, it ought to be wrong, but it remains true that no scientific training, however thorough and comprehensive, can ever replace the practical knowledge and experience of crime and criminals gained only by contact with them. The method of starting every constable at the bottom and leaving him to work his way up has been severely criticised, but the results of it have not been so unsatisfactory as is sometimes supposed.

This, however, does not do away with the necessity of scientific training. When all is said and done there is hardly a case of any importance where the co-operation of some

scientific specialist is not required. Scientific methods seldom if ever solve a problem, but they do what is often more important, convert a suspicion into a certainty by supplying a vital fact. The recognition of the importance of science is, however, no longer sufficient. What is required is at least an elementary knowledge of science in the police themselves. A section of Hans Gross' classical work *Criminal Investigation* is entitled "The Expert and how to make use of him." But Professor Gross was himself an eminent scientific man. He recognised that the police could not make use of the expert without having an elementary knowledge of the expert's work.

Intelligently made use of, a little learning is not a dangerous thing, as the proverb has it. It cannot be expected of the police officer that he should become a trained scientific man in any specialised sense, but an elementary grounding in scientific principles would make it possible for him to understand the scientific man's point of view and make the best use of his knowledge in the manner which Hans Gross has suggested. Much of the misunderstanding as to the nature of scientific method and the extent to which it can be applied to criminal investigation is due to the fact that its function is not properly understood. Blindly to accept the dogma that science is essential to this or that will be as barren of result as to deny, ignorantly, to science any usefulness at all. This is still the problem of many European countries in regard to their police organisation. Opinion is sharply and about equally divided between the scientific and the non-scientific; those who think that in some magical way science can solve every criminal problem, and those who suppose that it is mere theorising, and very elaborate and confusing theorising at that. The remedy is obvious. The police officer with a fundamental grounding in scientific principles can arrive at a competent decision for himself.

From a practical point of view the same seasoning applies. If scientific methods are to be employed the police officer has to prepare the way for the scientific man. He cannot

very well do this if he knows nothing of scientific technique. The examination, chemical and microscopical, of dust is a good example with which to begin. It was again Hans Gross who first directed attention to this branch of investigation. He cites the case of a waistcoat found on the scene of a crime. The dust was extracted from it by means of beating the garment in a brown paper bag. The dust was found to consist of fibres of cellulose mixed with gelatine. It was thus concluded that the owner was a woodworker, while the presence of gelatine (glue) suggested that he was a cabinet maker. This deduction was afterwards confirmed.

Thanks to the work of Locard, Türkel and others the examination of dust is now a very important factor in criminal investigation. But where the scientist is not himself on the scene of the crime the policeman has to collect such evidence for him. Precautions are obviously necessary when handling articles which have to be examined by such delicate scientific methods, and a knowledge of those methods is necessary for the policeman if he is to appreciate the precautions which may be required in any particular case.

Locard's case of the dandelion seed is a good example. The police were not at first able to trace the murderer of a peasant who had been found dead in a field near Lyons with a knife in his heart. Later a man was arrested with, however, no other evidence against him than that he was a vagrant of no fixed abode and that there was a very small patch of blood on his waistcoat. Conclusive evidence was, however, obtained, by an examination of the right sleeve of the suspect's coat. There was found upon it a minute dandelion seed of the very rare Order of Compositae. On the scene of the crime a dandelion plant of this Order had been discovered. Confirmatory evidence was obtained in this way. The police in charge of the investigation were aware of the value of scientific evidence. Had this not been the case the coat of the suspect might never have been examined, or, if it had been, this minute but vital piece of evidence might have been lost.

There are circumstances in which the police officer may actually have to make a scientific examination himself. A knowledge of toxicology is of great value to the police and he should certainly know something of the common tests by which poisons are detected. This question will be considered hereafter.

The question of handwriting is also one of very great importance. The day of the old-fashioned "handwriting expert" is over and the study of handwriting, if it is not yet an exact science, is one which is founded upon mathematical and physical principles. There may be, and frequently there are, circumstances in which the police will wish to decide very quickly whether a document which has fallen into their hands is likely to be genuine or not. A handwriting expert may not be available and in any case his report will take time. An elementary knowledge of the principles of the examination of handwriting may be of the greatest assistance to the officer in charge of the investigation. In any case he ought to have sufficient knowledge of handwriting to be able to form some preliminary conclusion before consulting the expert.

The handling of pieces of paper which may contain messages in secret ink requires considerable precaution. Messages may be defaced or even rendered illegible if they are unsuitably treated through ignorance before they reach the laboratory. This is another example in which a knowledge of the chemicals employed for secret writing is of use to the police officer.

As a result of the widespread forgeries of bank-notes which took place in Germany in 1926 the banks installed ultra-violet lamps with a view to deciding quickly between genuine and forged notes. The ultra-violet lamp is an apparatus which has become of first rate importance in the technique of criminal investigation. The lamp can be used for the examination of suspected writing, for the deciphering of messages written in secret ink, and for the examination of the paper of bank notes and other instruments suspected

to be forged and it is indeed the quickest and most effective method of detecting many kinds of forgery.

The fluorescence produced by the ultra-violet ray, a phenomenon which will be discussed in detail in a subsequent article, is applicable to many other investigations besides cases of forgery. There are circumstances in which it can usefully be employed by those who are not scientific specialists and it is certainly desirable that the police officer should know something of the Wood Light. Most of the ultra-violet ray tests cannot be properly interpreted except by an expert, but in circumstances where an expert is not available the police officer by applying a test himself might be able to arrive at some preliminary conclusion.

The microscope has been one of the earliest allies of criminal investigation. It is only necessary to recall the Orrock case of 1882, famous in its day but now almost forgotten. The circumstances were that on December 1st of that year a policeman named Cole was on duty in Ashwin Street, Dalston. He saw a man climbing over a wall whom he suspected of an attempted felony. Cole attempted to arrest the man who struggled with him and finally drew a revolver, firing three shots. These all missed the constable, although one penetrated his truncheon case. Later his assailant fired a fourth shot which proved fatal. The murderer escaped and could not then be traced.

Various articles were found on the scene of the crime. There was a black felt hat, a fragment of bullet in the truncheon case, and two chisels. One of these proved to be the vital piece of evidence. A careful examination revealed some scratches on the chisel at the point where the blade entered the handle. It was impossible to decipher these with a naked eye, but under a powerful magnifying glass the letters "Rock" were decipherable. With this small clue in their hands the police visited all the tool manufacturers and tool sellers in the neighbourhood of Dalston. It was not, however, until a year afterwards that the chisel was traced to a small shop kept by an old woman named Preston. She explained that all the tools sharpened in the shop had

the name of the owner scratched upon them. After examining the chisel and the letters "Rock" she remembered it had been left in the shop by a young man named Orrock. This man was known to the police and confirmatory evidence was quickly obtained. A further and more careful microscopical examination of the chisel revealed the missing letters "Or." Orrock was tried and convicted.

Some training is necessary in order to use the microscope properly, but it is nevertheless true that once its comparatively simple technique is mastered it is an instrument which can be used by anybody. The higher branches of microscopy are as specialised as any other kind of scientific knowledge, but as the Orrock case shows there are circumstances in which the microscope can profitably be used by those who are not experts. An elementary knowledge of microscopy is indispensable to the police officer.

With some further training the technique of photomicrography can be mastered. It is, however, essential to observe here that satisfactory photo-micrographs, even of simple objects, cannot be taken without considerable knowledge and experience. Those with a taste for photography, however, are generally able to master the technique. Photo-micrographs very often reveal evidence which an ordinary visual examination through the microscope fails to detect. The Orrock case may again be cited. The scratched letter on the blade of the chisel appears very much more clearly in the photograph than on the chisel itself.

Photography of all kinds is in fact becoming of increasing importance with every kind of criminal investigation, and, as Hans Gross has remarked, every police officer without exception should be able to use a camera. The scene of the crime, any important details in connection with it, footprints, fingerprints, blood-stains, and suspicious articles left on the scene of the crime ought to be photographed as a matter of routine. It is the practice in some parts of England not to photograph footprints, but to rely entirely upon plaster casts. This is an exceedingly unsatisfactory procedure. In any case, photography is not used to the extent

that it might be, and in all cases where it is possible metric photographs should be taken.

Dr. Ainsworth Mitchell has reminded us that in early trials the evidence regarding bloodstains was not as conclusive as it is now. He cites as an example of the trial of Thompson, Pain and Farwell, charged with libel in 1682 after the trial of Robert Green for the murder of Sir Edmund Godfrey three years earlier. One of the witnesses for the prosecution stated in his evidence that he was shown a ditch where there was some blood. He was unable to say whose blood it was and going a little further he saw some more "whitish" blood in another part of the ditch.

Then and for a long time afterwards evidence regarding blood-stains no more conclusive than this was accepted. In the twentieth century when Precipitin Reaction is a commonplace of murder enquiries it is possible to give the Court precise information regarding suspicious stains, not only as to whether they are in fact blood, but as to whether they are human blood or that of an animal. It is the duty of the police to examine the scene of the crime and to locate blood-stains. A certain amount of scientific knowledge is desirable and indeed necessary to conduct such an examination to the best advantage. The Precipitin Reaction is very delicate and it is necessary that the greatest precautions should be taken in collecting the blood-stains. Those without a knowledge of the principles of the bio-chemical examination of blood cannot be blamed from neglecting precautions in collecting samples of which only a scientific knowledge could make them realise the necessity. There are not a few cases on record where samples of blood have reached the laboratory in a condition which caused the analyst serious difficulty and even rendered his tests unreliable.

Finger-prints will of course be made the subject of a subsequent chapter. It may, however, be observed here that the uses of the microscope and the camera in connection with the identification of skin impression has not by any means reached its final phase. The poroscopic method of Locard has not yet been employed to any great extent in Great

Britain, and a considerable knowledge of photo-micrography is necessary before it can be usefully employed. In many cases, however, it makes identification possible where satisfactory finger-print evidence is lacking, and it is therefore a method with which every police officer ought to be acquainted.

This introduction has been an endeavour to show the relation which exists between science and criminal investigation. It is clearly necessary if the police officer and the scientific man are to work in harmony that each must know rather more of the other's work than either knows at present. Both are required for the conduct of any important enquiry and the closer the co-operation between them the more satisfactory will be the result.

Some of the more important scientific principles and technique commonly employed in the detection of crime have now been indicated. An elementary knowledge of these principles will not only assist the police officer directly in his investigations, but will also make it possible for him to employ the expert to greater advantage when it is necessary to consult him.

A course of training for the police officer might well include training of the use of the camera and particularly the technique of metric photography; the use of the microscope and its accessories and the taking of photo-micrographs. This might be followed by some instruction in the theory of X and ultra-violet rays and in the use of the Wood Light, and the taking of radiographs.

It is impossible for the police officer to receive any very satisfactory training in connection with examination of handwriting since the subject is highly specialised, but it would be desirable, all the same, that he should receive some instruction as to the modern principles upon which the examination of handwriting is based.

Since cases of poisoning are very common it is essential that the police officer should have some knowledge of toxicology, and that he should also understand the modern bio-

chemical methods that are made use of in the examination of blood, seminal, and other stains.

With such training and knowledge at his command the police officer will be able to appreciate and realise to the full the possibilities of science when applied to criminal investigation.

THE USES OF THE CAMERA.

Apart from its specialised application, photography is in general of very great importance in criminal investigation of all kinds. There are circumstances in which even an amateur photograph may be of great value. In this connection we may recall the case of the Englishman accused of the murder of a Brazilian friend when both were sailing in a small yacht in the harbour of Rio de Janeiro. The Englishman returned with the dead body of his friend, and since they had quarrelled seriously a day or two before, the case against the Englishman looked very black and he was arrested and tried. The appearance of the wound on the Brazilian's head was consistent with the view that he had been struck on the head with some blunt instrument. The accused, on the other hand, asserted that his friend had fallen from the masthead.

By a fortunate accident a photograph had been taken of the harbour while this boat had been sailing. The photograph showed a black spot against the white sail. It was enlarged and proved to be the figure of a man actually falling. This curious coincidence resulted in the acquittal of the accused.

It is not, of course, generally possible to apply the camera to so contemporary a circumstance relating to a crime or misdemeanour. Some years ago, however, the English police made a number of arrests in connection with offences against morality in public parks and other open spaces. The charges were sometimes denied by the accused, and it was suggested in one case that if photographs could be taken by the police where circumstances permitted, all difficulties in connection with the evidence would be removed. Cases when photographic evidence could be obtained are exceptional, but where it could be supplied its value would be obvious.

In cases of riot, other breaches of the peace, and even in some examples of common assault, photography may be of vital importance. The difficulties are considerable, but if it

were possible on occasions when the police are called out to restore order for a photographer, or better, a cinematographer to accompany them to make a photographic record of the proceedings, very useful evidence obtained *in situ* may be made available. In subsequent legal proceedings the evidence of eye-witnesses may be, quite unintentionally, so misleading as to be useless. The camera, having no emotions, may supply just the evidence required. As example there is the well-known case of the cinematograph film which actually caught the assassinator of President McKinley *in flagrante delicto*.

A very imperfect photograph from the technical point of view may yet be invaluable as evidence. A witness, policeman or civilian, of common assault who is in a position to take even a hurried snapshot of the affair may discover that it has recorded essential facts. The result may be blurred and indistinct, but be sufficient for the purpose of general identification and may in addition record the actual blow or other act of violence concerning which unassailable evidence is required.

It might fairly be argued that cases in which photographic records can be obtained in such difficult circumstances are rare. This is certainly to some extent true, but it is also true that they would be less rare if the importance of such evidence were fully realised, and provision made for supplying it wherever possible. It is, perhaps, not practicable to equip every police officer with a camera, but if this could be done and the constable were given an elementary training in its use, he would find it an invaluable aid to his work.

Even in such elementary cases as road accidents disputes very frequently arise. The position of the vehicles involved in relation to each other and to the surrounding objects is often of great importance in arriving to a decision. There is no better method of recording this than a photograph, provided always that it is supplemented by careful notes relating to distances. The camera used for such purposes need not be large. Excellent results can indeed be obtained with many of the small folding cameras now on the market

which can be carried easily in a hip pocket. Enlargements are, of course, essential, but these present no particular difficulty.

In the large majority of cases, the police officer does not witness the crime but is summoned to investigate after its commission. In these circumstances a professional police photographer will generally be available, but if for any reason there is delay in his arrival, as there may be in affairs of murder, housebreaking, and entry or robbery by violence, in lonely and remote districts, the police officer may have to deputise. The importance of taking photographs of the body and of the scene of the crime at once or with the least possible delay cannot be too strongly emphasised.

It is very difficult to lay down any rule as to the extent to which ordinary photography as distinct from definitely expert technique can be applied to an investigation. A great deal depends upon circumstances. It may be said at once, however, that in the absence of the expert the efficient amateur can produce very good results. In cases of serious crime the ordinary pocket camera is, of course, of very little use, but any reliable folding model of half or even quarter-plate size will produce satisfactory photographs in the hands of those accustomed to its use. It is not the function of an article of this kind to discuss the technique of ordinary photography. Such information can readily be gained from numerous books written on the subject, and practice will make perfect. But it is of importance here to indicate what kind of photographs should be taken and why.

In affairs of murder it is essential first to record the position of the body itself, and, secondly, that of the body in relation to surrounding objects. Whenever possible photographs should be taken on each side so that the disposition of both the right and left limbs and of the clothing is clearly shown. It is desirable that the photographs should be taken at the closest practicable range. Details are often important and much may be lost by too small an image. In this connection it is well to remember that although enlargement is always practicable, provided the negative is reasonably good, en-

largements always lose something in sharpness, and the greater the enlargement the more pronounced is the blurring effect. For this reason, if for no other, the advantage of a close range photograph will be evident.

The photographing of the body in relation to surrounding objects is a much more difficult matter. There is only one really satisfactory method of making such a record, and it is one to which recourse is not always sufficiently had: the photography of the body from above. Only by means of such a bird's-eye view is it really possible to present an intelligible idea of the actual conditions under which the body was found. A ground plan can, of course, and always ought to be made, but it will necessarily lack much which the photograph records. That is the advantage of photography: it misses nothing.

It is always difficult and sometimes impossible to take such a photograph, but it should be attempted if practicable at all. If a telescopic step-ladder is available it can generally be done. A simple method is to fix two long but narrow pieces of wood to the top of the ladder, or at any convenient distance along its height so that they project horizontally in respect to the ground or floor. The distance apart will be arranged so that the body of the camera can rest upon and be secured to these supports. In small rooms it is sometimes possible to insert rooks high up on opposite walls connected by two parallel lines of wire. To these two wires the body of the camera can be secured. The camera, of course, must not be so close to the ceiling as to make it impossible to focus the image. This is in any case by no means easy, but with the aid of a ladder it can be done. Exposure requires precaution in both arrangements. The camera will not be rigid and is easily disturbed. It is desirable to control the shutter from the ground by means of a long tube and bulb. To take an instantaneous photograph in such circumstances is not difficult, but time exposures require great care to avoid disturbing the camera. These makeshifts, of course, presuppose the lack of a special stand.

It is always highly desirable and in some cases essential

that the camera be at right-angles to the object photographed. Photographs taken obliquely are not necessarily useless, but owing to the distortion which results they are often very misleading. Relative distances and size are important and an oblique photograph will not present them correctly. It is not true that a photograph never lies.

A photograph properly taken in this way will possess many of the advantages of a ground plan. Though it will necessarily be less comprehensive in range, it will be more so in detail.

The question of metric photography follows. Metric photography presents no particular difficulties and all photographs should include a test scale. It is only necessary to mark pieces of narrow strong paper accurately in millimetres and centimetres or inches and appropriate fractions of an inch and secure it in a suitable position, care being taken that the paper lies absolutely flat. When the photograph is taken the scale should have been so placed that it appears on the negative, preferably along the edge. Paper scales should be marked with Indian ink, and the figures and description of the scale used written in large characters, an obvious convenience for reading them afterwards.

The value and utility of metric photography cannot be exaggerated. Independent measurements can be checked against it and it provides a permanent and exact record of the state of things prevailing at the beginning of the enquiry.

If the murder or other crime has been committed within doors, it is necessary to take photographs of the approaches to the house and of the entry if it is known, or the suspected place of entry (i.e., in the case of accomplices within the house) if it is not. In photographing so large an object as a house or even a door it is not necessary that the metric scale should lie along the whole length and breadth of it. It will be sufficient if a yard or metre of paper marked with its appropriate fractions appears on the photograph. All doors and windows which show sign of forcible entry should be photographed at the closest possible range.

These are all examples of photographic technique which are within the competence of a photographer who is not an expert. This is not to say that work of this kind can be undertaken by a beginner, but with a little training, practice, and common sense such work can in emergency be carried out by those without specialised training in photography.

The same can hardly be said of the photography of traces but it is appropriate to allude shortly to this aspect of the work. Leaving aside foot and finger prints, blood-stained weapons, marks in dust, scratches upon locks, woodwork, or glass are all indications of which a photographic record will have to be made. We will deal only with blood-stains and marks in dust.

A large blood-stain or even a collection of smaller stains can be photographed without much difficulty, providing they are accessible. The closest range should be used and the metric scale. Traces in dust are often very valuable as evidence, and the investigating officer can at least make a careful search for these and perhaps arrive at some conclusion of the practicability and desirability of photographing them. This is a matter in which investigator and photographer have to co-operate closely. It is often extremely difficult to discover these traces. They are generally to be found upon highly-polished surfaces where dust has accumulated. Very careful examination, preferably in a darkened room and with sharply oblique illumination from an electric torch, is the most likely to succeed. Every possible precaution must be taken to preserve the impression, since a draught of any kind, not to mention other accidents, may destroy it. The trace should be covered with a cardboard box larger than its greatest area, and it should be photographed as soon as possible with a metric scale.

Arrests can occasionally be made upon evidence supplied by photographs of these impressions in dust. They may represent a characteristic weave of cloth produced by the elbow of a jacket or trouser knee. An enlargement of the photograph is made and a count of the threads taken per

centimetre. This count and the pattern of the weave will often serve as a means of identification of a suspect when no other evidence is available.

There is another aspect of photography of which the full possibilities have by no means been exhausted. This is the taking of the "contact" photograph. The actual procedure is so simple that it merits some description here. The simplicity of the technique is liable to induce the belief that anyone can carry it out. It is quite true that those almost without experience can obtain mediocre results, but in this direction mediocre results are useless and they may be dangerously misleading. Contact photography has many uses mostly in connection with the examination of suspected documents, and it is only applicable to such things as leaves of paper and envelopes which can be enclosed in a printing frame or similar piece of photographic apparatus.

The procedure is to place the thing to be photographed in a printing frame and to put in contact with it a film or plate in the dark room. The printing frame is then closed and the whole exposed to the light for a period depending upon the opacity of the object. The frame is then again opened in the dark room and the plate or film developed in the ordinary way.

This method is very useful for photographing envelopes which are suspected to have been opened and regummed. A contact photograph will show the gummed flap which will in a normal closure be of uniform thickness. In a regumming the adhesive material is generally irregularly applied. This will appear in the photograph, since where the gum is thicker darker patches will be visible. This must not be accepted as a rule without exceptions. Expert openers of letters never apply raw gum to reclose them, but the moistened gum from another envelope. This generally escapes detection.

In examples where it is suspected that a message has been written under a stamp—by no means an unknown subterfuge—contact photograph and an enlargement is desirable. To remove the stamp may be very unwise. The writing is

necessarily small and the steam or water applied may cause the ink to run and thus make the writing illegible. A contact photograph cannot change it in any way. It must be borne in mind that the contact method photographs *everything* that is in contact with it, so that in such an example any writing on the notepaper inside corresponding to the position of the stamp will also appear. This, while it complicates the deciphering of anything written under the stamp, does not make its elucidation impossible.

In cases where mechanical erasure has been made with or without the addition of forged characters a contact photograph is often the most satisfactory method of revealing it. It is by no means always possible to detect the manipulation by holding the paper up to the light. The writer recalls a case within his own experience in which a mechanical erasure had been made upon paper of good quality of the parchment type. This paper has naturally an irregular opacity in patches. Although the forgery involved only a small sum, it had been skilfully carried out and the erasure could not be detected with any certainty merely by examination with transmitted light. But a contact photograph revealed a definite differentiation of tone in the neighbourhood of the erasure which was afterwards confirmed by other means. A photographic plate or film is a very delicate and selective instrument where varying degrees of illumination are concerned. With proper precaution in regard to exposure and development it will frequently reveal what the eye has missed.

Contact photography of water-marks upon suspected Treasury notes will often reveal the forgery at once. Abnormalities in the outline of the water-mark are shown up more distinctly than by ordinary methods of photography. The structure of the paper is also brought out with great distinctness. This is generally one of the most important points in arriving at a decision.

From the foregoing examples it will be obvious that contact photography is capable of very wide application in

criminal investigation. It has the great advantage that quick results can be obtained.

It has already been pointed out that the procedure is fundamentally simple. Many precautions, however, are necessary in using this method or the result will be useless or so difficult to interpret as to be practically useless. The examination of a document for erasure provides a good example. Since the light is transmitted through the paper and since even the best paper is not uniform in opacity, errors in exposure or in making the contact in the frame may produce very unsatisfactory results. The plate is very easily fogged and the greatest care must be taken in the exposure. These are among the precautions to be considered.

An ordinary printing frame of a larger size than the film to be used should be employed. This must, indeed, be chosen to suit the document. It should be fitted with a piece of absolutely colourless glass which must be scrupulously clean, since any fingerprint or smudge may appear on the negative. The document to be photographed is placed upon this and afterwards the plate or film with the sensitized side in contact with it. The ordinary back to the printing frame is useless for contact photography since the light enters at the hinged opening. Nor must the back carry the short metal pegs which hold it in place to enable the back to be opened for the purpose of viewing a daylight print. It is preferable to have a piece of wood specially cut to fit the frame with about a millimetre clearance all round. This is covered with several thicknesses of black light-proof paper so that it afterwards fits the frame tightly. In the present writer's experience this is the only satisfactory method of protecting the back of the frame from light which if it enters there will spoil the photograph. As an additional precaution it is advisable to muffle the back of the frame in a black cloth when making the exposure.

The document or envelope must be in uniform contact with the plate or film. This can be ensured by pressing in the back sufficiently tightly. If the document is not completely flat there will be uneven illumination in the frame

which may produce misleading results. No definite rules can be given regarding exposure. It depends entirely upon the amount of light which will pass through the paper to be photographed. Almost every individual case will require different treatment. Daylight exposure is, however, to be preferred in the majority of cases, since it gives better contrast.

Contact photography is also applicable to fingerprints discovered upon glass or paper. These should be developed with red lead, placed in the frame, and exposed with the same precautions mentioned above. This method, which has much to recommend it in certain circumstances, will be considered more fully in a later chapter.

Those with some experience of photography, after a short period of training and practice, should be able to master the technique. Contact photography properly carried out does not damage a document in any way. It is, however, important that the contact frame should be of sufficient size to contain the matter to be photographed entire. This practice of forcing the part of the document to be exposed into a frame too small for it and pressing the back in so that the protruding parts are creased or even torn is not to be recommended. It is rarely that documents of greater size than quarto or, at most, foolscap will be involved. Frames of this size are quite convenient to handle.

There are other and more technical aspects of the subject which it may be well to notice here. Contact photography can sometimes be employed with success in the development of faded writing. It is often the practice of the forger to "wash" a document. That is to say, to remove some or all of the writing with a bleaching agent and replace it with other words or figures. It is in many cases possible to restore the original text by treatment with reagents. In the case of iron gall ink it is the colouring matter only which is removed. The iron salts remain upon the paper. By treatment with potassium ferrocyanide the faded text reappears in blue. The degree of success, however, depends upon the numerous factors which include the type of iron gall ink

used, the age of the document, and the conditions under which it has been kept prior to the examination. In some cases, although the original writing can be redeveloped, it is so faint that it cannot be deciphered. The fine detail that a good contact photograph can supply is often of assistance here, and what is not legible upon the paper itself may stand out more clearly in the photograph. It is usual in such circumstances to take three or four photographs and superimpose them.¹ This triple or quadruple negative will produce a print upon which the text is legible. There are conditions under which the ordinary photograph, triple or quadruple as the case may be, is more suitable, but the contact photograph is often better.

Photomicrography is a branch of science now applicable to criminal investigation in many important ways. It may as well be said at once that its technique is difficult to master and almost that a good photomicroscopist is born and not made.

A clear distinction must be made here between the actual technique of photomicrography and the interpretation of the results. The technique itself calls for manipulative skill; the interpretation of the results for specialised knowledge of the branch of science with which the photomicrograph is concerned. To employ an illustration, a microscopist might produce an excellent photograph of a small quantity of dust which had been submitted to him, but he might not be able to make a report as to the nature of that dust after he had photographed it. Bacteria, fungus spores, starches, textile fabrics, physiological debris and so on have characteristic microscopical forms which require an expert not only in microscopy but in the particular branch of science concerned to recognise and interpret them.

On the other hand, there are the microscopic results which can be interpreted more easily. The Orrock case quoted in the last chapter is one of these. It was a question of magnifying for the purpose of making clearer lettering which could have been deciphered by anyone if it were made sufficiently distinct. Counterfeit coins may in some cases provide

¹ See page 111.

another example. A minute but characteristic fault in the casting unobserved by the naked eye may speak volumes when magnified and photographed. No specialised knowledge will necessarily be required to interpret its significance.

Since the technique of microscopy will be considered in some detail later, it is not necessary to describe the microscope here. The principle of the apparatus is understood by most people, which will be sufficient for the present purpose.

Briefly, the technique of photomicrography depends upon attaching to the microscope a camera with long extension bellows in such a way that the microscope replaces the lens of the camera. This is not the only form since of recent years a small camera of special construction can replace the more cumbrous apparatus. This can be affixed to the microscope, and is so light that no stand is necessary to hold it. It is a great convenience since the microscope can be operated in any position with the greatest ease. The object to be photographed is first focussed under the microscope, the attachment to the camera is made, and the image focussed on the ground glass screen in the usual way.

The source of light is always, or nearly always, artificial. It consists essentially of an electric lamp within a metal lantern provided with a lens to intensify the illumination. The direction of the illumination is either from behind so that the light passes through the microscopic slide with the object upon it, or in the case of opaque material it is reflected upon it by means of a condenser. Articles which the police commonly examine, such as scratches upon weapons, faults in coins, and documents, will require to be examined by reflected light.

On the face of it the procedure appears simple enough, but in practice many difficulties arise. Focussing the image requires much more delicate management than is the case with ordinary photography, nor is it possible to decide without experience what, in fact, is the exact point of correct focus. This is particularly difficult in photographing indentations in metal or holes in coins. The entire field to

be photographed is not in the same plane, which very much complicates the problem of focus. Only judgment founded upon experience can settle such questions.

Vibration is also a serious difficulty. Insignificant movements which would have no effect upon the ordinary photograph will entirely ruin a photomicrograph. The insertion of the dark slide with the plates, if not carefully done, will disturb the focus, and blur the photograph. A photograph which is not perfectly focussed is of no value.

For documents a special frame replaces the ordinary stage which holds the microscopic slide. It is adjustable and independent of the microscope so that any portion of the writing or paper can be brought within the microscopic field.

The methods of illumination employed are very varied. In the case of coins and weapons, uniform illumination of the surface is generally desirable, but for indentations on paper and some cases of the examination of pen and pencil strokes sharply oblique illumination is necessary. In the recent case of Podmore the indentations on the page of a receipt book had thus to be illuminated in order to make the characters legible. It is worth remarking in this connection that, without this refinement of photographic technique, Podmore could not have been convicted.

The method usually adopted is to take the photograph in a dark room. The illumination is a thin pencil of light from an electric lantern with an iris diaphragm stopped down to one or two millimetres. This slender pencil of light is directed upon the paper at a sharply acute angle. Oblique illumination is also used in cases where it is required to decide which of two crossing pen strokes is uppermost, a question often of vital importance in cases of forgery.

Where dust has to be photographed through the microscope transmitted illumination is generally, though not always, required. This is a matter of particular difficulty for non-specialists because the dust may present quite a different appearance under the microscope from that which even examination with a lens will reveal. Dust which contains starch is an example. It is only under a powerful

magnification that its true form, a colourless more or less spherical granule, varying in size with different types of starch, is apparent. What is true of starch is true of many other substances likely to be found in dust. Such disconcerting revelations will increase the difficulties of those who, however great their manipulative skill, have not specialised knowledge of the phenomena presented.

It is nevertheless true that for the technique of photomicrography *sui generis* it is manipulative skill which is the first essential. A really expert amateur photographer who has mastered the technique of the microscope itself can become an efficient photomicrographer at least in its more elementary stages. As such things go, the photomicrography of scratches on weapons or locks, of coins and the simpler cases of the manipulation of documents are elementary branches of photomicroscopy, a working knowledge of which can be acquired in a comparatively short space of time.

The technique of the radiograph remains to be considered. Radiography has not been extensively used in connection with criminal investigation, and it is, indeed, doubtful if the expense involved for the apparatus is really justified. Its application is limited. There are some cases, however, in which it is of value, the examination of bombs being notably one. It is often unsafe to open an unexploded bomb unless the nature of its mechanism is first known. A radiograph is often the only means of deciding this. The method of taking a radiograph is an elaboration of the technique of contact photography. Films enclosed in a special pack are employed. This is placed in contact with the object to be radiographed and the whole exposed to a stream of X-rays. The manipulative details are generally simple, which is more than can often be said for the interpretation of the results.

The most promising development of the use of X-rays has been the examination of fraudulent works of art and of canvasses which have had painted upon them two pictures, one on top of the other. The paint in the more recent work

generally offers less resistance to the passage of the rays than the older work, so that in the radiograph the original picture is revealed. Fraudulent retouching had been detected in this way, and, on the other hand, the presence of older and more valuable work of art under a layer of more recent paint.

Leaving aside, however, its application to the examination of bombs and in some cases other suspicious packages, the Rontgen Rays have not a wide application in criminal investigation.

Photography is becoming an increasing important technical element in the work of the police. There are many directions in which it can be developed, and, as has been shown, many uses to which it can be put, by the police officer; and an elementary knowledge of the science and art of photography should be an essential part of the police officer's training.

THE MICROSCOPE.

It has already been pointed out that the essential function of the microscope is to magnify. In this sense it is the most approachable of all scientific instruments since it obviously gives results which do not necessarily require interpretation by a specialist. It differs in this respect from most other physical apparatus. Mastery of the technique, for instance, of the spectroscope or polarimeter will not suffice if they are to be usefully employed by the operator. In all cases the results have to be interpreted. This is often also true of the microscope, but there remains in the case of this instrument a field of utility outside that of specialised scientific investigation.

But knowledge and mastery of the technique of microscopy is at the same time necessary. The function of the microscope does not differ from that of the lens which can be used by almost anyone. Microscopy, however, has a specialised technique which does require, even in its more elementary aspects, a certain amount of practice and skill. Even everyday magnified objects appear very different according to the way in which the light falls upon them; this is a matter of ordinary experience it is unnecessary to illustrate. To mention but one technicality, the question of illumination is of vital importance in microscopy. Faulty illumination, misleading under ordinary conditions, may completely deceive under the microscope. It is a remarkable fact, however, that even experts trained in the use of the microscope and knowing the difficulties of its use, have not realised the problems it presents to the novice. There are several cases on record where microscopists have taken their instruments into court and invited judges and counsel to look down them. In one case in particular an expert carefully adjusted the focus and illumination with the view of giving the presiding judge ocular demonstration of his point. His Lordship endeavoured to use the instrument and

failed. Nor is this at all surprising. The microscopist had apparently overlooked the fact that the eyesight of individuals may differ sufficiently to require a readjustment of focus, which can only be carried out by the observer himself. Focussing even a low-powered instrument cannot be done without practice; so that it is probable that the judge could see only a blurred image with no significance for him, if, indeed, he could see anything at all. The case, an excellent one, was in consequence lost. Mistakes of this kind do not occur now. The development of photomicrography has made the presence of a microscope in court—never a wise expedient except in very special circumstances—entirely unnecessary.

In order to use the microscope a detailed knowledge of optics is not necessary, but it is desirable to give here a brief description of the instrument itself. Optically it consists essentially of two lenses. The first is the objective, a lens of short focal length, that is to say, one which magnifies at short range, and a second, the eye-piece, so arranged in respect to the objective lens that the magnified image formed by it comes within the focus of the whole system.

These lenses are attached to the tube of the microscope. The objective mounted in brass is screwed on to what is known as the nose-piece; the eye-piece is generally mounted in a collar which slips into the top of the microscope tube. The tube itself is fixed to a stand, and it can be moved up and down for the purposes of focussing. This is carried out by means of what is known as the coarse and fine adjustments. The coarse adjustment is used for the preliminary focussing; the fine, which moves the tube through the smallest fraction of distance required for the final focussing, is very delicate. Small microscopes sometimes only carry a coarse adjustment. To the stand is also fixed a stage which holds the microscopic slide by means of clips. A mechanical stage is a contrivance with adjustments similar in principle to the coarse adjustment, which not only holds the slide but makes it possible to move it so as to bring any part of the slide into the field of vision without touching it with the

fingers. Under the stage is a pivoted mirror which can thus be moved to reflect the light through the slide and system of lenses so as to illuminate the object. These are the essentials of the simplest microscope.

In practice the object to be examined, prepared according to the circumstances, is placed upon the microscopic slide. This is fixed upon the stage by means of the clips. The microscope should be placed in a good, preferably a north, light if daylight is being used to illuminate. The illuminating mirror is adjusted so that the maximum amount of light is reflected from it to illuminate the field. This is judged by the brightness and evenness of the illumination when the eye is applied to the eye-piece. Practice will accustom the operator in determining this and making the necessary adjustment of the mirror. No explanation can replace that. In focussing the lenses to obtain a clear image, the coarse adjustment is first used. This is accomplished by first manipulating the objective so that it is as near the object as possible without actually touching it. While this is being done the operator does not, of course, look down the microscope, but observes the objective by placing his eye on a level with the stage. He then looks down the microscope and adjusts it first with the coarse adjustment so that the objective recedes from the stage until the correct focus is attained. In no circumstances ought the microscope first to be focussed by advancing the adjustment towards the stage. In nine cases out of ten, and especially with the inexperienced operator, the focus is missed the first time and the objective thus advanced until it presses upon the slide and breaks it. This is in any case an annoyance, and if a liquid is being examined it may damage the stage and the lens. This rule does not apply to the final focussing with the fine adjustment. This may be cautiously moved either up or down. If the first adjustment has been properly made the final focussing of the microscope with the fine adjustment should require only a touch. Whenever practicable the object on the microscopic slide is protected by means of what is known as a cover-slip. This is a piece of very thin glass, square or

circular, placed on the slide over the object. Particles small but not in themselves microscopic cannot, of course, be covered with the ordinary cover-slip. A cell, commonly known as a live box from its use for examining living insects, is useful for this purpose. It consists of a brass slide with a round hole in the middle to which is brazed a brass collar with a glass face fitted to the upper edge. Over this fits tightly, but so that it slides on and off, another brass collar with a glass face. An object small enough to be conveniently placed in this cell, but too thick to be covered by the ordinary slide, can be secured between the two glass faces.

In using the microscope there is another practical detail of considerable importance. The operator should accustom himself to using the right or the left eye indifferently for microscopic examination. More important still, the eye not being so used should not be closed, but allowed to remain passive. These things are sometimes troublesome to the beginner, but with a little perseverance they become a matter of habit, almost of second nature. They are important because the strain on the eyes, inseparable from prolonged microscopic work, is very greatly minimized if this technique is followed.

Daylight is not commonly used for illumination, and in many cases it is quite unsuitable. The intensity of daylight, in any case, varies so much that it is quite impossible to employ it where a consistent effect is essential. Artificial light can easily be controlled, and it is desirable always to use the same source of illumination for general work. This can be supplied by any powerful electric lamp with a suitable reflector. Where circumstances permit it is better to employ a special microscopic lantern which is fitted with a bulls-eye condenser. An electric lamp of moderate power will, with this attachment, provide suitable illumination. We are not for the moment concerned with special illumination. It is of importance to observe here that when using daylight direct sunlight must be avoided. The field can also be too brilliantly illuminated even with artificial light,

and the 'exact degree of light intensity required depends entirely upon the circumstances.

Illumination by transmitted light is not the only method employed in microscopy. From a criminological point of view it is probably not even the most important. Opaque objects such as the surface of metals, thick paper, and textile fabrics must be examined by reflected light. Illumination by reflected light is more complicated than that by the method of transmission already described, but it is essential that its technique should be understood.

In examining the writing upon a document, special illumination is not always necessary. The white paper may reflect sufficient light if a low-powered microscope or objective is being used to make the examination practicable. It should be remarked here that for the examination of documents a frame to hold the paper over which the microscope can be moved by means of a special attachment replaces the stage. In the case described above the object is illuminated in the same way as if it were being examined with an ordinary lens.

But with high-power objectives, and in many other cases, this is not sufficient; it is necessary to provide a more powerful source of illumination lighting up the object from above. This can be supplied by means of a lamp and a bulls-eye condenser. The condenser is mounted upon a stand with a swivel arm by which it can be adjusted at any angle. The lamp is placed between this condenser and the stage of the microscope and the bulls-eye lens so adjusted in respect of the stage and the lamp that the light from the latter is focussed in a bright spot upon the object on the stage. The principle is precisely that of using a burning glass except that the lamp replaces the sun.

The principle is simple, but in practice difficulties arise which only experience can overcome. This is particularly so where high-powered objectives are being employed. In this case the objective is very near to the object and it is not always possible to decide the exact illumination necessary unless the object is actually in focus. Very delicate adjust-

ments are in such cases necessary to focus the light in exactly the right spot. It is sometimes possible to adjust the illumination with a lower power with which, the objective being further away from the object, the operator is better able to see what he is doing; but since the illumination required for low magnifications is by no means always that which is required for the higher powers this subterfuge is not always applicable.

The effects produced by examination with reflected and transmitted light in cases where either are practicable are, of course, entirely different. The microscope in this respect confirms the experience of the naked eye. Everyone knows that, for example, a piece of coloured glass varies profoundly in tint according as to whether it is observed with the light passing through it (transmitted) or the light falling upon it (reflected). In criminal investigation, as in other branches of science which employ microscopy, this fact—to which we shall have occasion to return later—is of very great importance.

Not only the intensity but the direction of reflected illumination effects the appearance of the object examined. This is of great importance to the microscopist engaged in criminal investigation. A good example is an examination of what is known as the sequence of pen strokes. It is often essential to decide when examining a written document which of two crossing pen strokes is uppermost. A decision on this point may establish the fact that a word supposed to be contemporaneous with the rest of the wording on the document was added afterwards. If the first pen stroke was dry before the second crossing it was made it is often possible to decide by microscopic examination which is uppermost. But this cannot be done if the illumination is not very carefully manipulated. The source of the reflected light should be a microscopic lantern with a bulls-eye lens. This should be fitted with an iris diaphragm which is stopped down so that the lamp emits a very fine point of light. The document should be examined in a dark room, the only source of illumination being this thin ray which must be so adjusted

as to strike the pen strokes to be examined at a sharply acute angle. The superimposed stroke stands out more clearly when the document is illuminated in this way.

Illumination of the object is the first essential to be considered on examining such evidence as faint scratches upon weapons. It is a matter of common experience that marks upon metals, paper, or wood which are practically invisible when viewed at certain angles show up with surprising clearness if observed from others. Practically, an excellent method to decide the angle of illumination required is to examine the object with a lens, carefully noting its angle in respect to the light where the irregularities of its surface are most prominent, and to reproduce that angle of illumination on the microscopic stage when making the more searching examination.

From the foregoing outline it will be evident that the elementary technique of microscopy is within the competence of the non-expert. It must also be borne in mind, however, that special work of this kind even if elementary requires some training and experience. Out of this arises the question as to what use the police officer with an elementary training in microscopy can make of his knowledge.

In the first place, there is the use which the police can make of the microscope himself. In this connection the non-expert has some advantage over the specialist. He may wish to collect evidence very quickly which, however, will not necessarily be produced in court but is taken merely for the purpose of following up a clue. The expert before making any report must be absolutely certain of every detail; he has his possible expert testimony to consider. The police officer is not necessarily in this position. Even if his conclusion has not been correct the most that can happen will be the following up of a clue which leads nowhere; a disappointing interrogation, and a certain amount of wasted time, inevitable accompaniments of any criminal investigations. On the other hand, if his conclusion is correct, the promptitude with which it has been arrived at

may result in the arrest of a suspect who would otherwise have escaped.

To quote an example, a typewritten document falls into the hands of the police which upon microscopical examination of the individual characters suggests that it was produced by the same typewriter as another document, the origin of which is known. The second document connects the typewriter with a serious crime. The police officer may not be sure that he is right, and in any case he will send the documents to an expert; but his suspicions have been aroused. A little later the expert confirms the police officer's tentative conclusion, and suspects are arrested or interrogated in consequence. If he does not confirm it, no harm has been done. The vital consideration is that the period of lag, during which the suspect might have escaped, is covered.

Two typewriters of the same age and make often show pronounced differences in the lettering they produce, undetectable to the naked eye, which the microscope will reveal. Conversely, every typewriter has individual characteristics often sufficiently obvious for the non-expert at least to suspect if he microscopically examines two examples of its script.

Even in some cases of forgery a microscopical examination may make it possible for the police officer to arrive at some preliminary conclusion. The frontispiece of my book *Some Persons Unknown* representing a figure seven turned into a nine is an example where investigation by a non-expert would clearly arouse suspicion in his mind. This is a glaring example and all forgeries are not by any means so clumsy. But there are a multitude of cases where forgery without being palpable would be almost certainly suspected after a preliminary microscopic examination.

Marks upon watches and jewellery, knives, revolvers, and tools often do not require expert interpretation at all. It is merely a matter of revealing them by magnification. The Orrock case previously quoted is an example. Any scratch upon a weapon or other metallic exhibit is always worth a little elementary research.

The microscopical examination of occupational dusts does not generally fall within the scope of elementary microscopy, but in exceptional cases it may do so. In the case of metal workers including coiners very fine metallic dust is discoverable in their clothing. In these investigations the metallurgical chemist is the ultimate court of appeal, but a preliminary microscopical examination will often show that the dust does contain metallic particles. It is important to note here that reflected illumination is necessary. Under transmitted light metallic dust is unrecognisable. It would appear as black particles quite indistinguishable from other dust. Under reflected illumination it will reveal itself brightly lit up, however small the particle. This alone would not establish the fact that the dust was certainly of metallic composition, but it would be useful preliminary evidence. It is a good illustration of the important bearing which illumination has upon investigation of this kind.

It will now be clear that there are a number of directions in which the police officer, trained elementarily in the work, can utilize the microscope. It will therefore perhaps be of some interest to indicate the types of microscope likely to be useful for police work. It can in the first place be laid down as an axiom that the high-powered instruments are not necessary. They are indeed undesirable. The oil-immersion objective, for example, cannot be usefully employed by those without considerable training and experience. Biological and bacteriological examinations hardly fall within our scope and it is for these that high-powered instruments are mainly required. It is quite a mistake to suppose that high magnification is necessarily more informative than the use of a lower power. The reverse is often the case. When examining documents, in particular, too high a magnification is often misleading. Enlargements in excess of 80 or at most 100 diameters are practically never required. This is also applicable to the examination of scratches on metallic surfaces and to weave and general appearance of a textile fabric. For the latter,

in particular, 80 diameters is the maximum magnification likely to be useful for general purposes.

It would be out of place to recommend any particular microscope, but all good manufacturers of optical instruments of precision produce what is commonly known as a "field" type of microscope. These instruments are light, of small size, and often have a tripod form of stand which in the writer's opinion is the most suitable. It is common to supply with this type of microscope two eye-pieces and one objective, generally a two-thirds. To this should be added a one-inch objective. A combination of these eye-pieces and objectives will give the most useful magnification for all general purposes. Certain manufacturers specialise in these field models and there is one in particular now on the market, a very efficient instrument, which takes to pieces and packs into a very convenient leather case of the pattern used to carry field glasses. The field type has much to recommend it even if it is not to be carried about, since anywhere but in a laboratory it is convenient to have a microscope which can be easily moved. My own portable microscope has no rack and pinion coarse adjustment but works upon the telescopic principle; but it has, of course, the ordinary fine adjustment. For a portable model this has many advantages. The milled heads of the ordinary coarse adjustment project on each side of the tube often more than an inch. They are thus very vulnerable and once bent, however slightly, they will put the coarse adjustment out of action. If it is required to move the microscope to any extent even if only from room to room an instrument with the telescopic form of coarse adjustment has much to recommend it. The microscope may be entirely in lacquered brass, or the standing parts may have an oxidised finish. In the portable models the latter is greatly to be preferred. On the whole it stands wear very much better.

A microscope when out of use should always be covered or replaced in its case. When it is much in and out of use, a convenient method of covering it is a large glass bell jar

which can be obtained from any scientific instrument manufacturer for a small sum. It is essential, of course, that the lenses and mirror are kept scrupulously clean. A silk handkerchief specially kept for the purpose is the best thing to use.

No description of microscopical apparatus suitable for police work would be complete without an allusion to the excellent pocket instruments which have been put on the market in the last two or three years. They are not toys but perfect reproductions of the larger microscope. There is a compound eye-piece of the standard pattern and a compound objective in which one lens screws over the nose of the other, so that one or both of the objective lenses can be used accordingly to the magnification required. There is a coarse adjustment on the telescopic principle and a fine adjustment controlled by turning a collar at the objective end of the tube right or left. These microscopes are capable of producing magnification from 40-120 diameters. The image is free from aberrations and chromatic effect. This is a remarkable achievement in an instrument shorter than a fountain pen with cap and less than twice as thick. For those engaged in criminal investigation they are almost indispensable. It is not always possible to have even a portable microscope on the spot just when it is wanted. These small instruments having no stand can be carried in the pocket and used anywhere. They are capable of giving magnifications equal and superior to those obtained with a two-third objective on a larger microscope. They further provide excellent preliminary training in the use of the microscope. There are, of course, certain disadvantages. The field is small as it must necessarily be in such an instrument and the illumination a little difficult to control, but the former disadvantage is not serious, nor is the latter difficulty ever insuperable. The illumination is generally reflected, that is to say this microscope is used like an ordinary lens, but by placing the object to be examined against a window pane and holding the instrument horizontally objects can be examined by transmitted light.

Finally, these microscopes are very reasonable in price, costing no more than a powerful lens.

To view the question of microscopy from another angle, even in cases where the police officer will not require practically to apply his knowledge, it may still be of great assistance to him. Being aware of the importance and function of microscopy, he will be in a better position to exercise due caution in connection with any investigation in which microscopic examination may play its part. It will therefore be appropriate here to consider the matter from this point of view.

In general there is the technique of collecting microscopic exhibits. In this connection we must allude to the reprehensible practice of placing such things in paper envelopes. Paper is of all things the most unsuitable. The surface of paper and its nature in general makes it impossible to clean. Cellulose fibres are liable to be detached from the surface and become mixed with the exhibit if it is a powdery substance of any kind, vegetable seeds, or any fibrous material. This is subsequently a source of annoyance and confusion to the microscopist. Exhibits destined for microscopical examination should be collected in glass. Chemical apparatus manufacturers supply small glass dishes about an inch and a half in diameter with a vertical wall, into which fits a glass stopper. These "weighing bottles," as they are often called, are very suitable for the collection of such material. They are very easily cleaned and dried. It is well to avoid the ordinary type of weighing bottle which is in the form of a small cylinder with stopper. This type is easier to handle but being of less diameter and taller it is difficult to dry. It is, of course, essential that these bottles should be thoroughly cleaned and dried before use.

An investigation officer who is to collect samples for microscopic examination should have a supply of these bottles. It is better that they should fit into a case with specially cut holes to receive them, and it is obviously desirable that they should be so arranged in the case as to remain upright when being carried.

The method of collecting samples for microscopic examination will of course vary greatly according to the circumstances, but some general rules can be laid down. Stains, dust, weapons or other articles left on the scene of the crime, and clothing will in general be the most important exhibits.

With the question of large stains we are not concerned for the moment, but minute stains, whether suspected to be of blood or not, upon woodwork, fabric or metal should receive careful attention. When possible they should not be removed from the material to which they are attached, but the portion of the material itself should be removed and preserved with the stain upon it. It is very important to remember that small or even large blood stains are not always recognisable as such and any stain, however small, which could possibly have any significance ought to be preserved for microscopic examination. Weapons or other articles found on the scene of the crime should preliminarily be minutely examined not only for fingerprints, but for hairs, blood or other stains and scratches. The pocket microscope with the low power is very useful for this purpose. Anything upon the weapon or other instrument which might become detached in transit should be removed and preserved. This, of course, must be very carefully done to avoid disturbing fingerprint evidence. In the case of a pocket knife the groove into which the blades fit should be examined and any detachable matter which can be removed by sharp tapping should be preserved. The final extraction of matter that adheres can be left to the microscopist. Precautions in packing such exhibits need not be insisted upon. On account of possible fingerprints alone, it goes without saying that they must be packed in such a way that the surface does not come into contact with the packing material.

The problem of clothing is a very difficult one. That found on the scene of a crime, and of that of the victim, in cases of murder, should be examined with rigorous care. Again, anything detachable such as hairs, grass seed, or other vegetable material, any suspicious looking dust such as tobacco ash visible and loosely adhering should be removed

and preserved. The inside of turn ups of trousers should be examined, and the lining of all pockets. It is an open question whether it is desirable to remove the dust found there and then or leave it *in situ*. It depends upon the probable nature of the dusts and the circumstances. If it is removed, that from the different pockets and from the two trouser turn ups must on no account be mixed, but preserved separately.

The packing of articles of clothing is a vexed question. There is necessarily a conflict between the theoretically ideal and the reasonably practical. A rigid object presents few difficulties, but clothing is not rigid, and the neat brown paper parcel is obviously an insidious temptation to make a virtue of necessity. If the brown paper parcel must be used, highly glazed paper is essential, the glazed surface being used so as to be in contact with the article packed. If, however, it is at all possible to employ a large box of wood polished on the inside with a coat hanger and hooks so that the exhibit can be secured at top and bottom in such a way that its surface does not come in contact with the packing case it is much better. From a microscopical point of view a hat will often supply the most interesting and arresting of circumstantial evidence. A hat should always if possible be packed in a box bearing in mind the general principle that any hairs adhering to the inner band should first be removed.

Scratches upon locks, indentations or splintering of wood produced by housebreaking instruments should be carefully examined with the lens or microscope *in situ* in order to decide if it is necessary to remove them for further examination. This is important. Such evidence may be insignificant or of very great value. Under magnification it is often possible to decide if the marks left possess small but characteristic peculiarities which might connect them with some particular tool afterwards found. Such things, and particularly file marks, will often entirely escape the naked eye.

It will be obvious from this brief outline that a knowledge of microscopy as distinct from its practical application is of considerable value to the police officer. If he knows the

nature of the work which may have to be done upon an exhibit he is obviously in a better position to prepare and transmit these exhibits in such a manner that their subsequent examination may render the maximum assistance.

We have also indicated the extent to which such work is within the competence of the investigating officer himself. It is not true that a little knowledge is a dangerous thing. A study of the subject of microscopy, however elementary, if it confers knowledge, will also bring with it to those who approach it in the right way, a recognition of the limitations as well as the possibilities of elementary theory and practice. The expert is not less necessary because his collaborator has some knowledge of the subject in which he specialises. He is more so. The police officer on account of his knowledge will put him in the way of information and material the significance of which would otherwise remain unrecognised.

THE ULTRA-VIOLET RAY.

It is only comparatively recently that the use of ultra-violet light has come to be applied to criminal investigation. This is rather surprising since the fluorescent effect of the rays was discovered many years ago. The immense practical importance of the discovery, however, in other directions besides that of criminal investigation, has only lately been realised. To point this out is to sound a note of warning. The results obtained from the "Wood Light" are very remarkable. Its use has opened up new possibilities for criminal investigation, but its application has limits, however widely set, as in the case of any other scientific instrument. This warning is necessary when it is remembered that some investigators in their enthusiasm have almost implied that the "Wood Light" in the large majority of cases makes other methods of scientific investigation unnecessary. But in criminal investigation, as in other branches of research, it is impossible to be too careful. Confirmation of results should always be sought, and by other methods when they are available.

It remains true, nevertheless, that the use of the "Wood Light" has made investigation possible which could not otherwise have been conducted, and that there are a large number of ways, increasing almost daily, in which its application is of very great value.

"The Wood Light" has, of course, opened up an entirely new field of investigation relating to questioned documents. In his recent book Captain Quirk has reminded us of its employment by the German banks during the serious counterfeiting scandals in Germany in 1926 and onwards. Its use saved the German nation many millions of marks. Without a rapid method of deciding if a note were in fact genuine or counterfeit a situation, the seriousness of which is not even now fully realised, would not have been so soon

in hand. An ultra-violet lamp was installed in all the most important banks and every note was submitted to its scrutiny. Counterfeit notes showed a different degree and tint of fluorescence in every case. The method was simpler than examining the note even cursorily under an ordinary lamp or in daylight, and it was effective where an ordinary examination, however minute, would have failed. Expert scrutiny was not necessary. A responsible clerk carried out the work. This is of importance as indicating that in some cases the "Wood Light" can be used by those who are not scientifically trained.

This, of course, is not true of ultra-violet light examination of all kinds of forgery, but some notice of its use in examples where more expert technique is necessary seems to be appropriate here. Forgery of documents falls commonly under three headings:—(1) Forgery by addition; (2) Forgery by subtraction; (3) and Forgery by imitation. The last may obviously be coexistent with or independent of (1) and (2). Forgery by addition or subtraction with or without imitation can generally be revealed by ultra-violet light. It has been proved quite conclusively that different inks even when they do not fluoresce—and all do not fluoresce strongly—present their own characteristic appearance under the rays. It has been shown less conclusively that the same ink of different ages reveals differences. Where unlike inks have been employed upon the same document it can be asserted in general that they can be revealed as such under the rays. This will often in itself be evidence of forgery by addition. Forgery by subtraction can be demonstrated in nearly every case. The most common method of removing ink written wording from a document is to "wash" it. The ink is bleached out with a bleaching agent such as citric or hypochlorous acid, and the substitution—if substitution is necessary—made. The inorganic salts which most writing inks contain remain upon the paper. Under the ultra-violet rays the paper fluoresces, but those parts containing the washed writing fluoresce only weakly or do not fluoresce at all. The original text in consequence becomes visible. This differen-

tial fluorescence is so delicate that it will sometimes make visible a text which has been erased by mechanical means.¹ The ink and the salts it contains sink deeply into the paper and cannot be entirely removed from the fibres. Examination under ultra-violet light may be the most satisfactory means of examination, although other methods of restoring the text exist. This is one of the most valuable applications of the "Wood Light." An erasure which has been skilfully carried out with very fine sand paper does not necessarily produce sufficient thinning to make it evident that the document has been tampered with. Obviously the most satisfactory demonstration is the re-development of the text. If it is possible to re-develop it at all the ultra-violet rays will succeed.

The problem is more complicated in the case of those documents which have been written with aniline ink, that is to say an ink not made from an iron salt and galls but from an aqueous solution of an aniline dye only. Ink written characters of this kind contain only traces of inorganic salts and are almost completely removed from the paper by washing. Re-development, however, is not hopeless. The paper is treated with any suitable solution which fluoresces brightly under ultra-violet rays. When the treated paper is exposed to the rays even in these cases the text will often reappear. This is explained by an oxidation effect of the cellulose of the paper about the points where the ink was originally in contact with it. Owing to this chemical change there is a differential fluorescence as between the untouched paper and the points over which the pen has passed.

Closely allied to forgery, from the technical point of view the examination of paper suspected to contain secret writing has in the past presented problems of a very formidable kind. It is generally possible to develop secret writing by chemical means, but not always. In any case the procedure is slow

¹ This, of course, is more or less exceptional. In actual fact ultra-violet rays will reveal the text, in all cases where the treatment has not been too drastic. But both in "washing" and erasure the forger dare not be too drastic or the surface of the paper is appreciably injured. He thus leaves invisible—and sometimes even visible—traces of his fraud.

and cumbersome and considerable damage may be done to the document. This is a very great disadvantage since it is often desirable that it should reach the person for whom it was intended without there being evidence upon it that it has been intercepted. There has not yet been a secret ink invented which ultra-violet light will not detect. In most cases a simple application of the rays is sufficient to make the writing clearly visible. Nor does it seem probable that a secret ink could be devised for this purpose. It is not essential for the substance used to be fluorescent. The paper will fluoresce and thus render the non-fluorescing writing visible. In actual fact the common substances used for secret ink such as saliva, urine, and milk all show the fluorescent effect.

In the examination of correspondence which has been opened with criminal intent the use of the rays are also of great value. In the case of Major Fink who was accused of forgery of a cheque it was necessary for the analyst to whom the scientific examination was entrusted to make an elaborate analysis of the sealing wax on the envelopes which had been employed by the accused. The defence was that the letters had been tampered with by some person unknown and not by Major Fink. The accused did not deny having forwarded the letters, but he denied that he had been guilty of the forgery. An analysis of the wax of the seals was accordingly made and this was compared with that found in the possession of the accused. The composition of the two samples of sealing wax agreed exactly, and Major Fink was therefore convicted. The ultra-violet rays were not commonly used for investigation of this kind at that time, but an examination by this method would have been of the utmost value. Ultra-violet rays are now often used for the examination of seals on postal packets. In this connection it is again necessary to sound the note of warning. The use of ultra-violet light is sometimes through its very delicacy liable to confuse. There is an analogy to be found in the example of the refinement of analysis devised for the detection of arsenic. When the Marsh Test was first discovered, the minute traces it was

capable of revealing were a source of some confusion to the analysts. They discovered arsenic where arsenic had never been suspected before, so that the very refinement of the method caused doubts to arise. In the Lefarge case, the traces of the poison found were by the prosecution attributed to administration with intent to murder, and by the defence to accidental absorption of arsenic. This is a classical instance of how newly discovered refinements of method may at first actually mislead. From a slightly different point of view the use of "Wood Light" introduces difficulties which may deceive the unwary. The fluorescent effects produced by it are in some cases so delicately selective that false inferences may be drawn from the test. Two examples of sealing wax, for instance, one of which has been melted by heating in a spoon, and the other of the same composition melted by direct contact with the flame may show differences in fluorescence. It is obvious that very serious errors may arise in this way by arousing suspicions with no basis in fact. It will thus be obvious that the very delicacy of the test is from some points of view one of its limitations, and that confirmatory evidence is sometimes necessary before the tests with the "Wood Light" can be properly interpreted.

There are circumstances in which the use of the "Wood Light" is the only method of examination possible. This may arise in the case of motor car accidents where fragments of glass and traces of oil are left behind on the scene of the crime as in the case of a callous motorist who has driven on after killing or injuring a pedestrian. In an example quoted by the Government Analyst of Ceylon a motor car had knocked down and killed a child. The only clue left to the identity of the author of this outrage were some fragments of broken glass, mostly in a very fine state of division, found on the road. These were submitted to the analyst who examined them with the ultra-violet rays. It was discovered by this means that more than one type of glass was among the fragments, but there was a particular variety which emitted a characteristic brown fluorescence. Some of the glass from the headlight of a suspected motor

car was tested and this was found also to show this brown fluorescence. The culprit was, largely on this evidence, convicted.

Examples of this kind are interesting as illustrating conditions in which no other test is possible, or at least such in which no other test would be conclusive. The analysis of the glass, a difficult matter in any case, would have been useless where the traces contained fragments of other glass.

These are among the most important applications of the "Wood Light," but it has many others. Its use by archaeologists to examine palimpsest documents bears a direct relation to criminal investigation. A palimpsest is a document from which the original writing has been removed or has faded. The parchment has afterwards been surcharged with other writing. On a modern document the surcharge may take the form of concealing the writing by overscoring with a pen heavily charged with ink. If the ink of the text differs from that used for the surcharge the underlying writing can nearly always be read under the "Wood Light."

On the Continent the "Wood Light" is used in some countries by the Customs to examine dutiable material. The rays will distinguish between, for example, raw and cleaned, and between crepe and vulcanised rubber, a distinction from the tariff point of view which is of very great importance. A great deal of illegal evasion has been prevented in this way. A large number of other dutiable articles are now examined with the "Wood Light" at important centres almost as a matter of routine.

It will now be obvious that the ultra-violet rays have many valuable applications in criminal investigation. In many cases, the "Wood Light" can be used by those without scientific training; so that it seems desirable to give some description of the ultra-violet lamp and to explain the principle of the ultra-violet rays themselves.

It is generally known that the rainbow is a spectrum of white light from the sun. The rainbow effect can be artificially produced by passing white light through a glass

prism. The prism splits up the light into its component parts in the following order, red, orange, yellow, green, blue, indigo and violet; each of these colours corresponds to light of a definite wave length. At the extreme right and left of the spectrum there is a "dark" region. That on the left corresponds to what is known as the infra red; that on the left, to the ultra-violet.

The velocity of light is approximately 300,000 kilometres a second. The term wave length means the number of its vibrations, the size of the ripples over that 300,000 kilometres. The longest waves are those of red light of the order of 800 millionths of a millimetre; the shortest are the violet of the order of 400 millionths of a millimetre. These vibrations, therefore, as distinct from the velocity of the light itself which is constant, are more frequent in the ultra-violet than in white light. The rays are consequently highly active chemically and give rise to the phenomenon which has been described.

The mercury vapour lamp is one devised to give the maximum concentration of ultra-violet rays. Not only sunlight but any white light develops a certain percentage of ultra-violet rays. The sparks from an induction coil emit rays of very short wave length. An ordinary carbon arc light also produces appreciable quantities of ultra-violet light. The tungsten arc is very rich in ultra-violet radiation. None of these sources of illumination, however, has been found of any use in practice. Only the tungsten arc develops ultra-violet rays in sufficient quantity to be of practical use, but the cost of its maintenance and care required in its manipulation make it quite unsuitable for ordinary purposes.

In 1906 the first mercury vapour quartz lamp was made in Germany. This apparatus has been the basis of all ultra-violet apparatus since that time. The reason for the use of quartz instead of glass will presently be explained. Essentially, the burner consists of a quartz tube highly evacuated containing pure mercury. The two poles of the electric current are fused into this tube. When the current

is switched on the high temperature developed vaporizes the mercury and an arc is produced across the poles of intense brilliancy.

The earliest mercury vapour lamps made were constructed of ordinary glass of very high melting point. Their disadvantage was that ordinary glass absorbs a very high percentage of the rays so that except as sources of ordinary illumination these lamps were not of much use. It was discovered, however, that quartz offered very little resistance to the passage of the rays and it is employed in all ultra-violet lamps for this reason.

The rays properly called ultra-violet are not visible, a fact of considerable importance. The ordinary ultra-violet lamp is quite useless for demonstrating the fluorescent effect which is one of the essential properties of the U. V. rays from the point of view of criminal investigation. In the sunlight lamp they are emitted together with the white light. The problem of filtering out the visible light was solved by Wood who devised a system of screens made from solutions of copper sulphate and nitrosodimethylaniline, an orange dye. From the practical point of view Wood's discovery has been greatly improved by the invention of a screen coloured with nickel oxide which prevents the passage of the visible light, but allows the ultra-violet rays to pass. In practice the completely dark screen is not generally used, but one somewhat less dense which allows the passage of a little visible light, and achieves at the same time a greater concentration of ultra-violet rays.

A special lamp has been constructed which is particularly suitable for analytical and criminological examination. It consists essentially of a case in which the burner is enclosed. The burner itself includes two receptacles which contain the mercury—into which the terminal connections are ground—joined by the evacuated tube of quartz. The system is controlled by a handle which tilts it right or left so that the mercury can flow, and, when the current is switched on, completes the circuit. At the bottom of the case is an opening which contains the screen. The case containing the

burner surmounts a compartment which is open in front but across which curtains can be drawn to exclude daylight when necessary. Documents or other objects to be examined are placed in this compartment and the light is turned on. It is not necessary to conduct the examination in a darkened room. Provided the lamp is not in direct sunlight the fluorescent effect can always be observed.

There is also a hanging model of the same type of lamp in which the burner is enclosed in a lantern-like holder. This type has interesting applications from the detective's point of view since it can be carried about and used in a room like an ordinary lantern. It is of great use in searching for finger prints and similar clues on the scene of a crime. Nothing is easier than to miss a fragmentary finger print particularly on a neutral coloured surface. The ultra-violet lamp misses nothing. The sharply contrasted effects produced by fluorescence are of great value in discovering insignificant traces.

From what has already been said, it will be obvious that the use of the ultra-violet lamp presents no particular difficulties. There are, however, one or two precautions it is necessary to regard. The eyes and even the skin must be protected if there is any need for exposure to the unfiltered light. Ultra-violet light can and does produce inflammatory burns upon the skin which may be very painful, and it can cause temporary blindness and great pain in the eyes if they are exposed to it. Smoked glasses should therefore be worn when dealing with the unfiltered light and gloves to protect the hands. The filtered light is not so active in this respect, but some individuals are intolerant of the rays and even while using the screened lamp goggles are a wise precaution.

The handle controlling the burner and the flow of mercury which establishes the contact should be gently manipulated or the lamp may otherwise be burnt out. Once the mercury has been vaporized there is generally no trouble; it is the initial establishment of contact which requires care. When the lamp is burning it is only necessary to place the object to be examined in the compartment provided for it or

in the path of the rays in the case of the hanging lamp. The fluorescence will then immediately be apparent.

There is no doubt that in the ultra-violet lamp the police officer will find a very powerful ally. The direction in which it has been most employed is in the examination of documents. Examples of its applications in this direction have already been indicated and it has been shown that the examination of letters suspected to contain secret writing is a use to which the police themselves can put the apparatus. The investigation of anonymous letters, so frequent a feature of criminal investigation, is another case in point. The characteristic fluorescence of paper and the appearance of the ink makes it quite simple to compare two letters suspected to emanate from the same source.

The rapid examination of stains is another direction in which ultra-violet light greatly assists preliminary investigations. In cases of rape it is very important to decide the nature of stains found upon garments. Seminal stains under the ultra-violet rays generally show a faint bluish fluorescent while those of urine have a distinctly yellow tint. In dealing with such serious matters it is essential to obtain expert confirmation by means of the Florence test and an examination for spermatozoa which can only be carried out in the laboratory by the specialist. But it is often useful and sometimes essential in such cases to form a tentative conclusion with the least possible delay.

In regard to blood stains very great caution is necessary in considering their identification by means of ultra-violet light. It is frequently asserted that human can be distinguished from animal blood by this method. Investigation seems to indicate that this may prove to be the case, but the technique is not sufficiently advanced, in the writer's opinion, for this assertion to be accepted without considerable reserve. That ultra-violet light may ultimately prove to be the simplest and most efficient method for the identification of blood-stains is extremely probable, but for the present further developments have to be awaited.

In general it may be said that the application of the

technique of ultra-violet light for the non-expert resides for the most part in elementary examination in cases of counterfeiting and forgery and in identification where means of comparison are available. Examples such as the identification of the broken glass of the motor car lamp, of counterfeit bank notes, and anonymous letters are cases in point. Where identification relies upon the recognition of a particular fluorescent effect and examples for comparison are not available, specialised experience and training are necessary, and the assistance of the scientific expert essential. Sufficient has been said, however, to indicate the great and varied possibilities of the use of the ultra-violet lamp by the police officer himself when he relies upon comparative methods.

FINGER AND SKIN PRINTS.

There is some evidence that the significance of fingerprints was understood by the Chinese, and it is in any case true that the discovery that individual prints are unique in design was the beginning of a real technique of identification. The system is the bedrock of criminal investigation so that it is not surprising that greater attention should have been paid to it than to any other branch of police technology.

The system is so well founded that among the inexperienced there is sometimes a risk that it will be taken too much for granted. This article has for its object the consideration of certain points which recent investigations have proved to be of considerable importance from the practical point of view.

The term finger prints is now really out of date. The investigating officer has to consider not finger prints so much as skin impressions generally. It is a common fallacy that the comparison of a finger or other print with that taken from a suspect is a more or less simple matter. This is not true. If prints found upon the scene of the crime were always well defined the examination would be elementary, but this is the exception and not the rule. Skin prints are in nine cases out of ten fragmentary. The matter of comparison is therefore greatly complicated. But it has become less so since the application of Locard's poroscopic method. A magnified image of the print reveals the sweat pores. Dr. Locard has shown that these pores vary in number and position with each individual in any given area so that it now no longer is necessary merely to rely upon a finger print. A skin impression of any part of the palm of the hand is sufficient to establish identity. Theoretically, at least, it is possible to do so on the evidence of a single pore. The individual pores vary profoundly in size and shape and in many cases it would be possible to demonstrate upwards of a hundred points of similarity between two photomicrographs of the same sweat pore.

The porosopic method is of great significance in connection with the development of skin prints. In this regard the traditional technique for bringing up latent prints is by means of powders such as grey powder or red lead. Excellent for the straightforward examination of ridge markings, this method may be quite unsuitable to the more refined technique of the poroscope. The powder tends to fill the pore marks and it is in some cases impossible to distinguish them at all in a print developed in this way. It is always better where the porosopic method is to be employed to take a photomicrograph either without development or after development by chemical means. In the case of a skin print on a dark surface, development is often not necessary. If oblique illumination is used there is often sufficient contrast, and always in the case of a photomicrograph. The question of poroscopy will be considered later.

Prints are not always easy to discover. In the first place it will perhaps be well to indicate direction in which it is of no use to look for them. Rough surfaces such as iron or wood which is unpolished do not take finger prints, neither will rough stone yield results. There is no case on record where the human body alive or dead has preserved a finger or hand print. Textile fabrics do not register any impression. Although it should invariably be examined not all kinds of paper retain the impression. This applies also to blotting paper which even if examined immediately after the impression has been made never reveals anything but an indefinite smudge. Marble is in a different category. If highly polished it takes an impression well, but even marble is porous enough in some cases to leave the result in doubt. Slate is also a bad medium but in the case of school slates which are more highly polished results can be obtained. Many of these examples are, of course, subject to the exception of prints in blood, faecal material, dye, ink, or other agents which leave traces where the moisture of the fingers will not.

The clearness of the impression left depends very much upon the condition of the hands. The traces are caused by

the oily secretion of moisture, mineral salts, and fatty acids which the sweat pores produce. It is interesting and of importance to note that the more serious the crime and the more nervous the author, so will the finger print evidence be the clearer. The criminal is nervous and his hands become unduly moist so that he leaves more perfect impressions behind.¹

In general, it may be said that all highly polished surfaces should be examined first. Daylight is not the most satisfactory illumination. It is better to use a small torch with which surfaces can be examined with oblique illumination. Any smudge or smear, however unimportant it may seem, should be very carefully investigated. It must be remembered that persons with very fine papillary markings often leave traces which it is very difficult to recognise on cursory examination as fingerprints at all. If one is available it is better to replace an electric torch with a portable ultra-violet lamp. The fluorescent effect produced by the lamp is extraordinarily useful in showing up fingerprints which might otherwise be missed.

It is worth noting that on the evidence of several eminent continental experts gloves are not always a complete protection against the leaving of recognisable impressions. In the case of an individual with strongly marked papillary ridges and who has used very thin gloves recognisable traces are sometimes left. Thin rubber is besides not absolutely impermeable and it is apparently in this way that gloved hands sometimes leave prints. More commonly, however, the external surface of the rubber is moist in any case and its thinness is not proof against the ridge markings of the fingers. There are at least three recorded cases where prints have been found which were subsequently proved to have been made by gloved hands.²

Whenever prints are discovered upon moveable objects it

¹ There are exceptions. Fingers very moist with perspiration often leave indistinct traces through the very excess of moisture.

² Such evidence, however, is very difficult to confirm with certainty. The laboratory work of Stockis seems to be conclusive; but his experiments were carried out under conditions which could hardly obtain in practice.

is better to pack and remove the article to headquarters. The obvious precaution of careful handling must, of course, be observed. Packing does not present many practical difficulties. In the case of bottles two square pieces of wood a little larger than the diameter of the bottle should be used. These are secured to the bottle top and bottom by means of nails driven into them, so that the nails act as wedges. Thinner pieces of wood should then be nailed to the four sides of the square pieces so that the whole becomes a kind of skeleton packing case. In this way the sides of the bottle are preserved from contact with anything in transit. Cups and glasses can be packed in the same way. Knives or other weapons should be secured between two chocks of wood fastened to another piece of wood so that they are free from contact with other packing material.

When fingerprints which are not upon moveable objects have been discovered nothing should be done except to protect them until the arrival of the photographer who will decide upon the practicability of photographing them. The investigating officer who is not a professional photographer cannot attempt this except in special circumstances. Fingerprints, for example, upon curved surfaces should be photographed on a film in a specially constructed dark slide which enables the negative to be curved exactly the same degree as the curved surface to be photographed. Photographs of curved surfaces on a flat plate or film may mislead. This is not work for amateurs. There are circumstances also where two fragmentary prints upon angular surfaces ought to be photographed upon the same plate. This involves special apparatus with a rotating dark slide which no one but an expert can employ.

Great care should be taken to protect any impression however unpromising it may appear, since enlarged photographs may reveal papillary markings undetectable by visual examination, which may be of first rate importance. All impressions should be covered as soon as possible with small cardboard boxes or similar material with a weight on the top to prevent movement. It is a golden rule that if a police photo-

grapher is available, no development of any trace should be attempted upon a non-portable object until the photographer has seen it.¹

In other cases and particularly when photography is impracticable, it is often desirable to transfer fingerprints and for this purpose a number of methods are available. Photographic paper has commonly been used. The procedure is slightly to moisten the paper with clean water being careful to remove the excess so that the surface is only slightly damp, and then to apply the paper to the print and press it down evenly leaving it in contact with the impression for about ten to fifteen seconds. The paper is then carefully lifted when it will be found that the impression has been transferred to the paper. This method is simple and on the whole works well, but this type of emulsified surface is not altogether the best for the purpose. The results obtained vary with the quality of the paper and sometimes even sheets of paper from the same packet do not give consistent results.

An improvement upon this method has recently been introduced by A. Claps, Assistant in the Laboratory of Technical Police at Lyons. In place of the photographic paper Monsieur Claps employs a piece of ordinary photographic film. The film is damped with water on the non-sensitized side in the same way as the paper. It is applied to the print with even pressure in the same way and the print is thus transferred.

This method is the simplest and the most satisfactory which has yet been devised. The surface texture of the photographic film is almost an ideal medium for transfer since it is always uniform. The film is also much stronger than the paper which is a considerable advantage. The paper has a tendency to crack, a great disadvantage in the circumstances. It is further possible in the case of the film to make an ordinary photographic reproduction of the print of the actual size.

¹ The present author emphatically agrees with Mr. W. Henry, Officer in charge of the Habitual Criminals' Register, Garda Síochána, that no finger-print ought to be developed until it has been photographed, and that if a good photograph can be obtained of it, development is not necessary.

Besides this, the film method is particularly useful for obtaining records of prints upon curved surfaces or in awkward corners. Paper is not very satisfactory for this purpose. It lacks the resilience of the film which can be readily bent in any direction. The precautions to be taken with this method are elementary. It is only necessary to avoid the use of an excess of water in moistening the film, and to take care that the pressure applied to the print is uniform. It goes without saying that the film must not be moved while in contact with the print.

The development of fingerprints has not until recently received sufficient attention. It is too readily assumed even to-day that the development of prints with powder is quite a simple operation. This is perhaps true of a very clear print, but not all criminals are so accommodating as was the murderer Mayor who left on the scene of his crime a print of his index finger said to be among the most perfect ever discovered. In the case of fragmentary prints every detail will be of importance where it may be difficult to demonstrate the required points or resemblance if any part of the print is damaged by faulty development.

In regard to powders in general, it is essential that they should be of uniform particle size. It is further necessary that they should be dry for otherwise the powder tends to aggregate and may thus be the source of considerable trouble. The powder should be heavy, that is to say its basis should be one of the heavy metals, mercury or lead. "Grey powder," a mixture of mercury, chalk and graphite is commonly used in England, while on the Continent red lead and lead carbonate are employed. All these materials are satisfactory provided always they are of good quality and of uniform fineness. The powders should be kept in tightly corked or stoppered bottles to prevent contact with moisture.

In the writer's opinion there is no objection whatever to applying the powder with a brush as long as the right kind of brush is used; and that proper precautions are taken in using it. A brush of very soft camel hair may be used which has been cut so that the hairs do not converge to a point but

resemble those of stippling brush. The powder should not on any account be brushed on to the print. It should be used to take a charge of the powder. The brush is then held over the print and the handle tapped to dislodge the powder. When the print is covered the powder should be left in contact with the print for a minute, and the excess of powder can then be carefully brushed off. This is the most difficult part of the process. Any but very light touches with the brush do damage. On the other hand the brushing must be sufficient to remove the excess of powder and leave the furrows between the ridges clear. There is no other way of attaining proficiency than by practice."

Powders are not entirely precluded even where the poroscopic method of examination is to be employed. The method used by Locard is to apply warm red lead. In this case all excess of powder must be carefully removed, for it will otherwise be quite impossible to make any proper examination and pore count. In the case of ridge counting a slight excess of powder is not so important. Even if a little remains in the grooves it will not necessarily obscure the ridges.

Development with powder is in most cases applicable only to prints which are visible without the development. Latent prints on paper can, however, sometimes be developed in this way. But of recent years very satisfactory chemical methods have been evolved for making visible skin impressions upon paper.

The use of dilute ink has now little more than an historical and academic interest, but it is still sometimes made use of and a brief notice of it seems to be appropriate here. If paper which is marked with skin impressions is brushed over with dilute ink the prints appear in darker relief. It is important to note, however, that the print obtained in this way is negative. That is to say that the furrows and not the ridges are coloured. The effect is due to the fact that the oily secretion from the fingers repels the ink which stains that portion of the paper more deeply where the oily secretion has not been in contact with it. For this reason, if for no other, this method is liable to cause confusion. As a

recent case has shown—one in which it was desired to establish the identity of two impressions—negative prints can give a great deal of trouble. In this instance the attempted comparison of a negative print and a positive was the cause of the mistake. It is one which is extremely easy to make, so that no method of development which produces a negative print is to be recommended.

One of the more recent methods for the development of latent fingerprints is by means of iodine vapour. It has the advantage of being simple to apply in practice. A few crystals of iodine are heated upon a bath of sand and the paper is held over the violet vapour which is evolved. The method is very delicate. Prints in some cases which have been made upon paper three years before treatment can be made visible in this way. The phenomenon is explained by the fact that the fatty acids absorb iodine, the print actually appearing in yellow. They are positive. The disadvantages are that the colour is fugitive though it can always be redeveloped, and that the prints are difficult to photograph.

Dr. Ainsworth Mitchell has recently evolved a method which in many cases gives excellent results. The chemical used is osmium tetroxide, a liquid which boils at about the same temperature as water. When paper containing skin impressions is exposed to the vapour of this liquid, the prints appear in a strong black. The definition is not quite so good as when iodine vapour is used where the definition is first rate, but it is at the same time very satisfactory. The contrast is, of course, much better than that obtained with iodine vapour which gives yellow prints. It has not, however, been found possible to develop old fingerprints by this method, and iodine remains as the most satisfactory reagent for that purpose. This is not usually a matter of much importance since it is generally fresh prints only which have to be developed.

The type of paper upon which the print has been made has a profound effect upon the degree and sharpness of development. Upon very absorbent paper it is seldom possible to develop a print at all. Highly sized paper gives

the best results. This is due in the case of absorbent paper to the oily secretions sinking into the paper so that the outline of the ridges is blurred or entirely lost. The fatty acids also undergo chemical changes which interfere with the reaction.

These chemical methods are comparatively simple to apply in practice. It is only necessary to vapourise the chemical to be employed and hold the paper over the paper.

The photographing of skin prints is generally a matter with which only the expert photographer can deal, but the investigating officer should be acquainted with the elements of the process. Both developed and undeveloped prints can be photographed. In the former case the procedure does not greatly differ from that employed for any photographic work at close range. Without very careful manipulation of focus, however, it is impossible to obtain good results. Photographs of fingerprints in which the definition is not perfect are, of course, quite useless, but a thoroughly expert amateur photographer can, if it is absolutely necessary, take such photographs and may with practice obtain good results. Graphite on a white surface photographs better than red lead, while lead carbonate gives good results on a dark surface. It is, in the writer's opinion, preferable to grey powder.

The photography of undeveloped prints require much more elaborate illumination. It is necessary that the papillary ridges should be very brightly illuminated. Stockis' method is usually employed. In a special box is contained first a parabolic mirror, and in front of this is the source of illumination. The rays from the light intensified by reflection from the mirror pass through a condensing lens on the face of which is a disc of black paper screening off a considerable area of the light rays. There is next a diaphragm formed by the other end of the box in which a hole rather smaller than the black disc and centred in relation to the optical axis of the system. The light passing through this diaphragm falls on the print. By this means the papillary markings are brilliantly illuminated and can be photographed.

The apparatus is not really elaborate nor particularly

difficult to use, but as with the microscope considerable experience is necessary in adjusting the illumination to meet the requirements of every particular case.

A third method is contact photography which is applicable to prints on glass or semi opaque material. The fingerprint must be powdered, before the photograph is taken, with graphite or red lead. The technique is not more difficult than in the case of other kinds of contact photography, and the results are often very satisfactory. It is however, not always easy to get good contrast between the print and the background which is liable not to be uniform if the exposure is not absolutely right. The writer has found that the use of an orange screen is very useful in some cases since it gives a more even tone to the background. When this is used a longer exposure is advisable. Regarding exposure in general no rules can be laid down. It is essential to ascertain by experiment in every individual case the exposure giving the best results.

Under transmitted light an undeveloped fingerprint has a very interesting appearance. The lines do not appear as continuous but are seen to consist of numbers of minute globules of oily deposit. These are interrupted along the lines by the sweat pores. A satisfactory photomicrograph of a print cannot be taken under transmitted light. With reflected light, however, the lines appear continuous, and by suitable arrangement of the condenser they stand out brightly illuminated with very distinct delineation of the pores. In the case of transmitted light much of the deposit from the finger is in the form of such minute globules that transmitted light passes through them without detectable interference so that only the larger globules are visible; but the whole of the deposit reflects light, which explains the better recognisable image revealed by reflected illumination. It is, in fact, often impossible to distinguish the lines at all if they are examined by transmitted light. From a practical point of view this is immensely important. For photomicrographs of fingerprints on glass or other polished surfaces development with powders is generally unnecessary. In most

instances when the object is movable it is possible so to arrange the reflected illumination as to obtain an excellent photomicrograph of a print without development. This is a great advantage if it is required to examine the pores. Development with powders often obscures the pores altogether so that an opportunity of establishing identity is perhaps missed which might have been easily available. If, however, development is for some reason found to be necessary, and it is desired to make a poroscopic examination, chemical development is to be preferred. If iodine or osmium tetroxide is used the size and shape of the pores are not affected.

The question of poroscopy has been emphasized for the reason that, in the writer's opinion, sufficient attention has not been given to it at any rate in Great Britain.¹ Through lack of completeness in the traces left, fingerprint evidence is not always conclusive. In the case of poroscopy a fragment of a print half a centimeter square may go further to establish identity than a much larger fingerprint recognisable as such but too indefinite to be of much use for the purpose of identification. This indicates at once the importance of minute search on the scene of a crime and the application of modern methods of development, photography and enlargement, and photomicrography, which this chapter has outlined.

¹ It is not, of course, always possible to trace the pores in a fingerprint. Under some conditions they are not reproduced.

FOOTPRINTS.

The examination of footprints as an aid to detection is an art older than civilisation. Primitive man protected himself against his marauding neighbour by looking for the imprints of his feet, and by such means could either follow them or, if the enemy were formidable and an open aggressor, anticipate and prepare for his approach. We shall all of us recollect in this connection Friday's discovery of the footprint in the sand. This is an example from fiction but it is founded in fact.

It is for this reason that in Australia native trackers were, and probably still are, often employed to trace criminals. The native relies to a large extent upon his acute sense of smell which is the equal of that of a bloodhound. But at the same time their knowledge of footprints is extensive and by an instinct, product of the accumulated experience of thousands of years, they can often interpret the significance of a set of footprints, without being able to explain the method, quite as fully as a trained investigator.

For the very reason, perhaps, that the study of the footprint has so deep a foundation in tradition, the methods of examination of this evidence have been taken rather too much for granted. There is no more useful clue than a good footprint, but there is a sense in which there is none more dangerous. In the introductory article an allusion was made to the Hebron case in which the accused was wrongly convicted upon the evidence of a footprint, nor is this an unique example of a clue of this kind proving a positive danger if carelessly examined; while, on the other hand, in such an affair as the Stepney murder the careful examination of the imprint of a nail in a boot supplied indubitable evidence of the presence of its owner on the scene of the outrage at the material time.

With foot, as with fingerprints, their importance as evidence will be directly proportional to the points of identifi-

cation which can be demonstrated. This should be self-evident, but having regard to the kind of evidence which has been produced in the past, and is produced occasionally still, to demonstrate the identity of two impressions it is clear that its significance is not fully recognised.

It is accordingly essential to bear in mind that general form, or even general measurement, is not of much use. Characteristics likely to be unique both in shape and detail are the points which have to be considered. Failure to appreciate this aspect of the matter has resulted in the past in the practice of quite inadequate methods of measurement and the taking of casts. It used to be suggested, for example, by quite responsible writers that the best way of preserving a footprint was, where practicable, to dig it up. The disadvantages are that it is hardly ever practicable, and when practicable, it is extremely dangerous. It is almost impossible to dig up any footprint without distorting it, and even if this difficult operation is accomplished, the exhibit will hardly survive transport. There is no objection to removal in this manner after measurements, casts, and photographs have been taken, but there is practically no case in which the original impression will have any advantage over the good reproduction.

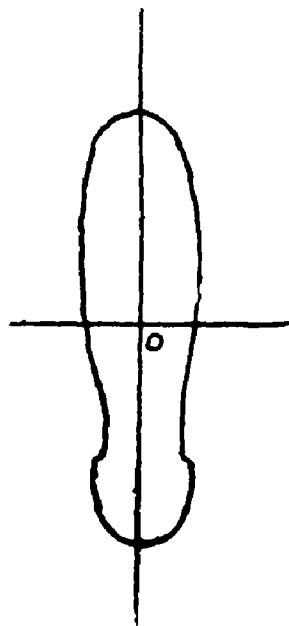
Measurement of footprints is necessary for the reason that a cast may fail or the footprint alter as the result of sudden changes in weather. There are no means of protection which will infallibly guard an impression in snow or ice against a thaw, and a thaw may set in rapidly. To take measurements of a cast is a comparatively simple matter, but the measurement of the footprint itself presents more difficulty. In cases where for some reason a cast is not available the suspected imprint cannot be compared directly with an imprint made by footwear subsequently discovered. There remain only the measurements in numerical form. It is thus obvious that the operation must be standardized or the results will be useless. Evidence to the effect that the print ~~was so long~~ at its greatest length and so broad at its maximum width will not be conclusive or even particularly convincing.

Many people wear the same make of shoe of the same original size. The mere statement concerning two dimensions might be reconciled with a hundred examples.

But no two people have exactly the same sized feet and bare measurement is only useful if and so far as it can express individual differences in size, impressed by the wearer upon his boot or shoe, in numerical terms. The greater the number of measurements taken the more precise the evidence available as to the size and shape.

The process of measurement while it requires care is not particularly difficult.

The illustration below represents the fundamental principle of what is, in effect, the graphical method. The exact centre of the trace is ascertained by measurement. The vertical line passing through it is the ordinate, the horizontal line, the abscissa, the point O is the origin. It is obvious that with this "frame of reference" a theoretically infinite number of vertical and horizontal measurements can be taken, and an outline of the print can be reproduced with great accuracy if the number of measurements is sufficient. A thin and accurate measuring rod with a sliding arm at right-angles is a convenient frame of reference to apply in practice.



Ordinate and abscissa measurements can be taken, for example, at every tenth of an inch. So large a number is not generally necessary, but it is better to take too many measurements than too few. There are times when this tedious procedure will be very useful. It will be obvious that with these measurements it is possible to reconstruct a fairly accurate representation of the footprint on paper. It is only necessary to draw a line on a piece of paper corresponding in length to the ordinate; mark this off in tenths of an inch, and then mark the paper to the right and left of the ordinate at the points corresponding to the abscissa measurements. The result will be a dotted outline of the footprint. It will be more than this. The dots will correspond to, perhaps, as many as 250 exact dimensions for the purpose of comparison, which is carried out by making the suspect make an impression with the suspected boot and applying the same operation.

In cases where a cast cannot be taken and the print is likely to disappear measurements of this kind will be of great service.

In the majority of cases, however, where the footprint can be preserved direct measurement is not so important and need not be so elaborate. It must be borne in mind that measurement alone is not the best evidence of identification. Nails, impressions of rubber soles, faults and repairs in the leather are much more valuable indications. For this reason the matter of casting is important. What is required whenever possible is reproduction down to the minutest detail.

A plaster cast of a footprint in firm ground is not very difficult to make, but the question of the preparation of the plaster of paris remains. The plaster must be added to the water, not the water to the plaster. If the latter is done the mixture tends to form lumps and it is very awkward when this has happened to make the mixture homogeneous before it sets. Hans Gross recommends the addition of small quantities of plaster of paris at a time and a final rapid stirring. The stirring should be not only rapid but violent. Water always contains a certain amount of dissolved air. Upon the

addition of the plaster of paris the air is liberated in the form of small bubbles. If the mixture is not strongly stirred these will not rise to the surface. They may appear on the surface of the cast and interrupt the smoothness of the outline. It is better if possible to boil and cool the water before mixing. All the air is expelled in this way.

In the case of a firm print some oily substance should be applied before the plaster is put in or it will be difficult to lift the cast. The method of rubbing the print with a fat, however soft, is not to be recommended. It is preferable to melt vaseline or lard and apply it with a small soft brush. Even the firmest footprint may have weak points which light application of a soft brush will not break down. The minimum amount of the fatty agent should be used.

These remarks apply to a dry footprint. Where it is wet or moist this treatment is not necessary since the cast comes away quite easily. It is indeed undesirable to use fat or vaseline if the surface is not dry.

The plaster should be poured into the print fairly quickly, since it rapidly sets. But too much haste is disastrous. Where small pockets such as nail marks form part of the print these may retain air, and if the plaster is added too quickly it will not fill the depression and a hole will appear in the cast where there should be the mould of a nail or other projection. Since the marks on the sole of the boot or shoe are most important, a small quantity of the plaster should first be rapidly but cautiously added to ensure filling all indentations. The best method is to add the mixture with a spoon for this first addition since the application can be more easily controlled than by pouring from a vessel, but if a small beaker with a narrow lip is available this can be used.

The question of strengthening less firm a print next arises. A decision as to whether or not an impression requires reinforcing in this way is not always easy to form. It is worth remembering, however, that an impression should never be treated in this way unless it is absolutely necessary and that some impressions, hereafter mentioned, should on no account

be so treated. But in cases where a detailed footprint is to be cast from soft earth, it may be desirable. The detailed parts of the print may be too fragile to resist the fall of the plaster and valuable indications thus be destroyed. The only satisfactory medium for this purpose is an alcoholic solution of shellac. This must not be brushed or rubbed on but delivered from an atomising spray. After this has been applied the print must be left for half an hour, and no rain, if a sudden shower develops, must be allowed to fall upon it. The shellac varnish sets during this period and the mould can then be taken as before. It is not necessary to oil the impressions in this case.

Reinforcement is applicable only to cases where the footprint is quite dry. The shellac will not take in the presence of moisture, and, far from improving matters, will increase the difficulty of obtaining a good mould.

There is the general question of impressions in very moist material. As a preliminary it is well to remember that such examples fall into a different category. Where the medium taking the impression is firm, an impression, nearly enough exact, of the boot or shoe is recorded, but in the case of mud, slush, or melting ice this is not the case. The general form and outline of the print will not be greatly affected, but the details may be profoundly altered. This will be obvious when the holes made by nails in snow or ice are considered. So long as it remains hard their exact form will be recorded. Theoretically this is not true since even freezing snow sublimates to vapour without passing to the aqueous phase, so that the print is altered by loss of material; but in practice the amount of snow subliming over so small an area is negligible. When snow or ice begins to melt, however, serious distortion may take place. The indentations made by the nails will be enlarged, other characteristics and even the general outline will be distorted. This is an example applying to a print made in hard snow which was freezing when the print was made and has afterwards begun to melt. The effect will not be the same in the case of a print made in slush which has remained at a constant temperature. In

such a case the mobility of the material may cause a reduction in the size of indentations such as are produced by nails. Slush in these circumstances behaves like liquid mud which yet retains sufficient density to retain an impression for some time. With mud of this kind also, nail marks and similar traces will be reduced in area. These alterations while they may not render identification impossible must be recognised and allowed for. It is never possible in material of this kind to obtain such satisfactory results as in the firmer medium and caution is necessary in drawing conclusions.

Nor is the question of obtaining a good mould under these conditions an easy one. In melting snow, however, excellent results can often be achieved by the use of dry plaster of paris. Any water remaining in the indentations must first be carefully removed with small pieces of blotting paper. The print is then powdered with a fine stream of dry plaster of paris. Rapidly absorbing water from the snow it thus sets. It is desirable to apply the plaster by sieving through a muslin bag in which the plaster can be placed and the bag shaken over the print. It is essential that only small particles such as will pass through the muslin should be applied to a print of this kind. Having formed the first thin layer liquid plaster can then be applied in the usual way.

Mud is by far the most disappointing medium from which to draw a mould. Apart from the primary distortion affecting both the general form and the detail to which allusion has been made, a secondary cause of trouble will be the application of the plaster itself. The contact of the plaster sometimes suffices again to alter the form of this unstatic material. No reinforcing agent is of much use and shellac must not be applied. In some circumstances, however, a 3 to 5 per cent. solution of gelatine in hot water may be painted on very lightly with a brush to form a very thin layer. On account of the moisture this does not set completely, but it forms a "gel" system on the surface of the print which slightly reinforces it. If this treatment is not overdone it can do no harm, and in some cases the result is improved. Dry plaster must not be used in this instance,

but the thickest practicable mixture of plaster of paris and water.

Impressions in dust and sand give better results than might be expected if the proper method is followed. About a tablespoonful of plaster is added to half a pint of water and the mixture thoroughly stirred. The thin milk is then very carefully applied to the print little by little so that the plaster sets in a thin film over the surface. Water containing increasing quantities of plaster is then added carefully, finishing with a mixture of the standard thickness. A considerably longer time is necessary for setting in these circumstances. Thick plaster of paris hardens very quickly, but the thinner mixtures may require an hour or more.

A word may here be added regarding reinforcement of the plaster itself. In all casts but particularly those of any thickness, it is necessary to reinforce with small pieces of wood placed in the mould before it is completely filled and covered with the remaining plaster so that it forms a strengthening core about the middle of the mould. Where the thinner plaster has been used the wood must not be placed upon it until it is hard enough to support the weight. It may otherwise sink too deep and distort the mould. The half made mould should be tested for firmness before dropping the pieces of wood into it.

Plaster of Paris is without doubt the best medium for casting although various others have been tried with varying success. Some are very unsatisfactory and among these is gelatine which should not be used except occasionally in the manner already suggested. It is not easy to agree with Hans Gross that the use of paraffin wax is as satisfactory as that of plaster of Paris, and that stearine is the only substance in which impressions in dust or sand can be taken. The use of suet or other semi-solid fat, pitch, resin, or cement need only be mentioned to be condemned. Moulds can be made in all these materials but their manipulation requires exceptional skill and the fragile nature of the mould in the case of the fats makes it necessary to remould in plaster from it, a second and equally risky operation.

There are, however, new methods which promise to be of considerable utility. First among these may be mentioned that of the eminent French detective, Goddefroy. Up to now the method has been used mainly for recording marks upon weapons, the handles of tools, and similar objects, but there seems to be no reason why it should not be applied to footprints. Goddefroy employs aluminium foil of the type used for wrapping cigarettes. In special cases thinner foil is used. The principal is to apply the foil to the surface to be modelled and to apply even pressure over that surface so that the marks are reproduced on the foil. Either a positive or negative mould is available according to which side of the foil is turned uppermost. The modelled foil is reinforced by pouring plaster of Paris upon it. The foil adheres to the plaster of Paris but it can be removed if desired. In this case the same markings are found on the plaster of Paris to which, of course, the aluminium foil has communicated its design. The great sensitiveness of this foil to impressions makes it a very efficient medium for moulding. In the case of plaster there is not perfect smoothness of surface in most cases, and the foil does record with extraordinary sharpness the smallest indentation or other mark.

The application of this method to the recording of footprints will undoubtedly yield good results. It would seem to be necessary only to apply the foil to the footprint lightly pressing it down. The weight of the plaster afterwards applied would be sufficient to carry the foil into every interstice of the print. The difficulty of lifting is entirely eliminated since the foil does not, of course, adhere to the earth or other medium at all. In the case, however, of footprints in dust or mud it is doubtful if the method would be satisfactory. It is obviously more difficult to control the application of the plaster mixture where small quantities have preliminarily to be added, if the print is covered with foil.

Recently the French detective, Ashelbé, has described a very interesting composition which he proposes should be used primarily for the transfer of fingerprints, and which he

has called Aid. There are very great possibilities in the compound which may ultimately prove more satisfactory for taking moulds of fingerprints than plaster. This preparation consists of a mixture of gelatine wax and glycerine. Full details are not available concerning its preparation but the most satisfactory way of mixing it seems to be to prepare an aqueous solution of gelatine, heated to near boiling point, and then gradually to add the wax. The glycerine is finally added to bring the whole to a right consistency. When cool this mixture sets to a firm mass in which any required degrees of flexibility can be induced according to the temperature to which it is heated. For the transference of fingerprints Ashelb  heats the mixture in a spoon and pours it over the print. This is the method which could be employed for taking impressions of footprints, but no experiments have apparently yet been made. It may prove to have the same disadvantage as paraffin wax which undergoes contraction on cooling and thus does not record a mould of the same size as the print. There are, however, great possibilities in this new method and it is well worth a series of exhaustive experiments.

It may be said in general, however, that at present a plaster of paris is the only substance which can safely be used for recording footprint impressions, and that when the proper precautions are taken better results can be obtained by this method in all circumstances than by any other.

FORENSIC BALLISTICS.

In an investigation of any gun or pistol shot injury there are two related but distinct lines of inquiry—namely, (1) the examination of the wound, and (2) that of the projectile if it is found and of the suspected weapon. (1) can and must always be carried out, (2) will depend upon whether the bullet is discovered, and whether the weapon is traced.

The examination of the wound is the business of a medical officer, but at the same time it is desirable that the investigating officer should know something of the general nature of such injuries.

When a bullet is fired from any firearm it is acted upon by (a) the force of the explosion, (b) the resistance of the air, (c) the pull of gravity, (d) the wind, and (e) the “spin” due to the rifling of the barrel. In most criminal cases the effects of gravity and wind can be neglected since these factors only become of importance at long ranges; but it is important to note in passing that the range at which any given bullet is fired from any given firearm will profoundly affect the appearance and nature of the wound it inflicts.

This is directly related to the wounding power of the projectile which depends upon its energy (e). The energy is commonly expressed by the formula:—

$$E = \frac{MV^2}{2}$$

where M is the mass of the bullet and V is the velocity in feet per second. V^2 is, of course, very large in comparison with M and as the range increases the wounding power falls off very rapidly. Between 300 and 700 yards, for example, a projectile will lose more than half its energy. It is not, of course, generally possible to decide other than approximately from the nature of an injury at what range the shot was fired; but there are circumstances in which it may be

practicable to ascertain this by means of collateral indications. Where more than one shot is fired, and one which has missed its mark has been buried in woodwork, it is worth ascertaining the depth of entry which may give valuable information concerning range.

In most criminal cases the wounds to be investigated will be "clean," that is to say, produced at comparatively short range. Such short ranges can be divided into two main groups: shots which have been fired point blank, and those at greater ranges. The nature of the wound inflicted will vary considerably with the range, and as we have said, an approximate idea of distance can be gained. Evidence of range judged from the nature of the wound may be very valuable providing that it is properly considered in relation to other evidence and that it is not relied upon as being absolutely precise.

At point blank range the projectile will have done a great deal of damage. The wound will generally be large and there will be much tearing of the skin. The most definite evidence, however, will be the blackening of the wound which is produced by fragments of *unburnt* powder which have penetrated the skin. The same effects are noticeable up to a range of about six inches but they are appreciably less between a point blank range and six inches. In the case of a heavy charge, however, there may be singeing at six inches (Sidney Smith). The nature of the blackening is exactly the same as tattooing which is produced by a like effect, i.e., the rubbing of unburnt gunpowder into the punctured skin. This is the most valuable indication relating to point blank and very short range. Powder tattooing is not generally found at all at ranges beyond two feet.

But at these longer ranges discolouration of the wound is noticeable and is due to a metallic deposit from the bullet itself and to the bruising of the tissues. It is essential to bear this in mind. On a cursory examination the effects produced may easily be confused with the tattooing effect of a point blank discharge.

Where the bullet is fired at point blank or close range

particles of the powder are driven into the skin. The depth to which these have penetrated will often give an idea as to the range of fire, but this is a matter for the medical examiner who in any case is the only person qualified to make a detailed examination of the wound.

The general indications, however, should be carefully noted by the investigating officer. For the sake of clearness they can be summarised as follows. If the wound is large and there is much tearing of the tissues, and if considerable blackening of the "tatooing" type is noticed, the shot has been fired point blank or at very close range. If the wound is "clean," the shot has been fired at a greater range.

True in general, these maxims must not be accepted rashly and uncritically. A bullet fired at a given range and striking a bone will inflict much more injury than one which encounters no such resistance, and the circumstances must be taken into consideration in arriving at a decision.

The shape of the wound both as to its entry and exit is also a significant indication. If the bullet has entered at right angles to the wounded surface the hole is generally round, but is smaller than the bullet. Some idea of the actual size can be obtained by observing the surrounding tissue, the dark ring about the edge of the wound, the bruising produced by the violent impact. This dark circle approximates to the size of the bullet.

In the case of an oblique impact, the hole is oval in shape, and this will be more pronounced as the angle at which the projectile strikes is more acute. There are circumstances in which it may be slit or star-like, but this generally occurs only where the shot has struck loose skin as, for example, the scrotum.

A ricocheting bullet may cause serious laceration as it enters, the effect being similar to that produced by bullets fired at long range. The causes, however, are rather different. The ricocheting bullet is deformed, and this does more damage than one of normal shape. The long range bullet has lost its initial spin and may strike base foremost or sideways. Wounds of this type are entirely a matter for the

medical examiner. There are circumstances where a great deal may hang upon the diagnosis, for the evidence of the wound may decide if the shooting must have been accidental, and its result unknown to the person who fired the shot, or whether it might have been deliberate.

An entry wound more or less clean depresses the skin and tissue, and is comparable in this respect with a punctured wound of any type. There is generally a metallic stain, black or grey, round the depressed edges. The bruising effect may redden or blacken the skin additionally according to the force of the impact. A wound made in firm skin or where there is bony structure is larger than that produced in softer parts. The characteristic depression of the skin and tissue is generally sufficient to identify an entry wound.

Exit wounds show much greater variation. In the first place they are always of larger size, there is greater laceration, and the orifice is more irregular in shape. The form may be a vertical or horizontal slit, star-shaped, or a bird-like form with extended wings. Again, the exit may produce an irregular tear.

A shot which has passed through the skull will generally show, if the velocity of the bullet has been great enough, a clean punched hole of entry. On the other hand, the exit wound will show a cone-like formation on the inner side of the skull, produced by splintering.

The indications quoted are normal and typical but the more exceptional cases ought to receive some consideration here. Cases have occurred in which these characteristic indications are absent. Hans Gross has reminded us that in 1893 an inquest was held upon a man who was reported, upon medical evidence, to have received a knife wound in the nape of the neck which was not thought to have been deep enough to have caused his death. A further investigation was for some reason made and a revolver bullet recovered from between two vertebrae. Mistakes of this kind are liable to occur where a superficial bone has been shattered and cut the skin.

The orifices of the wound of entry are not always turned

inwards, for where considerable laceration has taken place the skin may be pushed outwards, and the more so if the flesh is decomposing. There are circumstances also in which it is extremely difficult to distinguish the exit and entry wounds; and even experienced surgeons may remain in doubt. These examples are quoted for the purpose of indicating the risks attending too hasty a conclusion, and to emphasise the necessity of enlisting the services of the medical examiner with as little delay as possible.

Apart from the shape of the entry wound, proof of the direction from which the shot was fired can often be had by drawing an imaginary straight line between the exit and entry wounds. The bullet generally proceeds in a straight line after entering the body but there are many exceptions to this rule and it must not be assumed too definitely until the actual path of the bullet has been ascertained. It is, however, always well to note the relative positions of the two holes.

This brief outline suffices to show the great importance of the appearance and nature of the wound itself. To summarize, it is essential to note the shape of the orifice, the condition of the surrounding skin and the extent to which it has been damaged. To decide if possible which is the entry wound and which that of exit, and to get some idea, if this is practicable, from the relative positions of the two holes, the direction from which the shot was fired. A detailed examination by a medical man is in all cases essential.

The examination of the suspected weapon and the projectile found in the body or elsewhere often provides absolutely vital evidence relating to the author of the crime. In numerous cases, it has been scientific evidence which has been the direct cause of securing a conviction where other evidence would have been insufficient.

In the Gutteridge murder, for example, evidence was given regarding the marks on the base of a cartridge case and it was proved quite definitely that these marks corresponded to those which were made by discharging a similar type of cartridge from the revolver found in Browne's possession and

proved to be his. Enlarged photographs were prepared which placed the matter beyond doubt.

In nearly all cases where ejected cartridge cases are found on the scene of a crime, and where a suspect is afterwards arrested with a firearm found upon him, it is possible to compare the marking upon the cases with those upon the firearm, and to decide if in fact the suspected weapon fired these particular shots. Microscopic irregularities quite undetectable to the naked eye can clearly be demonstrated and compared by means of photomicrographs.

The bullet itself is also of equal value. In this direction physical and chemical methods are both available to examine it. A bullet found in the body or on the scene of the crime may be so deformed as to make physical examination of little use, but a chemical analysis of the bullet has established its identity or non-identity with the suspected ammunition. There are circumstances in which chemical evidence may be absolutely conclusive, but on the other hand it must be remembered that similarity in chemical composition, while it may establish the identity of type of two bullets, i.e., that they were supplied by the same maker, will not necessarily connect the suspected ammunition with the crime. On a final analysis, it proves nothing more than that the make of the bullets is similar. This, however, as has been said, may in many cases be conclusive when considered in conjunction with other facts.

The examination of the weapon if and when it is found is in some respects related to the study of the ammunition it has fired, and in some respects distinct from it. The physical examination of the breech can definitely be compared with the condition of the cartridge case and the marks on the projectile with the rifling of the barrel. But evidence regarding the condition of the barrel from which the period of time which has elapsed since the weapon was fired can sometimes be deduced, is distinct from the examination of the ammunition. In any shooting affair, therefore, our two main lines of enquiry become four—namely, the wound, the weapon, the cartridge case, and the bullet itself.

The wound has been considered in some detail; in the matter of the weapon the examination carried out will be both physical and chemical. We will consider first the chemical examination because this is never related to that of the projectile and is as a rule concerned only with the probable time at which the weapon was last fired.

Great caution is necessary in drawing conclusions from the chemical examination of the residue in the barrel of a firearm. Hans Gross has laid it down definitely that after two hours no rust is present, and no ferrous sulphate (sulphate of iron), there is considerable odour of sulphuretted hydrogen, and sulphides can be detected in the solution of the barrel residue in water. The solution is coloured yellow. Between two and twenty-four hours there is no rust, the solution is less yellow, and traces of sulphate are noticeable. From twenty-four hours to five days, rust appears and the solution contains iron. After ten days there is much rust and iron is not found in the solution at all.

It may as well be said at once that this is much too definite a connection of time with chemical composition. Taylor and Lucas are very properly much more guarded. So also are Robinson and Reiss, the last of whom being the most eminent authority. Lucas' results, also of great interest, are as follows:—

Time.	Chemical Condition.
2 to 3 hours	(a) With breech closed. Smell of sulphuretted hydrogen persists during the whole period, (b) With breech open. Smell of sulphuretted hydrogen never lasts more than five minutes.
5 to 10 hours	Traces of sulphides in 5 hours, none found after ten hours.

Sulphates Present *at all periods*.

Alkalinity Present *at all periods*.

This, if less conclusive than previous results, is much sounder, and remains of value. The disappearance of the

sulphide, for example, seems to indicate definitely that the shot was fired at least ten hours before, and if only traces are found, five hours before. The sulphates increase as the sulphides decrease so that the amount of sulphate may help to fix the period which has elapsed after ten hours. If rust has appeared the minimum time which has elapsed is probably 24 hours.

A chemical examination of this kind can, of course, only be made by a practitioner of experience, but it is important that the investigating officer should know that such an examination may be of great value. The suspected weapon should be protected by covering the muzzle to prevent dust getting in which might vitiate the analysis, and he should see to it that the firearm is carefully packed and despatched to the chemical examiner as soon as possible.

Physical methods rely upon the microscopic examination of the cartridge case and the bullet. In a very large number of instances it is possible to decide by this means the identity of suspected ammunition. The procedure, however, may have to be very elaborate to obtain conclusive results.

In the first place there are the grooves produced by the rifling of the barrel. At least theoretically these are unique for every firearm, even if it is new, and in the majority of instances the similarity of bullets fired from the same firearm can be demonstrated. An optical instrument known as a hastoscope can be used for this purpose. It is a comparison microscope in which two projectiles can be viewed at the same time and the rifling grooves compared. The holders which grip the bullets are fitted with micrometer screws by which the grooves can be measured and metric comparison made. With practice this instrument can be used by those understanding its principles which involve those of micro-measurement. A police officer trained in its use can make useful preliminary investigations, but it must be borne in mind that conclusive results are matters for the expert. There are many pitfalls and difficulties in the final interpretation of the results particularly in the case of new weapons in good condition.

Hastoscopic photographs can also be taken and comparative photographs of any given point upon two cartridges demonstrated. Those who can take ordinary photomicrographs can carry out this work. Since the enlargement is only four diameters these photographs are, as a matter of fact, rather simpler to take than the ordinary photomicrographs.

On the cap of the cartridge case is to be found the indentation due to the hammer or striker. This mark is often highly characteristic both as to shape and actual position. Here, again, an enlarged photograph will give very valuable information when comparative photographs of two cartridge cases are taken. An enlargement of four times actual size is generally sufficient. Such photographs present no particular difficulties to the skilled photographer. The interpretation of the results, however, is an entirely different matter. In the examination of projectiles and firearms as in other branches of criminal investigation, the question turns upon whether the evidence is required to follow up a clue or to present in court. In the former case the investigating officer with some training may obtain valuable information by making a preliminary examination himself. But where actual conviction is concerned the expert is indispensable. In this connection the physical and photographic methods are of value. The bullet or other clue is in no way altered, and can be passed to the expert for further examination. They differ in this respect from chemical methods which should on no account be undertaken by any but the expert. Results of this kind cannot usually be repeated so that it is essential that an expert examination is made in the first place.

There are, of course, many kinds of physical examinations which the non-expert should not undertake. In connection with the Best trial in America one expert forced a bullet similar to those used to commit the murder down the barrel of the suspected rifle to ascertain the appearance of the rifling marks on the bullet. Without commenting upon the utility or advisability of a procedure of this kind, it can be said at

once that such experiments should not be carried out except by experts after careful consideration.

The case of the trial of Browne and Kennedy for the murder of P.C. Gutteridge is a classic instance of the examination of a firearm and cartridge case. By a microscopic examination one of the experts (Mr. Churchill) proved that the marks on the breech shield of Browne's revolver corresponded exactly to those on the cap of the cartridge indentation for indentation, scratch for scratch. Photographs of this kind require expert manipulation, and cannot in any case be interpreted except by an expert where the evidence is to be produced in a court of law.

Mr. Churchill was quite positive:—"The cap of the cartridge takes the imprint of the breech shield of the revolver, and under microscopic examination it is possible for me to see that this particular cartridge was fired from this Webley revolver, and could not have been fired from any other revolver."

To summarize, the examination of the wound is capable of giving information regarding the range, whether the shot was fired point blank or at a greater distance, the entry and exit wounds, and the probable direction of the shot. In some cases the investigating officer will himself be able to arrive at preliminary conclusions which may be useful to him.

The chemical examination of the weapon, while often giving information of first rate importance must be carried out by a chemical expert.

The examination of the shot with a lens and the ha†roscope may provide evidence upon which the police can act quickly, but in this direction as in all others the assistance of the expert cannot be dispensed with.

The cartridge case, the examination of which does not differ essentially or in principle from that of the bullet, is in practice generally more intricate, but the marks of the striker on the cap may be no more difficult to interpret than the rifling grooves on a bullet. Correspondence, however, between minute scratches and indentations upon for example,

the breech shield and the cap of the cartridge case require special expert examination and interpretation.

It is of great use, however, to examine either a bullet or cartridge case with an ordinary lens. Some idea as to points of comparison can often be obtained in this way. The indications may be sufficiently strongly marked to be recognisable by means of a preliminary examination of this kind, and it is one which in the first place should not be neglected. File marks upon the breech shield of a weapon and scratches upon the cartridge case should be carefully observed. In some cases a very good idea as to whether a particular weapon has fired a particular shot can be obtained right away and acted upon while more precise information is being sought from the expert.

The possible importance of a chemical analysis of the bullet itself should also be borne in mind. Where this is to be carried out, the bullet should be sent to the laboratory as soon as possible. It should be placed preferably in a small glass tube, and sealed. As with the firearm barrel, it is important to ensure that the bullet does not come into contact with anything likely to contaminate it.

FORENSIC GRAPHOLOGY.

Apart from his ordinary duties, there is no kind of knowledge so useful to the investigating officer as a grounding in the theory and practice of graphology. When there is an important case in hand — or even sometimes in unimportant cases—what police headquarters is there which does not receive anything from a dozen to a hundred anonymous letters a day? Eighty per cent of these will be written by persons who have nothing to do with the case, and are without any useful knowledge of it, and a good many of the writers are hysterical or insane. Twenty per cent may be worth some consideration, two per cent may contain useful information, but even in this connection an examination of the handwriting may help in deciding which are the important communications and which are not.

If this is important, an ability to determine if two specimens of handwriting were produced by the same hand is a great deal more so. It is obvious that the connection of two documents with the same case may be of vital importance in coming to a decision about it. To determine this point with absolute certainty may be extremely difficult, but an ability to form an opinion upon this point, even if it is not conclusive, may be worth a good deal. The detection of not too obvious a forgery may also be of use to the investigating officer in many circumstances. In this connection it is well to note here, and to recall what has been said in a previous article, namely, that forgeries are of two kinds, the imitative and the manipulative. In the first, the question is one of examining the handwriting itself to determine if it is an imitation of the handwriting of another, or if it is disguised; in the second, indications of alteration either by erasure, scoring out or chemical washing have to be considered. The examiner of a document knowing that it is possible chemically to remove writing by bleaching will

know how to interpret a stain which might mean nothing to the uninitiated.

Before anything else is considered, it would be well to allude briefly to the manner in which documents should be handled if they are judged to be of importance. It is a good general rule to photograph them if this is possible. There is thus a permanent record of the document. Besides this, a photograph sometimes brings out evidence of forgery that the eye has missed. A point where an erasure has been made may come out very clearly on the photograph, or a stain due to chemical washing which was almost invisible to the naked eye may be revealed quite clearly. In some cases if different inks have been used, they may affect the negative differently and so reveal something suspicious. Lastly, the photograph can be examined in place of the document itself. Damage to the original is thus avoided.

This last consideration is of importance because if the document has to be passed on to the expert, it is necessary that it should reach him in the condition that it was when first received. As far as the actual writing is concerned, a photograph of natural size is quite as satisfactory for examination as the original.

On a last analysis a graphologist will admit that the only absolutely conclusive piece of evidence as to the authorship of a given specimen of writing is that of having seen the author write it. This does not diminish the importance of the internal evidence. This may be so strong as to make the presumption a practical certainty. We will briefly consider the principles of examination from which it is legitimate to draw conclusions in order of their importance. It is well to bear in mind that in deciding if a piece of writing is forged, the general principle will be to look for differences between the suspect writing and a specimen known to be genuine. This is not as elementary as it sounds. In the first place, no two samples of writing from the same hand are exactly alike, and there may be striking differences between two specimens of genuine handwriting. Secondly, there are or may be many points of similarity which do very little to establish

authenticity. Thirdly, where there is a presupposition that a perfect imitation is being attempted, the most telling analysis will be that of those points of difference which exist for the reason that the forger cannot eliminate them. There are certain things about any alien handwriting which an imitator cannot copy because he is not aware of them and with which in practice he cannot familiarise himself. Two primary illustrations of this are the relative heights of letters and the relative slope.

In the matter of slope, the reader can try an experiment for himself which is very instructive. It is best to choose a word containing four or five long letters, and to write it three or four times on a piece of paper, changing the slope with each example beginning with the natural slope. Now draw lines through the staffs of these long letters exactly in one and the same straight line with the staff. These lines clearly represent the angles of slope of the letters. It will be found that although the slope is altered, the ratio between the slopes of the letters remain the same. If, for example, in a double l formation, the second l slopes more than the first, this will be repeated when the slope of the whole writing is changed. If the next long letter is, let us say, a, b, and this b slopes less than either of the l's, this will be repeated throughout the specimens in which the slope is changed. There may be exceptions, and the correspondence may not be exact although it is often astonishingly close, but the general agreement will always be noted.

This method, comparatively simple in application, is of great value in examining writing suspected to be disguised. The most common method of attempted disguise is to alter slope, but the relative values of the slope remain, and can be determined in this way.

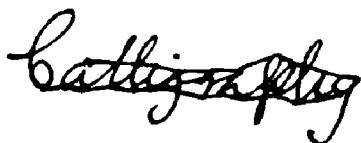
Where this examination is to be made, it is necessary either to make an accurate tracing of the writing, or to work on a natural size photograph. The original document must not, of course, be used. Practice is also necessary in drawing the lines accurately. It is by no means easy at first to draw a line in one and the same straight line with the staff of a

letter, and when the staff is not absolutely straight, it is more difficult still to determine the angle. With practice, however, it can be done fairly easily. A hard fine pencil should be used, and a ruler which is absolutely true. The slightest inaccuracy vitiates the result entirely.

This test is of great value. It can be applied anywhere with very simple apparatus in about half an hour.

A second elementary practical test is one relating to alignment. Children when they learn to write in copy books have lines to guide them, the intention being to train the writer first to keep the line straight, and secondly to maintain a correct alignment as between the individual letters of the word. But let anyone examine their own writing or that of a friend. First it will be noticed that in the majority of cases the lines are not straight. They may (1) slope upwards, (2) slope downwards, or (3) show correction, the line begins to rise or fall and is then brought back, so that instead of being straight and horizontal, it is more or less in the form of an arc. This is also to be observed of individual words. Individual letters are never in exact alignment each with the other. They rise and fall in respect of a horizontal line. The position of the individual letters is remarkably constant for a given individual, and may provide a means of identifying his handwriting.

The method of applying this test is fairly simple. Lines can be drawn from the extremities of the short letters just touching at top and bottom thus:—

A handwritten word, "Calligraphy", is shown in a cursive script. Two thin, slightly curved lines are drawn through the word: one line follows the top of the letters, and the other follows the bottom. These lines illustrate the alignment test described in the text, showing how the top and bottom curves of the letters relate to each other.

This examination is one not difficult to apply and, as the example shows, it reveals with surprising clearness differences of alignment and size. Hans Gross has advocated this method, and, provided it is not regarded as conclusive or exact, it is of great use. The top and bottom curves (to use the mathematical expression) will be found to agree in general for a given piece of writing.

It must, however, be borne in mind that a forger, or one

who is disguising his handwriting, can to some extent alter this characteristic. He can alter it first, because he is able to observe it, and secondly because a change in handwriting may automatically affect the alignment. This is not true to anything like the same extent of the relative slope. This may differ considerably in two specimens of handwriting, a genuine example and a good copy, without much affecting the general appearance. The relative slope is therefore more conclusive.

But in the case of the alignment, the examiner relies, as he does in any kind of forgery, upon the factor of fatigue. The imitator or the man disguising his writing becomes fatigued, and the characteristics natural to his script begin to assert themselves. In general it is true that the last part of a suspect document is where the highest percentage of valuable indications are to be found.

A third method of examination which is highly conclusive is the relative heights of the letters. In this case the heights of the letters are very accurately measured, and the relation between the heights worked out. As in the case of relative slope it has been established that the relative heights are constant for a given piece of writing. Even where an excellent imitation has been executed, the relative heights remain characteristic of the author's natural hand. This is highly conclusive for the same reason that the relative slope is conclusive. The imitator cannot decide as to relative height by inspection of the script he is copying. And if he does not imitate it the forgery may still look satisfactory.

This kind of examination is not so simple as those already quoted. In the first place it is essential to enlarge the handwriting about four times. Natural sized script is too small as a rule to be accurately measured. Accurate measurement is essential; and it must be carried out with a scale graduated in tenth parts of a millimetre. The work is trying, and it takes time, but for any who have accustomed themselves to accurate measurements, it presents no special difficulties.

There is no one test upon which it is safe in examining handwriting definitely to assume forgery, but of all, this one

is the most satisfactory. It must not be supposed that mathematically concordant results can be obtained. The handwriting of the same person shows differences of relative heights when written at different times and in different circumstances; but there are certain maximum variations within fairly narrow limits. If these limits are surpassed, there is a strong presumption of forgery. If the writing is, in fact, forged, they nearly always are surpassed. In quite clever forgeries, it is common to observe in curves relating to relative heights such profound differences between the suspect writing and the certainly authentic as to make it evident that the two specimens are not identical.

These are very briefly the principles upon which this kind of examination rest: measurement of angle, and measurement of height. They have been elaborated in a number of ways by experts, but basically, these measurements are a *sine qua non*. As we have indicated, the measurements of angle is, for preliminary purposes, within the competence of the police officer.

Angle and height have been considered first because they are more fundamental than minutiae, but there are other indications to be looked for to confirm the findings of these processes. A lens is a very useful adjunct in the examination of handwriting, and this for two reasons. It will first show clearly minute characteristics which may help to identify a given piece of writing, and secondly it may give an idea of the type of pen used, and how the nib has worn. The writing may be identifiable in this way.

As an example of the first we might consider the hook sometimes found at the termination of a down stroke of such letters as y, p and q, when the writer does not loop his y's and p's. The hook may be very small, but with a lens it will always be possible to see if it is directed to the right or the left. This is the kind of characteristic the forger will not notice. If in a suspected writing it is found by examination with a lens that all these hooks are directed to the right, while in the genuine writing they are all towards the left, there is probably something wrong. This characteristic is

not absolutely constant for a given handwriting, but eighty per cent. of the hooks will point in the same direction. The diacritic (crossing stroke) of the t is often hooked quite as characteristically. This is an example of the type of detail to look for.

In this connection those interested cannot do better than make a careful examination of their own handwriting, looking for small characteristics in it of a nature which cannot well be imitated. The forger, for example, can easily reproduce the position of the dot in relation to the letter, but if the dot is observed through a lens, it will be seen to have a characteristic shape. There are some thirty or forty different forms of i dot, circles, short lines lying in different directions, ticks, more or less triangular forms, and so on. Here again is a detail which the imitator cannot easily or consistently reproduce. In connection with i dots, it is an interesting fact that some people with the same type of pen consistently produce the same kind of i dot, while those of others vary in the same piece of writing. Sometimes as many as three or four types are noticeable. This is often of the greatest assistance in identification if the forger belongs to one of these categories, and his victim to the other.

There is another aspect of the characteristics of handwriting which is a very useful study for the police officer. In dealing with anonymous letters it is useful to be able to decide the probable age and education of the writer, and if the script is likely to be that of an insane or hysterical person.

The question of age can often be decided by the firmness of the line. With old people the writing tends to develop a tremble, particularly towards the end of a long manuscript; but there are many exceptions to this, since young people who are nervous, or with nervous disease, often show what may be mistaken for a senile tremble, while old people sometimes write with great firmness. This point, however, should be noted. As evidence of age the form of expression is often the most important point. Particularly in country places linguistic forms very often fix the period at which the writer was educated, or should have been educated, fairly accurately.

The actual script itself also frequently gives a key to the age of the writer if archaic forms of letters are used.

Communications from insane persons are a great problem to the police of all countries. This is aggravated by the fact that they are not always easily recognisable as the work of a disordered mind. The writer recalls an instance in which he received a communication for examination making a very serious accusation which, *prima facie*, gave no indication of insanity at all. It was coherently written, and well expressed. Obviously, also, it was the letter of an educated man. Certain small indications in the handwriting apart from the matter of the letter—persecution mania is always a possibility in such cases—induced a suspicion that the writer was not sane; but it was not until confirmatory evidence had come to hand that this was certain. The handwriting itself did not obviously reveal anything abnormal. In cases of doubt—and they are many—the opinion of a skilled pathologist is essential. But in some cases the handwriting makes a suspicion of insanity legitimate or even irresistible. Irrational misspellings should be noticed; repetition of words in the sense of duplication, a failure to complete words, and the misplacement of letters are often evidence of mental disorder. Sudden and unreasonable changes in the size of the writing are also symptomatic of insanity. It is very important to remember that some, and even occasionally all, of these indications may be found in conjunction with matter which might, if normally written, pass as being rational.

These are the types of indication which the police will do well to look for in the handwriting itself. They may give him valuable information.

There are some very useful indications which can be discovered both with and without a lens in regard to pen and ink. As to the pen, it is always worth noting whether a thick or thin nib has been used, a hard or resilient one. Broadness of fineness can be decided by inspection, but in the case of a resilient pen it should be remembered that a nib of this type even if it is of moderate fineness may give a fairly thick line. But its quality differs from that made with a

broad pen. Examination with a lens will show that the stroke has fine dark edges produced by the points of the nib. At the commencement of the stroke a small depression is noticeable due to the division of the nib points in any stroke in which the pen is held with the nib flat. If the side of the nib has been used the end of the stroke is angular; this is true of any nib. The "Waverley" or a ball-pointed nib gives a line quality rather similar to that of a stylographic pen. The fountain pen with a good quality nib has a smoother, more uniform appearance than writing with an ordinary pen, but a cheap fountain pen often gives a very ragged line quality produced not only by the wear on the pen but also by an uneven flow of ink. A "scratchy" quality is more often associated with a poor fountain pen than with an ordinary nib that has worn. The reason is that the ordinary nib is rejected as soon as it gives trouble, but owing to the difficulty of refitting a fountain pen nib, there is a tendency to use it for as long as it will write. In the matter of ordinary nibs, post and some other public offices are an exception to this rule.

The colour of the ink with which a document has been written should always be noted. It is also worth remembering that ordinary writing ink is never really black. When viewed through a lens it will appear in its true colour, blue or violet. Further, ink which appears to be of uniform tint may on examination with a lens show slight differences in colour. This is often a very valuable piece of information, for it may at once suggest interpolated forgery, the fact that more than one person has written the words, or that they were written by the same person at different times. The importance of a clue of this kind may be very great.

Examination of this kind is elementary, and involves no risk of damage to the document. An indication or the indications supplied by investigation of this kind may, however, give extremely useful information.

Manipulative forgery is an entirely distinct question. It may coexist with the imitative variety, but often, and indeed generally, it is independent of it. The manipulator of a

document usually wishes to make use of the existing signature, to erase or otherwise remove other writing upon it either with the substitution of other words, or with no substitution at all. He may want to make insignificant additions, which make an important difference, such as the addition of a y to the word eight, and a cipher before the corresponding figure. But here as far as imitation is concerned, he is less handicapped. In the first place he has very little to imitate, and in the second the imitation will not be so important. In a number of cases the drawer of a cheque does not write the body of the cheque at all; he merely signs it. No particular attention is therefore paid to anything but the signature, which is genuine. There are many cases in which if the forger successfully bleaches out all the original writing except the signature, and then types in the wording, the cheque would be honoured without question.

The examination, therefore, required in these instances is quite different. If it is suspected that an erasure has been made the simplest and most obvious examination is to hold the paper up to the light. It must not be supposed, however, that an erasure is inevitably revealed in this way. Certain kinds of parchment, like paper, do not show certain evidence of erasure which has been carefully done. But an examination of the suspected point with a lens will often succeed where the simpler method fails. A disturbance of the fibre of the paper may be noticed. If on the other hand the paper has been treated with gum, shellac, or some kindred substance to restore the surface, the lens will often reveal this. The paper will at this point reflect more or less light than the unattacked portions and the lens will increase the contrast, which may not show up clearly with the naked eye. It is best to hold the paper so that the light falls upon it obliquely.

A more common method of removing writing from a document is by washing it. It is perhaps well to state that the more common reagents used for this purpose are sodium hypochlorite, oxalic acid, and citric acid. Chloride of tin is occasionally used, but the three first mentioned are the most

usual. If these are properly applied, no ordinary writing ink will resist them, although some inks are much more difficult to bleach than others. A second point is of interest. The forger does not always completely bleach out the original writing, but relies on being able to write over it sufficiently closely to cover it. Thirdly, the washing materials always leave some trace; it may be insignificant, but it is there.

The most satisfactory preliminary procedure is to photograph the document. The stain left by the reagent used is one which nearly always yellows the paper. The camera may record this more sharply than the human eye, and a dark stain, the outlines of which can be clearly seen, will thus show up on the photograph. This is almost certain evidence of washing, and where it is noted the document should at once be sent to a laboratory for further examination. In some cases mere examination with a lens will reveal a suspicious surface condition at the point of attack with perhaps the presence of crystals. In cheques with coloured backgrounds any change in the colour, however slight, should be looked for.

In the matter of the bleached writing, the fact that it may not be completely invisible should be borne in mind. As a matter of fact it very often shows up in the photograph, even if only faintly.

Interpolations or additions are another matter. They may be extremely difficult to prove even if they are strongly suspected, and, in general, expert examination is required. But again ordinary photography may provide useful evidence. In this connection it should be remembered that orthochromatic plates are now available at a cost not much greater than that of ordinary plates. They are not very much more difficult to use, and the results they give in differentiating between insignificant differences in shades of colour are much more satisfactory than with ordinary plates. The chief precaution necessary in using them is to load and develop in total darkness. They can be desensitized and then developed in the ordinary way, but the best results are obtained without desensitization. If ink of a different tint has been used for

the addition, an orthochromatic negative will probably record the fact.

It is doubtful if an examination of the suspected interpolations or additions is of much use unless carried out by the expert. If it is merely the addition of a y, for example, and one cypher, a cursory examination will not, as a rule, reveal anything at all conclusive. But an examination with a lens may show something suspicious in the juncture of the suspect letter with the genuine one. In some cases the juncture is not complete, and a minute hiatus is to be seen, but this is not always so, and the added letter may, even under the lens, appear quite natural to any but an expert. A cipher standing alone is the most difficult of all interpolations to identify.

Falsification by tracing stands rather by itself. It may be the easiest or the most difficult thing to identify. It is very dangerous to the forger if he traces more than one signature from the same original, for if both are discovered, a mere superimposition of the two specimens and proof of their exact correspondence will reveal the forgery. But if only one tracing is discovered, and the original is not available, the counterfeit may be difficult to detect. But it depends. Resort is often had to tracing by the inexpert, who do not realise its dangers. A poorly executed attempt of this kind shows quite unmistakably what can best be described as a "wobble." The best way to familiarise oneself with the appearance is to attempt a tracing of a word. Really good traced forgeries where the tracing has been used as a guide, and not as a model, are matters for the expert.

Some allusions to typescript seem to be appropriate here because of the increasing practice of typing anonymous letters. It may as well be said at once that a typewriter is generally easier to identify than anything hand written. Close observation and the use of the lens can be of the greatest assistance to the police officer in this direction. There is no particular difficulty, once familiarity with the various kinds of type has been gained, to identify the make of typewriter used to write the matter under observation. The individual peculiarities of typescript are innumerable, and while some of

them are not easy to identify without considerable experience, the principle can be readily understood. Very valuable preliminary conclusions can be drawn in some cases from an elementary examination.

It might be said of this review that it has not given any very detailed information as to the examination of handwriting. That is quite true, but it is also true that no article could do this. The most that has been attempted is to outline the principles and indicate the direction that the investigation may take. To familiarise oneself with the problem of forgery, there is no better method than to experiment in forgery, to examine the result, and to test it by the methods laid down. One's own forgeries may be quite equal to or better than some performed with criminal intent, so that an examination of them may be quite as instructive as some that might arise in a criminal case. A careful study of one's own handwriting and that of one's friends is also one of the roads to success.

PRACTICAL PHOTOMICROGRAPHY.

Strictly speaking, photomicrography is the technique of enlarged photography, while microphotography means the photography of microscopic objects through the microscope. The article will be principally concerned with photomicrography, since except in special cases high magnifications are not required.

Low magnification photographs cover a very large field. It is not generally necessary to enlarge a finger-print more than four or five times. If it is desired to identify the weave of a piece of fabric a low magnification is sufficient, and in the case of handwriting enlargement to four diameters will give very useful information. This is also true of traces of tool marks on doors which have been forced, and sometimes of scratches upon locks. It will thus be evident that without entering the domain of ultra-microscopy a great deal of ground can be covered. Microphotographs under high powers require special technique.

There is a great deal of difference between taking a really successful amateur photograph, and even a moderately good specimen, for the purposes of criminal investigation. We shall presently see what those difficulties are. For the moment, however, it will suffice to reassure the reader with the remark that there is no new principle involved in taking the enlarged photograph. The technique of the snapshot is not, of course, absolutely simple. The camera has to be held steady, and it must be horizontal in respect of the earth. The conditions of light have to be taken into consideration, and the distance up to a certain minimum between the object and the camera. If these conditions are observed, the result should be satisfactory.

But satisfactory results for this type of photograph are in quite a different category from that required in criminal investigation. A slight blurring in certain parts of a land-

scape photograph may actually improve it. Too clear and sharply focussed an outline produces a certain hardness which is very unpleasing in work of this kind.

This is not true of technical police photographs. In the first place photomicrography is seldom if ever amenable to instantaneous exposures. A time exposure at once presupposes rigidity in the apparatus. The slightest movement will vitiate the result. Secondly, in this type of photograph the maximum sharpness of definition is essential. The slightest loss of sharpness may make important details either unintelligible or invisible. Thirdly, there is the difficulty of focussing. Where a photograph of natural size is being taken, and to a greater extent in an enlargement, the lens is close to the object to be photographed. Very slight alterations will accordingly affect the focus which at greater distances would have no effect at all. This makes focussing a much more delicate operation than in the case of an ordinary photograph.

It should perhaps be explained here that in all photography of this kind the view finder is not used. The image is viewed on a ground glass screen at the back of the camera, where it appears upside down. It is brought into focus by moving the front or back of the camera nearer to or farther from the thing to be photographed.

There is secondly the matter of illumination. This is not generally very complicated, except in the case of high magnifications, with which we are not now particularly concerned. But it is well to note that illumination is important. The amateur is liable to pay too little attention to it, and he thus falls into very gross errors. Photographic contrast is more marked in most cases than that which obtains in real life. If this is borne in mind it goes a long way to ensuring that sufficient attention is given to the matter.

Enlarged photographs can be taken up to three or four diameters with a camera which has what is called a triple extension. This means that the distance between the front containing the lens and the back can be increased by means of the familiar bellows to three times the distance of the

ordinary folding camera of the Lancaster type, which extends about a foot. The movement is controlled by means of milled nuts which work a rack and pinion. At the back is a ground glass screen for focussing. A convenient size is half plate, but a quarter plate camera will do good work. It is best that the camera should be of the ordinary type, with the usual arrangement underneath for a stand. But it is well to have in addition a long board upon which the camera can be rigidly fixed. This board should also be fitted with a vertical frame which will slide up and down, to which an object to be photographed can be fixed. The advantage of this arrangement is that the camera can either be used in the ordinary way on a stand for taking enlarged photographs anywhere, or can be fitted up in a room in which movable objects can be photographed.

The principle by which enlarged photographs can be taken with an apparatus of this kind can be understood by any one with an elementary knowledge of photography. The closer the lens is to the object the larger will be the image, but in order to make the image larger the extension of the camera has to be increased. For a given extension the lens can only approach the object a certain distance. It is thus obvious that the greater the extension, the nearer the lens can approach the object, and the greater will be its size in the photograph. It should be mentioned here that in taking photographs of this kind it is preferable to use the cap rather than the shutter. There is always a certain amount of vibration when the shutter is released which is liable to produce blurring.

The question of focussing has now to be considered. It has already been pointed out that the focussing of an object close to the lens is not an easy matter. The ordinary ground glass screen is not very satisfactory, and it is better to use one that has been acid etched. This type of frosted glass has a much finer grain. It is further a good thing to rub the glass over with a small quantity of vaseline, which helps to make the glass appear smoother still. Alternatively, an excellent method to make a screen is slightly to expose a

plate and then develop it until it is faintly grey. The plate is then fixed in the ordinary way and then washed and dried.

It is very difficult to give any rules about focussing, but the best method is generally to choose some prominent detail on the object to be photographed, and focus carefully on that. In actual practice it is always well to include a metric scale in any photograph of this kind. This should be marked in centimetres and millimetres in indian ink on a strip of absolutely white paper. This metric scale very often makes an excellent point to focus upon, but it is important to remember that the piece of paper used should be as thin as possible, otherwise it will not be quite in the same plane as the object photographed, and will not therefore be in exact focus with it.

While the focussing is being carried out it is, of course, necessary to have a black cloth over the head and back of the camera which excludes all light, since it is quite impossible to focus properly if much light is admitted.

Having correctly focussed the object, the plate-holder or film adapter is now placed in the camera. This must be done very carefully or the apparatus may move, and the focus be altered. It is particularly important to be sure that the screws which control the pivoting back are tight. Before starting work it is well to see that the dark slide moves quite easily in its groove.

The cap must, of course, be put over the lens before the protector slide is raised. Similar precautions must be taken in drawing the slide out as are observed when placing the dark slide in the camera, and it is quite essential in this case also that the slide should move easily in its groove. In making the exposure it is well to take the cap between the first finger and thumb round its upper edge and lift it upwards so that the fingers do not pass between the lens and the object when making the exposure. As soon as the exposure is completed the cap should be put on first and the slide replaced in the plate-holder as quickly as possible. It will be noted from this description that there is no difference in method in taking this type of enlarged photograph to

that employed in any other case. It is well to repeat, however, that great delicacy in focussing is the secret of success, and that the slightest movement of the apparatus, even to an extent which would have no effect upon the ordinary photograph, will vitiate the result.

No rules, of course, can be given in the matter of exposure. This will depend upon the intensity of the light, the colour of the object, and the speed of the plate in the lens. It may be said in general, however, that those unaccustomed to photography are liable to over-expose. In scientific work it is better to err on the side of over-exposure, but a little practise will quickly accustom the operator to the exposure required in varying conditions.

It may as well be said at once that for enlarged photographs of this kind artificial illumination is much more satisfactory than that of daylight. Artificial light is easy to control and standardise and, further, it can be directed from any angle and it can be reduced or increased at will. It is always advisable, however, to place a ground glass screen between the source of illumination and the object to be photographed, or, better still, to use an electric lamp with a bulb of frosted glass. The reason for this is that the filament of the lamp emits locally light of greater intensity and in consequence the object may be unevenly illuminated. The ground glass bulb or screen eliminates this difficulty.

The direction of the illumination will depend entirely upon the object to be photographed. In the case of a document, when no particular part of it is to be examined in detail, the light should fall directly on the paper so that it is evenly illuminated all over. But when an object such as a piece of fabric in which it is required to make a count of the threads per centimetre is to be examined, it is generally desirable that the lighting should be oblique. In these circumstances the weave shows up much better and it is easier to make the count of the threads. Owing to the fact that a shadow falls on the un-illuminated side of each stitch the contrast produced gives almost a stereoscopic effect.

An interesting illustration of this fact is supplied by the

photographs taken in the Podmore case. In this instance it was required to intensify by photographic methods certain indentations on the leaf of a receipt book which were quite illegible when observed in the ordinary way. Photographs of this piece of paper were taken under sharply oblique light and intensified by a method presently to be described. As a result of the lighting effect a shadow was thrown across these indentations which caused them to stand out more clearly than they otherwise would have done.

There are certain cases, particularly in those of documents, where illumination by transmitted light is desirable. This will sometimes reveal the difference of structure of the ink strokes in the enlarged photograph which would not be observed if the paper were illuminated by reflected light.

These rules for illumination are elementary and quite general. It is obviously impossible to lay down anything but general rules since the conditions have to be altered to some extent in every individual case. But it may be said in general that direct or oblique illumination are the two methods of lighting most required. It is usually possible to decide by inspection and experiment whether direct or oblique illumination is required.

The use of screens is generally a matter for the expert, and in the majority of cases they are not necessary for photomicrographic work at low power. But there are circumstances in which the results obtained by the use of screens are such a great improvement upon the unscreened photograph that some explanation of the principles seems to be appropriate here.

Objects which are black or white never require the use of screens, but the amateur photographer will be aware that different colours photograph in profoundly different ways which do not necessarily correspond with their apparent "lightness" or "darkness." For example, most greens appear black in a photograph while blues, which may be quite as dark a tone, appear much lighter. Yellow, again, even of light shade comes out black. This may very seriously affect the contrast obtainable in a scientific photo-

graph, and the photographing of, say, a piece of blue material may present considerable difficulty.

The theory of the screen is this. In order to give good contrast what is required is light of a colour which is largely absorbed by the colour of the object to be photographed. If, for example, an attempt is made to photograph a blue object in a blue light no photographic record will appear at all for the reason that the blue ray is not absorbed. If the object is photographed in a white light the result will be better because the object absorbs more white light. But the best result is obtained if light of a complimentary colour to the colour of the object is to be photographed falls upon it. Thus, if a yellow screen is used to photograph a blue object a very much sharper image of it is produced.

A green screen is useful for photographing certain kinds of reds and purples, but here it is essential to use a plate which is sensitive to green or the result, of course, will be very unsatisfactory.

The use of screens is now, however, often replaced by the use of filters which have been placed on the market by Messrs. Kodak. There are actually nine of these marked A, B, C, D, E, F, G, H, and H₁, and they correspond to the following colours. Orange, red, green, blue, violet, purple, orange, pure red, strong yellow, blue, and pale yellow. These filters, which are specially manufactured, are much more satisfactory than an ordinary screen, and the range of colours they control is, of course, much greater. It should be noted, however, that panchromatic or orthochromatic plates must be used with these filters, and it is necessary with this type of plate that the development should be carried out in darkness, since it is sensitive to red light.

The use of screens, of course, very greatly modifies the conditions necessary for exposure. In the case of blue light the exposure required does not greatly differ from that required in ordinary daylight. The exposure must be increased if a yellow screen is used, and the same is true of a green screen. But with certain types of yellow and green

screens triple the exposure will be necessary to that which is required with white light.

Foregoing directions are intended to apply where photographs are being taken, as it were, under laboratory conditions. That is to say, the object is moveable and that it has been possible to remove it to a suitable place for the purpose of photographing it. It may, however, very often be necessary to take enlarged photographs *in situ* under conditions much less easy to control.

In this case, a camera stand is necessary. It must be one which makes it possible for the camera to be used not only in a horizontal but in a vertical position. Special pivoted attachments are, however, quite easily obtainable which make it possible to use the camera in any position. In the matter of focussing and taking the photograph the same precaution must be observed in regard to rigidity of the camera and exactness of focus. Some special form of illumination will often be necessary since the ordinary lighting of a room will probably be quite useless for the purpose. A handy and highly satisfactory source of illumination is a powerful electric torch. This has the advantage of having a condenser lens in front of the electric bulb, which adds greatly to its illuminating power. It is essential, however, to use it in conjunction with a ground glass screen. Owing to the presence of the lens the filament of the lamp is strongly magnified and its image is actually projected on to any surface on which its light falls. It is thus impossible to use it without the screen of ground glass. Some sort of clamp is necessary to hold the torch. For this purpose a retort stand clamp, such as is sold by any chemical manufacturer, is very useful. Some kind of iron support is needed to hold the clamp. This can take the form of a thin iron bar about five or six feet long fixed in some heavy base. The clamp has a screw attachment which can be fixed to this and moved up and down to any required height.

The technique of microphotography is rather more complicated than that of taking enlarged photographs with a

long extension camera. For microphotographs either a microscope complete with eyepiece and objective must be attached to the camera, the objective used in conjunction with the microscope without an eyepiece, or a microscopic objective can be screwed into the front of the camera to replace the ordinary lens. Of these three methods the last is probably in principle the simplest.

Alternatively, however, the second lens of the eyepiece itself can be used. Magnifications up to forty or more diameters can be obtained by this method and, since the lens is larger, there is less tendency to distortion around the edges of the photograph. If the microscope is used, some means of attaching it to the front of the camera is necessary. For this purpose the writer has found that a piece of thick light-proof velvet answers very well. This can be sewn in the form of a sleeve which fits tightly round the collar holding the lens. The lens itself is, of course, removed. Round the other edge of the sleeve a piece of elastic is fastened, but so that the orifice is smaller than the tube of the microscope. The elastic will thus grip the tube of the microscope closely and exclude the light. In the absence of a special stand it is best to use the apparatus in a horizontal position. The body of the microscope can be swung back on its stand into a horizontal position, and the eyepiece will then be in line with the lens collar of the camera.

When the velvet sleeve is in position the focussing can be done. This is not so easy as in the case of ordinary photography. But it is carried out in the same way as when a microscopic examination is being made and the operator is looking through the instrument. The coarse adjustment is first used to obtain the rough focus, and the final focussing is done with the fine adjustment in the usual way.

With these higher magnifications it is much more difficult to judge when the maximum sharpness is registered. If, however, a very finely etched and vaselined screen is employed quite sharp focussing can be effected. There is a method of focussing using a clear glass screen and a focussing eyepiece, but this is not suitable for elementary work.

If rigidity of the apparatus is necessary for enlarged photography, it is still more essential in microphotography. Once the image has been correctly focussed, the operator must assure himself that the apparatus is absolutely rigid in all its parts. It is equally important that the micro-photographic apparatus is set up on a bench or table which does not vibrate unduly. If the room used for this work is near a main road, the photograph should on no account be taken when a heavy lorry, omnibus or tram is passing. Heavy traffic passing a laboratory at an inopportune moment has been responsible for the ruin of more than one micro-photograph. If such vibration occurs between the focussing and the insertion of the plate, it is necessary to re-focus before taking the photograph. Vibration during the exposure is absolutely fatal.

It is very undesirable to use the shutter for the exposure, and it is not really necessary. If the operator has an assistant he can hold a piece of blank paper in front of the objective. This does duty for the lens cap of a camera.

In micro-photography the illumination has generally to be more elaborate than when the ordinary lens is used. The objective is, of course, closer to the object, so that it cannot easily be illuminated in the ordinary way. There are exceptions to this. In some instances where documents which reflect a considerable amount of light are being photographed, an electric torch can be used arranged in an appropriate position and close to the paper. An ordinary electric lamp is quite useless for this purpose.

Usually, however, a bulls-eye condenser is the most suitable adjunct for lighting. This is arranged in such a way in respect of the source of illumination and the object as to throw a "condensed" spot of light on the part to be photographed.

This is a matter of experimental adjustment. The source of light should not be too far away from the condenser, which must be arranged so that a small bright spot of light falls on the object.

The most convenient form of bulls-eye condenser is one familiar to all microscopists which can be bought from any

shop where optical apparatus is sold. It has a brass stand with an arm fitted into it on a ball and socket. The lens itself is on a rod with a screw attachment fixed to this arm so that it will slide up and down. The condenser can thus be adjusted at any height and to any angle.

If the micrographic apparatus is of the type in which a microscopic objective replaces the lens of the camera, a special screw attachment in the lens panel is necessary into which the objective can be screwed. This form is focussed in exactly the same way as when taking an enlarged photograph, the only difference being that the lens is nearer the objective. On the face of it this would appear to be the simplest method, but in practice it presents some difficulties. The difficulty is the focussing. Where the entire microscope is used, the operator has the advantage of the fine adjustment. This is much more delicate than the rack and pinion device on the camera, which, besides being cruder, is more likely to alter after it has been made. Where the lenses are independent of the camera body, a slight independent movement of the camera, which does not disturb the microscope, will not necessarily make much difference, but it will easily be understood that where the lens is a part of the body, and relies upon it for its focus, the slightest movement will cause trouble.

In my own experience, the lens of the eyepiece has given very satisfactory results. Having no screw thread which can easily be utilised a regular adapter cannot easily be made for it, but a simple method of fixing it in position is to use a cork which fits the brass collar which normally carries the ordinary lens. The cork is bored with a hole the same size as the eyepiece, and the eyepiece is fitted in.

The lens of the eyepiece is much larger than that of the objective. It thus admits more light into the apparatus and simplifies the focussing. If sufficient extension is used, high magnification can be obtained, and there is no tendency to distortion at the edges of the negative, a condition which often obtains with the objective lens if they are not of the

more expensive type. The method of focussing and illumination is the same as in the other systems.

A frequent cause of failure in micro-photography is the arrangement of the specimen to be photographed. It is absolutely essential for the object to be exactly at right-angles to the lens. The slightest deviation from the rectangular position means that one side of the object will be in focus at the expense of the other side. Where a document is being photographed, the paper must be perfectly flat. It is not by any means easy to ensure that these elementary details shall be in order, but they are quite essential to success.

It will be well to conclude with a few directions in regard to the development of negatives. In the first place a thoroughly good ruby lamp is a sound investment. The cheaper varieties give a great deal of trouble, and they always allow the escape of a certain amount of white light. The alternative to the ordinary lantern form is the ruby-coloured electric lamp. A bulb of high candle power should not be used.

Any good developer may be used, "Pyro-Soda" being one which gives very consistent results in most cases. The plate or film should be thoroughly washed before it is put into the developer. If this is not done there are some plates which will be pitted all over. A mere immersion in water is not sufficient. They should remain soaking for about two minutes.

Under-development is a very common fault. The result is a grey, foggy effect. If erring at all, a bias in favour of over-development is better. The most satisfactory test of the end-point of development is to look at the back of the negative. When the high lights begin to show through clearly, the developing has proceeded far enough. The plate should again be washed before being immersed in the fixing bath. A plain solution of sodium thiosulphate (hypo) is quite satisfactory. About twenty-four ounces of hypo should be dissolved in one hundred ounces of water, or proportionately. The fixing should be continued until the plate has completely cleared and for about five minutes afterwards.

Thorough washing is essential. It should be continued for at least two hours in running water. The plates should then be allowed to dry in a cool place—direct sunlight will melt the film—and they can then be printed.

Allusion was made earlier in this article to the question of intensification. This is a matter for the experienced operator, but some mention of it is appropriate here. In cases where an enlarged photograph is taken of a faint smudge or trace of some kind, intensification may often be necessary before anything can be made of it. The method is simple in principle and highly ingenious.

The negative is developed, fixed and washed. If the image upon it is very faint, it is intensified. From this intensified negative a positive is made by means of a contact photograph. This will, of course, be slightly sharper than the original negative before intensification. This positive is intensified. From this another contact photograph is made, and this in its turn is intensified after development. This process is repeated until a really sharp image is obtained. Almost invisible traces can be brought up in this way.

This chapter has described in brief outline the elements of photomicrography. Without practical experience satisfactory results cannot be obtained, but if the information contained here is carefully followed, those with some prior experience of ordinary photography will not find that elementary photo-micrography presents any insuperable difficulties.

TRACES AND STAINS IN CRIMINAL INVESTIGATION.

As every policeman knows, the study of the history and development of finger print identification is a fascinating one. But its greatest if its least obvious significance is the indirect stimulus that it gave to the whole technique of scientific criminal investigation. It is now very difficult to realise the problems that the police must have encountered in their work of detection before the uses of finger prints were discovered. There were no proper means of identifying the individual in those early days, so that it was quite impossible for the police to be absolutely certain when they were dealing with a recidivist. The Bertillon measurements, although very valuable, were not infallible, as several cases of confusion of identity show. From the other point of view, an examination of the scene of the crime without the assistance of finger print evidence was necessarily much less complete than it is now.

This remarkable discovery did two things. It first made the identification of the individual absolutely certain once he was detained; and, secondly, if his finger prints were found on the scene of the crime it was an infallible clue as to his presence there. It is in this connection that we can describe the finger print as the most important type of identifying trace. But the indirect result of this discovery, however, has been the more minute and scientific examination of all kinds of traces with, of course, always the same object in view; the object is not only to identify the nature of the trace itself but definitely to identify that trace with a particular individual as distinct from all other individuals.

This has always been the aim of the detective, but the difficulty has been that in early times the methods by which any particular trace could be connected with an individual were exceedingly crude. There are many really horrible

stories of miscarriages of justice from this very cause; cases where, for example, a hat found on the scene of the crime has been found to fit the head of the suspected man; cases where the crudest possible method of comparing a footprint with the suspected man's boot has resulted in the conviction of the accused. The Hebron case, elsewhere quoted, is an example of this. It will be recalled that on the quite inconclusive evidence of a footprint the accused, who was completely innocent of the crime, was convicted and suffered unmerited imprisonment for many years.

This does not mean at all that the principle of such evidence is unsound. It is, on the contrary, when scientifically complete in the modern sense, the most convincing type of evidence there can be. That is why traces and stains have assumed such very great significance in modern criminal enquiries. The object is to try and make them as convincing pieces of evidence as finger prints themselves. The evidence they supply can never of its very nature be so finally convincing as the finger print, but combined with subsidiary facts, a scientific examination of this kind may complete the whole case.

Traces are of various kinds. There are finger prints and foot prints, mud and blood stains, dusts, hairs, and, in general, objects found on the scene of the crime. The object of the examination of any of these things is to correlate it with the examination of the suspected person so as to identify the individual with the object.

It is perhaps well to give an illustration of the technical requirements before discussing the methods actually employed. In an instance where a victim has been strangled with a particular kind of cord an examination will be made of the cord, whether it is made, for example, of silk, cotton, hemp, or some other material, for the purpose of identifying it. The related examination of the suspect when he is detained will be concerned with connecting him with this particular object. Thus, if fibres were discovered under his finger nails which could conclusively be proved to be of exactly the same material as the cord, a very high degree of

probability of identification has been established. This is, after all, exactly the same in principle as identification by means of a finger print. It is less conclusive because there may be different samples of the same piece of rope; there can only be one finger print. The one kind of evidence is a strong presumption, the other is an absolute certainty.

There is, therefore, a fundamental difference between the finger or skin print trace and any other trace. But indications of the latter kind are not useless because they are not absolutely conclusive in themselves. In building up circumstantial evidence, it is the degree of probability which carries the day. Each little fact added to the growing deposit of circumstantial evidence adds something to the degree of probability, and therefore to the construction of a convincing case.

After finger prints, bloodstains are the most valuable indications to look for. This does not apply only to affairs of murder. A housebreaker or an individual who has committed robbery with violence may cut or otherwise wound himself, or be wounded, and thus leave evidence that there has been blood shed from one cause or another.

When stains are found on the scene of the crime, they ought to be treated with the greatest care. It is worth remembering that bloodstains cannot always be identified as such. A fresh stain is fairly easy to recognise, but older ones have such various appearances that it is far better to assume that a doubtful stain is blood and treat it accordingly. Blood has to be biologically examined and apparently insignificant circumstances may affect the tests which have to be applied to it. A bloodstain should not be kept in a warm place or in the neighbourhood of a fire, and it should not be left in the sun.

Stains suspected to be of blood are always tested first to decide this point. There is one fairly simple test which can be applied by those without special knowledge of the subject. A small portion of the stain is treated with a little water and a few drops of an alcoholic solution of guaiac are added. The mixture is allowed to stand until a slight tur-

bidity develops, and then a few drops of hydrogen peroxide are added. If the stain is one of blood, a blue colour develops. This test is not absolutely specific; there are circumstances in which milk, pus, saliva, and sperm give this reaction. But if the water containing the blood is boiled, the Guaiac Test still gives a positive reaction. With the other substances mentioned boiling makes the test negative.

The Benzidine Reaction is another delicate test for blood. The test solution consists of benzidine in glacial acetic acid. Hydrogen peroxide is added to this and a small quantity of the solution of the bloodstain in water. A green or a blue colour develops if the stain is one of blood.

A test very commonly used is Teichmann's Haemin Test. A small fragment of the stain is placed on a microscopic slide and treated with saline solution to dissolve it. A minute grain of salt is added and the drop is then gently evaporated until it is dry. A microscopic cover glass is put on and when it is in position a small drop of glacial acetic acid is run under the cover slip so that it mixes with the dried residue. The mixture is gently warmed till small bubbles appear. If the slide is now examined under the microscope haemin crystals are noticed. They are of characteristic shape and brown in colour. This is one of the most usual tests for blood.

The Bordet Reaction is the one now always used in distinguishing human from animal blood. The test is carried out by the use of what is known as a specific serum. That is to say, a serum separated from the blood of an animal which has been injected with the blood of a human subject. This specific serum, when mixed with a sample of suspected blood, will give a precipitate with it if the blood is human, and no precipitate if it is not. There are other specific serums beside the human which are used if it is desired to test blood suspected to be that of an animal. In this case the serum employed is that prepared from the blood of an animal which was originally injected with the blood of another appropriate animal. These serums can, of course, be purchased ready prepared corresponding to human blood, or

practice if reliable results are to be obtained. The use of these methods will have made it evident that great care is necessary in dealing with the stain. The stains are exceedingly delicate, and since so much hangs upon their correct performance it is essential that nothing should be done in collecting the material to be examined which is likely to vitiate or confuse the test. As with other exhibits, it is better whenever possible to enclose them in glass tubes or small bottles which keep the stain out of contact with the air. If stains are being cut out of a piece of material great care should be taken not to cut too close to the edges. It is also worth remembering that bloodstains may be very minute and it is not sufficient merely to make an examination for the more obvious ones. Where the stains are upon fixtures it is much more satisfactory to get the expert himself to remove them, but where this is not possible the proper procedure is to detach the whole of the stain by cutting away the piece of wood or other material which carries the stain. Where this cannot be done, as in the case of a glass, a very sharp knife should be used to detach the whole of it.

There is now another biological test for blood which is sometimes of very great importance as a clue. It has been known for some years that the blood of the human species falls into four groups. By means of certain agglutination reactions on more or less the same principle as the specific reactions for determining the origin of blood, it is possible to decide in the case of any stain of human blood into which group the blood falls. We observe here increasing refinements in the technique of identity. The preliminary tests decide merely if the stain is one of blood; the Bordet reaction determines if it belongs to a human or animal subject; the Group Test will often give valuable information regarding identity.

This question arose at the trial of Maurice Freedman, who was tried and found guilty of the murder of Annette Friedman, on January 26th, 1932. It will be recalled that the razor with which it was suspected that the crime was committed

found by the police on the top of a 'bus. A test of the stains carried out by Dr. Roche Lynch showed that the blood belonged to Group 1. It was stated in evidence that only some three per cent. of individuals possess blood in this group, and the murdered typist's blood was of Group 1. There was thus strong presumptive evidence that this was the weapon used to commit the crime. In the positive sense, testimony of this kind cannot by itself be absolutely conclusive, but from a negative point of view it may be. As example, in this particular instance if the blood had *not* been of Group One the police would have had to search elsewhere for the weapon. Bloodstains and their biological examination become always more important in inquiries of this kind.

The first thing to be considered in any affair or accusation of attempted violation or rape is the stains which may be associated with the clothing of the victim, and/or the author of the crime. If they can be identified as being those of sperm it is clear that some sexual irregularity has either occurred or been attempted. Sperm stains have no characteristic appearance, so that any mark upon clothing in such circumstances must be preserved for examination.

A test commonly employed for the detection of sperm is known as the Florence Reaction. The reagent used is a mixture of iodine and potassium iodide. This is mixed with a solution made with the stain in distilled water with which sperm produces small brown crystals. The reaction is not completely specific since saliva also gives a similar reaction, but microscopical examination with the identification of spermatozoa is a confirmatory test. The chief precaution which must be taken in protecting a mark suspected to be of sperm is to prevent rubbing it. This damages the spermatozoa and may prevent their microscopic detection.

A sperm stain can sometimes be detected by its shape. It has irregular edges when found on fabric, somewhat reminiscent of a geographical map. On flesh, dry sperm has a bright somewhat varnish-like appearance. If these characteristics are noted it is a strong probability that the mark is in fact a sperm stain.

The detection of dust is one of the most recent branches of forensic science. The search for dust is generally associated with the individual. It may be in his clothing, in his ears, or nostrils, or under his finger nails. In many countries it is now a matter of routine for the dust in the clothing of a suspect to be examined, and in the case of certain criminal occupations, such as coining or the illegal manufacture of explosives, positive results are almost certain indications of guilt. The method of extracting dust from clothing was originally to place it in stout brown paper bags which were beaten. This procedure has now been replaced by the use of a special vacuum cleaner made by the Electrolux Company, of Stockholm. The ordinary dustbag is replaced by a special metal capsule containing three filters, which trap dust of three different particle sizes. The capsule is very easily cleaned, and it is a simple matter to remove the three grades of dust from the apparatus. But failing this special vacuum cleaner, the method of beating the clothing in a brown paper bag is the best. An ordinary vacuum cleaner must in no circumstances be used, since it is quite impossible properly to clean the dust receptacle.

Dusts are of two general types — occupational dust and dusts which are associated with locality. Occupational dust is definitely related to the identity of the individual. It has already been explained that metallic dusts, as an example, may give direct information regarding illegal occupation, but there are many other circumstances in which the identification of the wearer's occupation may be established by the examination of the dust in his clothing. Millers, mechanics, bakers, brickmakers, workers with coal and dye, boot-makers, perfumers, workers with tobacco, are among the very large number of workers whose occupation can be decided from an examination of the occupational dust associated with their clothing. Locard, Popp, Söderman, and Gross have all described instances where such an examination has established occupation.

It will be quite obvious that there are circumstances in which the establishment of this kind of identity is quite as

important as the detection by finger print. The ultimate importance of finger-print identification depends upon whether the police have in their possession a record of the criminal's finger prints. If they have, the matter of identification is a more or less elementary affair; but if they have not, the finger print in itself found on the scene of the crime is not of very much use until a later stage. But if from a garment or some other object found, it is possible to decide the occupation of the individual, the police have in their possession a piece of information which, for the time being, will be more useful to them than a discovery of his finger print.

The reconstruction from the individual's garment of that individual's occupation at once narrows the field of investigation. And it may narrow the investigation to a comparatively small group of people among whom the criminal can be found. This is well exemplified in an instance quoted by Hans Gross. A coat found on the scene of a crime yielded as occupational dust considerable quantity of wood fibre and glue. The presumption was that the owner of this coat was a cabinet maker. This line of enquiry was followed up and the author of the robbery was discovered. He was in fact a cabinet maker. It will be observed that his detection was independent of the fact as to whether or not he had been in the hands of the police before. This is the real value of this kind of research. It is a matter of common experience that in the case of the intelligent criminal it is very difficult to obtain evidence against him if he has not been in the hands of the police before.

Dusts of locality do not relate to the identification of the individual at all. An examination of them cannot be made until the suspect is actually under detention. They often have a considerable bearing upon an alibi and check the truth, or otherwise, of the suspect's statement. There is a very interesting early example of this, namely, the Kirkcudbright murder, which took place in 1786. In this affair the accused man who had murdered a girl in a cottage endeavoured to construct an alibi by asserting that he had not

been in the neighbourhood of the house at the time of the murder. He declared that he had, in fact, been in a wood some two miles away at the time. An examination of the mud on one of his stockings was found to correspond exactly with the mud which surrounded the house. On this evidence, together with a great deal of confirmatory material which was collected, the accused was convicted. Before being executed he confessed to the crime. This illustrates the principle very well. As a matter of fact, it would have been quite impossible at this period for the investigators to identify the nature of the mud with certainty, and without confirmatory evidence a very serious miscarriage of justice might have resulted had he been condemned on this evidence alone.

But modern methods of investigation make conclusions of this kind much more certain. In a very interesting study quoted by Popp a much more exact application of this method was applied. The incident occurred in Wildthal, in 1904. The suspected man, accused of murder, declared that he had not been anywhere near the scene of the crime at the material time; that he had, in fact, been working in a gravel pit. A minute examination of the dust in his clothing and the mud on his boots was made. In his clothes and more particularly in the mud on his boots an abundance of mineral matter was discovered which was conclusively proved to be, from the microscopic shape of the crystals, fragments of mica and another mineral, a double silicate of calcium and magnesium. This was the type of mineral matter of which large deposits existed in the immediate vicinity where the body was found. The accused man was convicted and ultimately confessed to the crime. There was in this case, also, ample confirmatory evidence, but had there not been, this might have been sufficient evidence alone on which to convict him. This example is an interesting comparison with the Kirkcudbright affair. The principles are exactly the same; it is the improved methods of examination which make the latter case so much more satisfactory.

Methods of examination are necessarily very varied, and in some cases highly complicated. It is difficult to lay down

any general rule because the method of examination required will depend entirely upon the nature of the dust, and in many cases only exceptionally highly-trained experts will be able to supply information concerning them. But assistance from those who actually practise the appropriate trade will also often be useful and help to solve problems which would otherwise be extremely difficult.

Chemistry and microscopy are, however, generally quite equal to the identification of a dust. The first examination made is always with the microscope. Mineral matter of various kinds can be detected by its crystalline form. There are various chemicals which have quite characteristic crystalline structure. Starches can be identified, since under high magnification these appear in characteristic form. Yeasts are also simple to detect.

The micro-chemical methods for the examination of dust are still under investigation, and although this is a comparatively new branch of research the results which are being obtained in the detection of minute quantities of a large number of substances are very impressive. There are characteristic micro-chemical reactions, microscopic appearance, or both, for a large number of the minerals which include quartz, granite, anhydrite, felspar, and scoria. There is no metallic dust, even when present in very small quantities, which cannot be detected by micro-chemical methods.

Organic substances present greater difficulty. To be able to discover minute traces of alkaloids in association with clothing of the person of a suspect is a significant example. In an examination of this kind the chemical reaction is carried out on a microscopic slide and the reaction watched under the microscope. With various specific reactions alkaloids produce colour changes which, when viewed microscopically, can often be detected even when the alkaloids are present only in infinitesimal amount.

As a final example, something should be said of the examination of the finger nails. There are quite a number of cases where even if blood is absent elsewhere, it has been discovered under the nails of a suspected person. An

examination of this kind for traces other than blood is tedious and troublesome and more often than not it is negative, but it should not be neglected. There are a number of instances in which minute fibres having reference to ropes (affairs of burglary), or to other kinds of cord (affairs of strangling) have been discovered. In one case it was possible to identify the gome (mixture of oil and dust) found under the finger nails of a burglar with a greasy mixture on the rope he had used to let himself through a skylight into a jeweller's shop.

It is not possible, except for an individual with experience of such work, to remove the wax from the ears of a subject under examination. It is, however, a well-known fact that occupational dusts are often found in the wax of the ears for as long as two years after the individual has ceased to follow a particular calling. There are therefore cases when it is necessary to check up a suspect's history when information of this kind can only be confirmed or disproved in this way.

It will be obvious that the examination of traces and stains is now a very important part of criminal investigation. The work is generally highly specialised and cannot readily be undertaken by any but experts. But we have endeavoured to make it clear what precautions ought to be taken in handling traces and stains, how they ought to be treated, and the conclusions at which a scientific examination may be able to arrive. It will be seen that from some of the cases quoted that no solution would have been reached had this kind of evidence not been properly interpreted. Advances in this kind of investigation are helping to solve many problems which a few years ago could not have been cleared up.

CRIMINAL ANTHROPOLOGY IN THE SERVICE OF IDENTITY.

The history of criminal anthropology has been a chequered and interesting one. Its meaning and significance have entirely changed in recent years. Criminal anthropology was originally associated with Lombroso, and the theory of the "criminal type." No orthodox Lombrosians remain, and the theory nowhere exists in the form that its inventor enunciated it. But from an historical point of view it has great importance. It is generally known that the great Italian came to the conclusion as a result of a detailed study of the criminal skull that criminals existed as a definite anthropological type, and that certain cranial abnormalities were associated with criminality. There is nothing inherently absurd in the theory, and contrary to accepted views, at least in Great Britain, it has never been proved to be entirely without basis in fact. Lombroso has been greatly misunderstood, and due attention was not paid by his critics to the definition of the word *criminal* itself. Mere conviction of an offence did not, for the school of Lombroso, constitute criminality. On the other hand, the fact that an individual had never been in the hands of the police did not, in Lombroso's view, necessarily prove that that individual was not a criminal in the theoretical sense. The view that criminality was merely a legal matter was not acceptable. Apart from its anthropological implications this theory, which has a psychological aspect, is almost as unpopular as the anthropological one. But the theory of criminal psychology in the specialised sense is very far from being exploded, and it was with this fact in mind that Lombroso's theory ought to have been judged.

However this may be, there is no question at all that this Italian alienist overstated his case, and in view of more recent investigations, the theory of the "criminal type" in

the anthropological sense cannot be said to have stood the test of time very well. It was modified from time to time, and in no very convincing manner, by Lombroso himself. His disciples, Ferri and Garofalo, modified it still further, and it cannot be said that any of Lombroso's original postulates really remain.

This does nothing to mitigate the great debt which criminology owes to this remarkable man. He was the first to make it clear, expressly and by implication, that the study of the criminal was at least as important as a study of the crime. Lombroso can truly be described as the pioneer of the science of criminal psychology. He initiated the study of the criminal mind, a study which has had a profound effect upon the technique both of detection and of penal methods. The serious attention which is now given to criminal science is very largely a result of his immense enthusiasm, and unbounded industry.

His influence has come to be almost entirely indirect, but his work led up to a much closer study of the formidable problem of identification. With the technique of fingerprints at our disposal it is difficult to realise the great difficulties which surrounded any question of identification fifty years ago. It is well known to all police officers that the general "description" of an individual does not, in fact, describe him at all. We are all familiar with it:—"Of medium height, brown hair and moustache, erect carriage; when last seen was wearing," and so on. The unfortunate police officer, however inexperienced, will not be long in discovering if he is set to watch for a particular individual, who has alighted from a train among two or three hundred others, that such a description is not of much use to him. But it is not uncommon, all the same, for descriptions of this kind to be issued even now. They are useless, and in some circumstances they may be worse than useless. The only description which can be of any value is one which emphasises characteristics that are more or less unique, and ones, too, comparatively easy to recognise.

It is in this connection that Lombroso's work has had so

great an influence upon the technique of identification. For the purpose of developing his theory, he made a minute study of the skulls and facial characteristics of thousands of criminals. It is for this reason that the term criminal anthropology is still current, but its meaning is somewhat different. The measurements of the skull and face, and the close observance of their characteristics are now no longer carried out with a view to the establishment of any particular theory, but with the practical aim in mind of certain identification.

This method was in use before the advent of fingerprints and was actually invented by Bertillon. The system of the Bertillon measurements aimed at distinguishing the individual from all others. The measurements made were twelve in number, and they included the height, the length of the outstretched arms, the foot and one of the fingers. It was claimed that no two individuals could agree in all these twelve respects, so that confusion of identity, once the measurements could be checked, was impossible.

The system was undoubtedly very satisfactory, but the classic instance of the Will Wests shows that it was not infallible. In this extraordinary affair, a negro named Will West was sentenced to a term of imprisonment to be served at the Levensworth Penitentiary, Kansas, in 1903. His Bertillon measurements were taken, and while this was being done the record clerk who thought he recognised the man looked up the card index. Under W, a prisoner of the name of Will West was discovered who was a negro, and whose measurements agreed almost exactly with those of the prisoner. • The photographs, also, were strikingly similar. Taxed with having served a term in that prison before, the prisoner West denied that he had ever been a convict there. He was not believed, but on investigation another prisoner was discovered who was actually serving a life sentence for murder. The two Wests were almost indistinguishable with their hats on. Their Bertillon measurements were substantially the same. Only their fingerprints were different.

In defence of Bertillonage, it should be noted that it is improbable, in fact, that all the measurements did agree with

exactness. But it was a serious disadvantage of the method that to record twelve measurements of this kind with complete accuracy in every case presents great practical difficulties.

Historically Bertillonage is significant. It is an anthropological method which provides a link between the more refined technique of to-day and the practical work in connection with criminal anthropology carried out by Lombroso.

It is also worthy of note that Bertillon was the first to introduce the full face and profile photographs. This is literally where the modern science of identification begins. The intention of the double portrait was to emphasise any peculiarity on the sound principle that a distinctive mark, however insignificant in itself, was more important for the purposes of identification than a striking characteristic of a kind which the individual might share with others.

The technique of identification has two distinct aims and uses. There is plenty of room both for the fingerprint and the anthropological methods, for the reason that they do not serve the same purpose. It is obviously impossible for a detective detailed to pick out, if he can, a wanted man among a crowd of innocent persons to make use of the fingerprint method. This infallible check upon identity will be applied afterwards. But on the other hand, how is the detective who may never have seen the wanted man to recognise him with certainty when he does see him? And if he is disguised can he be identified? These are formidable problems which the anthropological method of identification has set itself to solve.

In observing an object of any kind whatever, no general view of it will probably impress its image on the mind. In the process of observation, if the observer looks after the details, the appearance of the whole will look after itself. If it is desired to recall the exact appearance of an object, the synthetic process is the one upon which we must fall back; the image must be built up from its component parts. If these have been properly observed in the first place, the

parts will inevitably fall into their right positions in the whole. The reverse operation might be described as analytical—the method by which an attempt is made to get a general idea of the whole which is then analysed in order to arrive at the details. This is generally the procedure of the untrained observer. It gives rise to very curious mistakes, and it accounts for many of the strangest examples of mistaken identity.

Experience and common sense supply the explanation. An undigested conception of the whole gives the imagination plenty of opportunity to fill in the details. Various parts, and various configurations of those parts, can often be made, more or less, to fit the same whole, but if the parts have been well and truly observed, it will only be possible naturally to fit them together in one way. To illustrate by way of example, it is a remarkable fact that an ordinary observer is often extremely doubtful if a given individual he is asked to describe wears a moustache or not. In such a case he will obviously be more doubtful still as to the type of moustache. A moderately heavy moustache always partly conceals the mouth. The observer thinks he has a good general idea of the face; he is uncertain of the moustache. But in reconstructing the face he must include the mouth. If he is uncertain if the moustache covers any part of it, or if there is a moustache at all, he is almost certain to reconstruct it wrongly. There are now two mistakes instead of one. Circumstances can arise in which this process may be multiplied indefinitely. The original impression of the whole becomes modified in such a way that the mental image of the face at last bears no resemblance at all to the reality. Looked at from this point of view, mistakes in identity which *prima facie* appear almost incredible are quite easily explained.

Modern methods of anthropological identification have been devised which largely overcome these problems. The *Portrait parlè*, as it is called, which has been introduced by Bertillon, of the Service of Identity of Paris, is the result of a highly detailed investigation of the characteristics of the

human face with special reference to its identification in all circumstances. The method has something more than scientific significance. It is designed to train the police officer to develop his powers of observation in such a way as to eliminate as far as possible any possibility of error.

The basis of the system is the photograph, and as such it is a direct development of the original methods introduced by the eminent father of the present chief of the Service of Identity of Paris. As in the original procedure, two photographs only are necessary—a full face and a profile. But a great advance has been made in the method of studying these photographs. Originally, they were examined as a whole, but the new method is to prepare photographic representations of sections of the face so that they can be studied individually and out of relation to the surrounding features. The following are typical examples of the sections examined. In the first place, the longitudinal half of the face is represented; that is to say, that the forehead, nose, eyes, mouth, and chin appear, but the back of the head is eliminated. There is, secondly, a lateral division of the face. The upper half includes the forehead, eyes, and approximately half of the nose. The lower half represents the lower part of the nose, the mouth, and the chin. There is next a photograph which portrays only the hair and the forehead. These photographs, of course, all appear both in full face and profile. The individual members of the face also receive special attention. Photographs are made of the right and the left ears; the nose is also individually portrayed, and there are photographs of the mouth and eyes. These are the outstanding features and the basis of the whole system. It is impossible to realise without having studied the photographs what a very great difference these sectional photographs make to a real understanding and appreciation of the identity of any individual.

From a theoretical point of view, the fundamental principles of the Bertillon system have their origin in the anthropological statistics compiled by Sir Francis Galton. In order to study anthropological characteristics of the face and skull.

Galton prepared and examined series of photographs of normal and abnormal types. From these he constructed composite photographs by reproducing the portraits in the same scale, and applying each to the other. It is a remarkable fact that Galton discovered that in regard to shape and size and in the cranial abnormalities, the criminal examples showed a fairly close general agreement; while on the other hand, the faces and heads of men chosen from among, for example, the crack regiments of the British Army were symmetrical, and also agreed closely with each other. He further found that the expression of villainy associated with the criminal faces was purely incidental. It was the shape of the skull and the features which were typical.

This has an important application in the matter of criminal anthropology in the service of identification. To speak of a normal type of physiognomy is in a sense quite arbitrary, but from a practical point of view the term normal has great significance. For the purposes of identification, the perfectly symmetrical face is taken as the standard, and cranial and facial measurements are ultimately referable to that. The object of all measurements made is to decide in what respects the face and skull are asymmetric, that is to say, in what degree it deviates from the ideal normal. As example, measurements can be made to decide if the ears, eyes and eyebrows are in line with each other, how far the opening of the mouth deviates from the horizontal, and if the nose inclines to right or left.

The principles of the system will now be clear. The object of this elaborate procedure is to establish anthropological identity beyond reasonable doubt, and to make it available in practice for anyone who may be called upon to recognise the individual concerned. The face is dissected and examined piecemeal, and by means of detailed observation and exact measurement, the most insignificant characteristic is recorded and impressed upon the memory. No general examination of a portrait can be compared with this method.

It is now desirable to give some account of the photographic apparatus employed for this work. The camera

usually employed carries a whole plate, and is of the usual portrait type. The dark slides are of special construction and so arranged that both the full face and the profile portraits appear on the same plate. The focussing screen should be of the finest acid etched glass so that a perfectly sharp image can be focussed upon it. The lens should have a wide angle. The camera stand should be of the substantial type that photographers accustomed to take portraits use. A heavy rack and pinion adjustment should be fitted for raising and lowering the camera.

It is customary to have a special seat for the subject to occupy when the photograph is being taken. It should be small with some sort of attachment in front across the arms to prevent the sitter moving. Suspects and accused are not perhaps so difficult to photograph as they used to be in Bynne's time when it is said that they had often to be forcibly held down in their seats. But it is desirable at the same time to guard against movement as much as possible.

The question of illumination when taking the photograph is still an open one. Daylight is not very satisfactory since it varies greatly. Powerful artificial illumination is probably preferable, or flashlight. By this means constant results can be obtained at any time. In the full-face portrait the light should be slightly oblique, but in the profile it should fall perpendicularly. These types of illumination generally give the maximum amount of detail. It is necessary, however, to experiment with the lighting since circumstances alter cases.

One double negative, full face and profile, is sufficient for the reproduction of all the sectional photographs. It is only necessary in printing to mask that part of the negative not to be reproduced. It is desirable to print with vigorous gas-light paper.

The following sectional photographs constitute the *portrait parlé*.

The Forehead.—This should include the forehead down to the eyebrows. These should be particularly noted. The

shape whether arched or straight. The degree of projection of the bony foundation and the thickness of the hair.

The height of the forehead should be noted from the bridge of the nose to the springing of the hair. The breadth must also be observed.

Wrinkles on the forehead should be examined, and, of course, any special marks. The frontal bones and any protuberances should be noted.

In the profile section, a receding forehead will be the most marked characteristic. If there is recession, its extent must be observed.

At the bridge of the nose, do the eyebrows meet across or above it? Is there any falling in or cavity where it meets the arch of the brows?

The Nose.—It should be noted if the line of the nose is in general concave or convex, or straight. If convex, is it curved or angular? Alternatively, the line of the nose may be irregular, i.e., of the prize-fighter type.

In the full face any inclination to right or left should be observed. Is it broad or narrow, does it widen at the base? The distance from the base of the nose to the upper lip should be considered. It may be short, long or medium. The base line of the nose may fall towards the upper lip, making an acute angle with it, or it may rise, making an obtuse angle.

The Ear.—The ear is highly characteristic. In the first place there is the size, large, small, or medium. The way the ear is set on the head, rectangularly, or with a backward slope. Does the ear project, or lie more or less flat against the head?

The border and the convolutions of the ear may be strongly marked, or show a lack of decisive modelling. The details of the ear are in any case, however, highly characteristic. It has even been suggested that the ear is as distinctive as the finger print. This is an exaggeration, but it is true that an individual can often be identified in this way.

Not only the convolutions, but the lobe of the ears is often a striking feature of the individual. Many people have no

lobe to the ear, while if the lobe is present it may be pronouncedly pendant and large, medium, or very small. On the inside border of the ear where it curves at the upper part a slight projection is sometimes seen, known as the Darwinian Tubercle. This varies in size, being sometimes very pronounced and sometimes quite small.

The Eyes.—The eyes if properly studied are among the most important features for the purpose of identity. Very few casual observers are aware of the colour of the eyes of those they meet. The pigmentation is the first point to notice. But equally important is the distance apart that the eyes are set; their alignment; the size of the opening and its shape, with particular relation to any mongolian characteristics. The colour of the eyelashes should be noted and if they are long or short, abundant or scanty. The eyeballs may project to a considerable extent, which is a very useful point to note, since it is a detail which attracts attention. The depth which the eyes are sunk in the head is a matter to be observed.

Any squint or cast should be noted, and any difference of colour in the eyes. Indications produced by strabismus or nystagmus cannot be recognised without experience.

The Mouth.—Large or small; tight or loose lipped; upward or downward trend at the corners, whether horizontal or a slant.

This in brief outline is an illustration of the technique of the *portrait parlé*. It will be obvious that elaborate and laborious as such an investigation is, it is of immense value for the purposes of identification. The principle of establishing identity by means of it is the same as that of finger prints. If a sufficient number of points of resemblance can be established, identity is certain. That the method is not a substitute for that of finger print identification has already been observed. Its aim is rather to make identification of the individual possible by mere visual observation.

The value of this methodical system of examination as a training in observation is very great. Mistakes in identification do not arise necessarily from a lack of observation, but

from a lack of knowledge of how and what to observe. It is a well-known fact that a professional man in any department of knowledge will always be able to give a detailed account of persons or things which are related to his occupation. This is not necessarily because he makes a greater business of observation, but on account of the fact that he knows what to look for.

Observations of the individual is one of the principal concerns of the police officer. There is no question that one of the most common difficulties associated with a criminal enquiry is the vagueness of the evidence of identity. Examples where miscarriages of justice either in favour of the real offender or to the prejudice of an innocent person owing to uncertainty of identification are very numerous. The systematic technique of the *portrait parlé* has done much in helping to solve this problem.

The *portrait parlé* is not of use only to the police themselves. When photographs are being shown to those from whom evidence of identity is required, the principle can be applied in simple ways. It may often happen that a person in doubt when shown the complete portrait may be able to give a positive answer when viewing portions of the photograph separately. Failing the more refined methods of the sectional photographs themselves, a piece of paper covering first one portion of the face and then another will serve.

But a warning is necessary here. Most of us have seen that type of competition that shows the section of a photograph of a person, the problem to be solved being the identity of the individual. To concentrate upon one section of the face only is to mislead and confuse. The whole portrait should first be exhibited, and then the several parts of it section by section.

TOXICOLOGY.

From both the police and the judicial aspects, the problem of poisoning and the poisoner is a very intricate one. Poisoning is of all forms of murder the one which stands the greatest chance of passing unrecognised as a crime at all. The old superstition that mysterious poisons exist which cannot be traced is, of course, exploded. Once poisoning is suspected, an analysis following an autopsy will nearly always reveal the cause of death and prove conclusively if any noxious thing has been administered. That is not the difficulty. We are still justified in describing poisoning as mysterious, in some cases, for another reason. There are many toxic substances which produce symptoms easily mistaken even by competent medical men for those of natural disease. In such cases the death of the victim may be ascribed to natural causes, so that no suspicion of murder arises.

There have been unfortunately many examples in the past, and not a few in recent times. It is essential briefly to describe some of these in order to clarify a problem which is one very closely touching the matter of police procedure.

The crimes of Helene Jegado, for example, were not suspected until the July of 1851. Information was then given that a servant in the house of a certain Monsieur Bidard had been poisoned. The other maid, Jegado, was questioned and the answers she gave were regarded as suspicious. Further investigations were made and it was found that seven people had died from a mysterious illness in a house where she had been a cook. After this she moved from place to place, and wherever this woman went deaths always occurred. Jegado, however, appeared to be of good character, and she does not seem to have been suspected. With great cunning she even turned the murders themselves to evidence in her own favour. She was accustomed openly to allude to them, and to say that she was one of those unfortunate people whose advent

always seemed to bring death in its train. Jegado nursed her victims with apparent solicitude. Outwardly she was very religious, and many had great difficulty in believing that she was guilty of the crimes. The woman was, however, ultimately convicted and executed; but this in no way alters the fact that some twenty murders had probably taken place before suspicion was aroused.

It is of course true that this affair took place more than eighty years ago. The means for the detection of poisoning were not then so efficient as they are now. The difficulties of this affair, however, did not turn upon the discovery of the poison, but upon the discovery of the poisoning, a distinction which it is of some importance to bear in mind.

A modern instance is the mysterious Rougier affair of 1927. In this case Rougier's body was exhumed after eighteen months, it being suspected that poison had been administered to him. An examination of the body was made by Dr. Roche Lynch, who discovered traces of morphine. This seemed to indicate that a fatal dose of morphine had either been taken by or administered to Rougier, and was the cause of his death. The mysterious aspect of the affair is definitely related to the fact that the cause of death had not been discovered at the time. It was supposed by the doctor who gave the certificate of death that the old man had died of apoplexy. There was apparently no reason to suspect poisoning, so that the verdict of death from natural causes was returned. It was not discovered at the subsequent proceedings following the exhumation and autopsy whether, in fact, Rougier had died as the result of an accidental overdose of medicine, by reason of poison administered by his own hand, or by some other person or persons unknown.

Contrary to the accepted view, arsenic, the poison which was used by Jegado, is still the most dangerous instrument in the hands of the expert poisoner who understands its use. It has often been said that the so-called timed poisons which were supposed to have been used in the Middle Ages were a fiction of the imagination. This is not strictly accurate.

The appearance of the timed poisons corresponds with the discovery of the properties of arsenic as a toxic agent. When administered in small but increasing doses it simulates the symptoms of natural disease. The patient becomes ill with symptoms which correspond closely with gastro-enteritis, which increases in acuteness and ultimately results in death, it was impossible then, and it is by no means easy now, for a competent medical man to decide merely on the symptoms whether such a poison is being administered or not. Examples, ancient and modern, which prove this contention are very numerous. The case of Mrs. Maybrick which occurred in 1889, may be regarded as a modern instance having regard to the fact that the methods for the detection of arsenic were very nearly as refined then as they are now. The problem did not turn upon the question of the arsenic found, but upon the times when it had been administered, and the person who had administered it. The difficulties were very great. Maybrick, the victim, was in any case more or less an invalid and he suffered from gastric trouble. In the second place, it was alleged that he had been an arsenic eater and it was consequently suggested that he might have taken the arsenic himself. But the real difficulty in this case was that the suspicion of poisoning did not arise sufficiently early. It was thought for a considerable time that the illness of Maybrick was due entirely to natural causes, and it was not indeed until he died that any real suspicion arose. Exactly the same difficulty in somewhat different circumstances arose in the case of the alleged murder of Isabella Banks by Dr. Smethurst. Here again there was no suspicion of poisoning at all until the death of the victim. There was no apparent motive for the crime, or at least no sufficient motive, and in this case it was exceedingly difficult to decide whether death was due to poisoning or to natural causes attendant upon pregnancy.

The most recent case is the very remarkable affair of Sidney and Duff, which took place in 1929. This was again a series of cases of arsenical poisoning which were not discovered or suspected until long after all the deaths had taken place, and although there was no doubt at all that the fatal

doses of arsenic had been administered in all cases, the delay in the discovery of the cause of death made it impossible legally to fix responsibility.

It will now be evident that the whole question of poisoning and toxicology has two entirely separate aspects. One might be described as purely a matter for the police and the other one for the toxicological expert. Any expert poisoner will always adopt the slow method so that the symptoms will correspond more or less to those of natural disease. The essential point from the police point of view is to prevent the crime of murder if this is at all possible. This is extremely difficult. In such cases they are always working in the dark, but there are circumstances in which reports concerning prolonged illness ought to occupy the close attention of the police. On the other hand, the position is always an extremely delicate one. Malicious rumours, for which there is no foundation whatever, very often circulate particularly in small places, and it is by no means an easy matter to distinguish the possibly true from the certainly false. The medical man may also be in an extremely difficult position.¹ Unless he has some definite reason to suspect poisoning he will be naturally averse from making an investigation, a fact which necessarily complicates a problem for which no solution has yet been found. But it is for this reason that a knowledge of toxicology in its elementary form is of the greatest use to the police officer. A study of poisons and their effects may sometimes actually prevent the commission of a serious crime.

Any poisonous substance taken in a sufficiently large dose will have a more or less immediate effect, and indeed in most instances will follow directly upon the ingestion of the poisonous material. It is here worth making some allusion to the question of antidotes because there are times when prompt recourse to these will save the victim's life. The first and most obvious remedy applicable in most cases is to empty the stomach. This can be effected either by use of a stomach tube or an emetic. In cases of urgency it is possible

¹ Since this chapter was written the author has been asked to advise in a case of this kind.

for a lay person to employ the stomach tube, but it cannot be done unless he understands its use, and some experience is necessary. It will be well, however, to explain the principle. The tube is of rubber about half an inch in diameter and about five feet long. A glass funnel is attached to it. The free end is passed down the gullet into the stomach. The funnel then is held high above the patient's head, about half a pint of water is poured into it and the tube is then pinched to retain the liquid in the tube. After that the funnel is lowered to a level below the stomach so that the water and the contents are siphoned out. This is repeated until the water is clean.

An emetic, however, is generally the only practical method for the ordinary person to employ. Salt and water and mustard and water given in large quantities are generally the best since these simple ingredients are available almost anywhere. If it is obtainable, zinc sulphate in warm water is an energetic emetic and has the advantage that it is easier to administer since a smaller quantity of liquid is equally efficacious. It is often difficult to induce the person to swallow large quantities of an emetic. Tickling the throat with a feather is a traditional method which sometimes but not always induces sickness.

It often happens that the stomach siphon cannot be used until an emetic has been administered. The reason for this is that there may be solid matter in the stomach which clogs the tube.

The next step is to neutralise, counteract, or otherwise destroy the effect of the poison. If corrosive acids have been administered alkalis are the proper antidote, while, on the other hand, poisoning by corrosive alkalis require treatment with acid. The two most readily procurable acid and alkaline antidotes are respectively vinegar and washing soda. It is not very difficult to recognise a violently toxic dose of an acid or an alkali since there is almost certain to be corrosion and inflammation of the lips and mouth. The difficulty is to be certain if this corrosion has been produced by acid or alkali. If a bottle containing only traces of the sus-

pected substance is anywhere near the victim this can easily be decided by placing a small drop of it on the tongue. Acids invariably produce a sharp stinging sensation, and alkalis a "soapy" effect. There is further a very simple test with litmus paper which can generally be obtained quickly at any pharmacist's shop. Red litmus paper turns blue with alkalis, blue litmus paper red with acids. If no external trace of the poison is discovered, if a piece of litmus paper were placed in the victim's mouth the change would in most cases be quite evident. Carbolic acid is a favourite poison among certain kinds of suicides. The best antidote for this substance is not an alkali but a large quantity of Epsom or Glauber salt, which combines with the carbolic acid and inhibits its action.

In cases of poisoning with mineral salts and arsenic there is a mixture known as Murrell's Compound which consists of two solutions, one being a saturated solution of ferrous sulphate and the other a mixture of calcined magnesia, charcoal and water, in the proportions of eighty, forty, and one hundred. The two solutions are kept separate, but mixed in equal quantities for each dose. This antidote is said to be efficacious in cases of alkaloidal poisoning. The antidote should always follow the use of the stomach-siphon or the emetic, but it should be noted that in the case of corrosive substances, neither the stomach tube nor emetic must be used owing to the highly inflamed condition of the alimentary tract.

Corrosives whether acid or alkaline have certain well marked effects in common. There is agonising pain, violent sickness. The vomit is acid or alkaline as the case may be and will contain fragments of membrane. The most evident indication will be acute inflammation, and perhaps blistering of the mouth and throat. There is intense thirst and swelling of the throat. In the case of hydrochloric acid the corrosive effect is perhaps less marked than in the case of sulphuric. But there will be much coughing, and probably the acrid smell of the acid will be remarked.

The symptoms produced by carbolic acid poisoning are

similar in general to those of the mineral acids, but there is the characteristic effect of anaesthesia. Carbolic acid is an organic compound properly described as phenol which besides its corrosive action reacts upon the central nervous system. The symptoms can be compared with those produced by an hypnotic drug. The lips are blue, the breathing stertorous, and the pupils contracted. Artificial respiration may be a necessary part of the treatment to save the patient's life.

Oxalic acid is in some respects similar to phenol in its results. In strong doses it is corrosive, but weaker concentrations affect the nervous system so that there is prostration and coma which will end fatally if proper treatment is not promptly applied. It is well here to repeat that the proper antidotes are in all cases alkalis. Washing soda has been mentioned as being the easily procurable form of alkali because there is obviously immediate urgency, but washing soda is useless in the case of oxalic acid. It will neutralise and thus mitigate the corrosive effect, but the sodium salt of the acid is as dangerous in its secondary effects as the acid itself. It is essential to use lime or precipitated chalk, two forms of alkali which are also the most suitable for the other acids mentioned.

These violently noxious agents are not often found in cases of murder. It goes without saying that in such circumstances a doctor should be obtained at once, but the application of elementary knowledge pending the arrival of the doctor may save the victim's life.

It is very necessary that symptoms should be discussed in more detail than in the examples already considered for the reasons set out in the earlier part of this chapter. Ability to recognise the symptoms may in some cases actually avert a murder.

The form in which arsenic is available is generally that of the so-called arsenious acid or as a sodium arsenite in which the arsenious acid is mixed with water containing soda which dissolves it forming this salt. Arsenious acid is not readily soluble in water, while sodium or potassium arsenite easily

dissolve, but both forms are violently toxic. Three grains, and often less, constitute a fatal dose.

The symptoms of acute arsenical poisoning are a burning pain in the throat and stomach, severe thirst, and sickness. The last is often very severe. Weakness of the pulse and paralysis of limbs follow. The victim dies in collapse. Arsenic is an acute irritant which sets up an intense inflammatory condition of the intestinal tract very similar to that produced in cholera, the symptoms of which very much resemble acute arsenical poisoning. The antidotes in acute cases are hydroxide of iron and milk.

Examples of chronic arsenical poisoning are very much more difficult to recognise. They are more or less the same in nature, but they are greatly modified.

In the Smethurst case, for example, the medical men who attended Isabella Banks attributed her illness to dysentery for a considerable length of time before they became suspicious, and even after the post-mortem a great deal of doubt was expressed as to whether dysentery had not in fact been the cause of death. But the symptoms were, nevertheless, typical of arsenical poisoning. There was vomiting, purging, and great pain, and at the time of death the body had wasted almost to a skeleton. Wherever these indications exist, and the patient seems not to improve under appropriate medical treatment, there are grounds for further investigation. Skin eruptions are often associated with chronic arsenical poisoning.

There is one point of particular interest in connexion with the taste of arsenic. Arsenious acid is practically tasteless, but it is a feature of the evidence in murder trials that the victim complained that food or medicine tasted bitter. It has been suggested that this is not an uncommon complaint of invalids, and that since arsenic is practically tasteless, it is not relevant evidence. Where it can be shown that arsenious acid has been administered this contention would be sound; but where a solution of sodium arsenite in the form of weed-killer might have been employed, it is not. Such a solution has a distinctly bitter taste.

This is worth noting from the point of view of detection. A report that an invalid is complaining as to the taste of food may mean nothing; but on the other hand it may be a significant piece of evidence to be considered in conjunction with other facts. It is well to remember that we are considering the most neglected aspect of toxicology, but the one most useful to the police officer. The stray hint, the small indication which may prevent the consummation of the meanest and most revolting kind of crime.

The duration of the illness is no very useful guide as to its cause. If murder with arsenic is being attempted this will depend upon the skill of the poisoner who, if he is expert in his abominable craft, will not be in a hurry. Further, different individuals exhibit greater tolerance of arsenic, which is in turn influenced by the state of health. In this connection, however, it must be remembered that arsenic is cumulative in its effect. Simply expressed, this means for practical purposes that the poison accumulates in the system and that when the last dose is ingested making up in all an amount approximating to the fatal dose, the victim who may not previously have seemed gravely ill will *suddenly* become so, or actually die. This is a circumstance that the poisoner fortunately cannot control. No toxic substance has an exactly predictable effect, and it is impossible so to graduate the doses as to allow for such eventualities. Symptoms of this kind are not necessarily unnatural, but they should not be disregarded if there is the faintest suspicion of poisoning.

The effects of antimony are very similar to those of arsenic, but the fatal dose is greater. Five grains and often more constitute a fatal dose. In the affair of Chapman in 1903 three women with whom the prisoner lived died before suspicion was aroused.

After the third death the doctor refused to give a certificate without a post-mortem as a result of which a large quantity of antimony was discovered. The two other bodies were then exhumed in which the poison was also found. The bodies were in a remarkable state of preservation.* Antimony shares with arsenic the ability of delaying putrefaction. It

will be noted that in these cases large doses of antimony were administered, but that, despite this, certificates of death from natural causes were given by medical men in perfectly good faith.

Hydrocyanic (prussic) acid is one of the most violent poisons known, and it is said that its discoverer, the chemist Scheele, died from the effects of inhaling the vapour. It is not now very commonly used by poisoners, although suicides sometimes have recourse to potassium cyanide which is less toxic, the fatal dose being about five grains. The most useful antidote is energetic artificial respiration, and the inhalation of ammonia. If the victim survives for two minutes there is hope of recovery, for in the case of prussic acid they may be dead in as many seconds. In examples of death by poisoning with hydrocyanic acid it is very often possible to detect a smell of bitter almonds.

Alkaloidal poisons used to be greatly favoured by the poisoner on account of the fact that they were not easy to detect by chemical means. Dr. Lamson used aconitine to poison his youthful brother-in-law. The method was ingenious since in the first place no chemical test existed by which this alkaloid could be detected, and secondly the young man was a paralytic. It is a characteristic of alkaloidal poisons that they react rapidly upon the nervous system. Dr. Lamson may have supposed that the sudden death of his brother-in-law, if effected in this way, might be put down to his paralytic condition. He was tried and convicted, but it was found extremely difficult to prove the presence of aconitine in the body.

The most common alkaloidal poisons affect either the cerebral or spinal nervous system. In general, those that affect the cerebral centres produce first a period of excitement and exaltation followed by languor, sleep and coma. The pupils are contracted and the pulse weak. The coma gradually increases, and the poisoned person ultimately dies of asphyxia.

The antidote is the administration of potassium permanganate, the use of the stomach tube, and keeping the patient

moving by gentle means to combat the drowsiness. In the later stages artificial respiration, oxygen and very strong coffee are of great use. A careful watch must be kept for a relapse. The services of a doctor must be obtained as soon as possible. Morphine and atropine are examples of cerebral poisons. Strychnine is an example of an alkaloidal poison which acts upon the spinal cord. The symptoms resemble those of tetanus with which they have sometimes—notably in the case of Palmer—been confused.

A medical man can, however, always distinguish the tetanic from the strychnine spasm. There is first twitching of the limbs followed by a violent convulsion in which the body “arches.” Breathing becomes increasingly difficult, and the face livid. The muscles relax for a few minutes and a further spasm follows. Death is finally due to asphyxia, but the mind remains clear until death supervenes. The antidote is the inhalation of chloroform and the use of the stomach siphon containing tannic acid or potassium permanganate.

Methods of the detection of poison, and estimation of its amount, can only be undertaken by the expert. But the information which the investigation officer can supply may be of the greatest value. The expert may not have seen the body, and probably knows nothing of the collateral circumstances. It is for this reason that the symptoms in connection with poisoning have been emphasized. The investigating officer may have seen them, or heard of them, and may thus be able to form provisional conclusions of some interest to the expert. The officer in charge of the investigation should satisfy himself that the chemist is in possession of the following details if they are known.

(1) The interval between taking the last food or drink and
(a) the first appearance of the symptoms of poisoning and
(b) death (if this has occurred).

(2) The nature of the first symptoms.

(3) Whether any of the following symptoms were present, and if so, which:—

(a) Vomitting and purging.

- (b) Deep sleep.
 - (c) Tingling of the skin and throat.
 - (d) Convulsions or twitching of the muscles.
 - (e) Delirium and clutching at imaginary objects.
- (4) The nature of any other symptoms noticed.
- (5) Whether any other person partook of the suspected food or drink, and whether they also suffered from symptoms of poisoning.

These regulations have statutory force in India and are quoted in Lyon's Medical Jurisprudence for India.

It is not always realized by the layman that the examination of human remains, food, or other material for poison is a lengthy and complex process. Relevant information with even elementary knowledge behind it is of great assistance, and is a striking example of the value of co-operation between the scientific expert and the police officer.

CRIMINAL PSYCHOLOGY AND DETECTION (MURDER).

It is very difficult to realise to-day the fierceness of the controversy waged between the pro- and antagonists of the theory of the criminal type. Lombroso is dead and his theory died with him. But it is some measure of the greatness of the man that, even if his theory were thoroughly unsound, it has consciously or unconsciously influenced every criminalist and alienist since his time. The indirect result of his work was that it drew attention to the problem of the criminal himself. Of the period prior to Lombroso, it is quite accurate to observe that the criminal was not studied at all. The crime committed was punished often with great savagery; but it never seemed to occur to those concerned with the penal system that the criminal might prove to be a more fruitful study than the crime. This was quite definitely Lombroso's position even if this aspect of his work was implied rather than expressed.

Whether this debt to Cesare Lombroso is acknowledged or not, it yet remains true that of recent years the question of criminal psychology has been studied to a very considerable extent. The element of controversy which literally rent Europe in twain still survives even if it finds expression in rather a different form. The note of interrogation is still very prominent. Is crime ultimately a matter for the alienist or the judge? Each time this question is raised—and it is raised very frequently — the protagonists of each point of view are resurrecting the old controversy in a new and perhaps more acute form. The real objection to Lombroso's theory of the criminal type was that it was fundamentally wrong and fundamentally wrong-headed to suggest that the criminal differed in some definable manner from the ordinary human being. Stripped to its bare essentials, this was the ultimate matter at issue.

It is one which remains unsolved to this day, and is one of first-rate importance, not only to the judge, but to the police officer. Psychology is an affair of everyday life, and those who are most successful make use of it every day, even if they cannot scientifically define its principles. In social and business contracts we rely to a much greater extent than we realise upon an understanding of the minds of those with whom we deal, and a failure to interpret the minds of other people is a very serious drawback. This is clearly applicable to the detection of crime. Those who are engaged in it are bound to acquire either by experience, training, or both, some knowledge of the psychology of the criminal. The extent of this knowledge and the ability to apply it to the particular case may frequently make all the difference between success and failure.

Even fundamental theory must not be left out of consideration. It is a matter of no little importance from a practical point of view to decide if crime is a definite abnormality, or if it is associated with the normal mind. The behaviour of the insane can be predicted more or less, provided always that no attempt is made to apply the normal criterion. Similarly, if it is true that criminality is abnormal, it is quite clear that those who endeavour to deal with it as if the criminal act were one of a normal person who has gone wrong, will find themselves in difficulties. There are many circumstances in which the detective will have to put himself in the criminal's place if he is to understand the crime, the motive, and the precautions the author is likely to take to escape detection. He will be unable to do this if he understands nothing of criminal psychology.

The problem is an immensely complicated one which the present writer has discussed elsewhere.* It must suffice here to remark that there is a good deal to be said for the view that criminality is a psychological condition, and that its study from the standpoint of abnormal psychology is one which has to be taken into consideration.

Many forms of criminality are unquestionably patho-

* *Genius and Criminal: A Study in Rebellion.*

logical. It is generally assumed that a wealthy person who commits some petty theft is a kleptomaniac. In the majority of cases the conclusion is perfectly justifiable. Petty theft in children is also often pathological, and the Freudian School traces crimes of this kind to sexual repressions. The New Psychology is not universally accepted, but whether we agree with its conclusions or not, some psychological theory is necessary to explain certain kinds of crime to which no reasonable motive can be assigned.

There is a type of murderer to whom the same reasoning applies. Those who have studied the case of Anna Maria Schonleben, which has been so fully discussed by the eminent jurist, Feuerbach, will find it extremely difficult to reconcile this female poisoner's behaviour with that of a criminal who murders or robs to satisfy some material need. Schonleben seems to have administered poison to at least eighty people, in many cases with no assignable motive at all. Helene Jegado, whose crimes were committed in France a few years later, slew her victims with poison for no better reason than the apparent love of administering it. A yet more extraordinary example is that of the Swiss nurse, Marie Jeanneret. This woman was highly educated and intelligent. She was a most efficient nurse. Jeanneret was tried for poisoning her patients with atropine and was convicted. No motive for these crimes was ever suggested by the prosecution. It was proved, on the contrary, that from a material point of view she had been the loser as a result of some if not all of the deaths. These three women, who all differed in intellectual calibre, emotional sensibility, and social position, all joined issue in their love of poison, *sui generis*. But none was insane in any formal sense. Jegado, a French peasant, was stupid and cunning. Schonleben was of average intelligence. Jeanneret's education and intelligence was of a high standard. She was a devoted nurse with a sympathetic personality. It does seem necessary with such examples before us to postulate some kind of moral imbecility or instinctive criminality, even if these expressions are out of date as belonging to the periods of Lombroso and Ferri.

By way of recent examples, Peter Kürten, the Dusseldorf ripper, provides an illustration comparable with the preceding instances. England also produced its Jack the Ripper as a type of the instinctive murderer.

Yet more recently occurred the affair of the murder of a little girl by James Faraday Salvage. Sexual perverts are generally dangerous, but in this case no attempt was apparently made by the accused to violate the girl. He merely met her, enticed her to his room, and there committed the murder. Even the motive of the ordinary type of sexual pervert seems to have been absent in this example.

It is very easy to see the bearing of cases of this kind upon the question of detection, and indeed the history of the ultimate discovery of the crimes themselves points the moral. Schonleben poisoned some eighty people, three of whom died as a result before she was arrested. An investigation of Jegado's history revealed the fact that there had been several previous deaths for which she was almost certainly responsible. Jack the Ripper and Peter Kürten terrorized their native towns for months. The reason is obvious. No key to the author of the crime is supplied by the crime itself. The limitations suffered by those who consider only the crime and not the criminal could hardly be more tellingly illustrated.

Even those instances of more straightforward criminality seem to supply evidence as to the abnormal workings of the criminal mind. This is to approach an aspect of the question which cannot fail to be remarked by all students of criminology.

On June 1st, 1887, Dr. Cross, a medical practitioner of Cork, murdered his wife by administering arsenic and strychnine. Using his medical knowledge, he carried out his purpose with great skill, and he deceived two medical colleagues who gave a certificate of death from natural causes. There was a definite motive for the murder in this case. Dr. Cross had fallen in love with a girl, Miss Skinner, who had been engaged as governess. The doctor showed

subtlety in the matter of the murder, and adroitness in the manner in which he won the affections of the girl.

But a week after the death of his wife he married Miss Skinner in London, and returned with her at once to his own home. Suspicion was aroused as a result of this conduct, an enquiry was held and the body of Mrs. Cross was exhumed. The poisonous material was discovered, and Dr. Cross was tried for murder, convicted, and executed.

It is extremely difficult to square this behaviour with that of a completely normal individual. Murder is a highly dangerous occupation, and when it is committed by those who seem to bring their intelligence to bear upon the problem of avoiding suspicion, do so successfully, but finally make so clumsy a slip, we may justly consider that we are dealing with a state of mind which is not completely normal. The case of Dr. Cross is not exceptional. Criminal records of history abound with instances of the same kind.

This curious mixture of astuteness and folly is very commonly associated with the criminal mind. It has been excellently summed up by Dr. A. Krauss:—

“The specialists say that criminals are more astute than intelligent. But what is this astuteness? It is an instinctive, innate faculty, which does not depend on real intelligence and which is already found precociously perfected in children, in the lowest savages, in women, and also in imbeciles; although experience comes to its aid it is never capable of artificial culture. It is essentially a faculty limited to the consideration of concrete cases, and which is chiefly concerned with the deception of others. The mental inertia so often combined with this faculty is recognised in this, that a criminal, in planning a crime, does not calculate all the possible eventualities, and immediately after the success of his action he loses all caution, as if the energy of his mind directed to the project and its execution were exhausted at one stroke. Beside this instinctive faculty, intelligence is a faculty of infinite variety which matures slowly and gradually affects language and questions of abstract culture. It needs to be cultivated with diligence, and with the help

of a happy organisation of the nervous centres. It often happens late even in highly-gifted men."

This was written in 1888 and much of it in the light of modern psychological theory is highly debatable. In the main, however, the whole passage is interesting and suggestive. The last sentence expresses the view that a man may not attain to real intelligence until comparatively late in life, and thus implies that a criminal might be highly gifted but remain, as it were, adolescent in the direction of the intellectual faculties.

There is a good case for suggesting this as the crux of the whole matter. There is an element of the child in the criminal, both intellectually and emotionally, a fact not without some importance for those engaged in the detection of crime.

Perhaps one of the most striking modern instances of the combination of well-developed mentality with immaturity of what, for want of a better term, might be described as judgment, is to be found in the case of J. D. N. Potts, who murdered his tutor, A. F. R. Wollaston and Detective-Sergeant H. S. Willis, on June 3rd, 1930. He shot his two victims with an automatic pistol and afterwards committed suicide with the same weapon.

Potts was an undergraduate at Cambridge, nineteen years of age, and an exceptionally brilliant student. He was, however, of a very restless disposition, and openly expressed a wish to take to a life of crime. He was concerned with another in issuing a cheque knowing that it would not be honoured, and it was apparently as a result of the enquiry that the tragedy occurred.

In this example, also, we are confronted with the abnormal. The desire for a criminal career was in this case a matter of deliberate choice. Potts was further very egotistical, given to extravagance and peculiarity in dress, and was most unreliable in the statements he made. This is another instance not easily explicable, except on the assumption of a criminal habit of mind.

The fact that the crime in this particular case was

committed quite openly does nothing to weaken the argument regarding the importance of the relation between psychology and detection. In all cases of murder where there is any doubt as to the identity of the criminal the difficulties are always greater than in the more common types of crime. In most of the examples considered, the guilty persons had not been in the hands of the police before and were not, therefore, criminals in the legal sense. It is impossible in such cases to employ the method of reasoning often satisfactorily applied to the investigation of, for example, a burglary. An examination of the scene of the crime suggests that it has been committed by A, B, or C. A is in prison, B is abroad, and the chances are, therefore, that it is C, who is at large. C is apprehended and interrogated, and with the presumptive evidence before them the police know how to proceed.

It is quite another question when the police have to deal with a cultivated and perhaps highly intelligent person suspected of murder. It is necessary in such cases to understand something of the individual's psychology in order to be able to arrive at the truth. It is one thing to suspect and quite another to prove.

From the examples quoted it seems quite legitimate to agree with Dr. Krauss that the criminal mind, however astute, essentially lacks an element commonly associated with non-criminal people. There is a lack of maturity which is probably due to the failure of the criminal individual to adjust himself to the restrictions which society imposes upon us. Maturity is, after all, the lesson men learn by living in harmony with themselves and with their neighbour. The criminal man is anti-social in the sense that, like the child, his own wishes and desires are not subordinated to the dictates of society. The question of intelligence, as such, hardly arises.

This has to be taken into consideration when dealing with the criminal. He may be astute and even highly intelligent, but he is socially stupid, that is to say that he does not, or

will not trouble to understand another point of view. It is for this reason that the criminal betrays himself as did Dr. Cross.

The Dougal case is another illustration. After murdering Miss Holland with whom he had been living, the murderer showed the greatest ingenuity in disposing of the body. He buried the remains in a hole which he cut in the side of a ditch, and after the body had been disposed in it he filled up the niche with blackberry brambles. The ditch itself was then filled up. But Dougal's behaviour after the murder was very indiscreet. He did not destroy Miss Holland's clothing, and he was seen to open letters which came from her. His love affairs, absolutely untempered by discretion, gave rise to rumours which ultimately resulted in suspicions being aroused. It is quite impossible to reconcile this mixture of cunning and stupidity.

These are considerations which the investigating officer will do well to bear in mind. It seems to make very little difference if the criminal is educated or not; there seems generally to be this failure to appreciate the kind of action which will direct suspicion. The crime may be carefully planned and executed, but as soon as it is done, caution seems to be thrown to the winds; or rather there is a complete failure to appreciate the necessity of planning for the future as well as for the present, and of covering up of small items of evidence likely to be damaging.

Up to this point we have concentrated upon the murderer for the reason that he is the best illustration of the criminal psychology. The murderer is not necessarily a professional criminal at all. The motive of gain, therefore, in the ordinary sense does not in many cases complicate the study of his psychological make-up. That upon which we must again insist is the anti-social nature, not only of his acts but of his mind. By anti-social is meant a habit of mind which definitely separates the criminal from the ordinary social unit. There is not necessarily any conscious antagonism, but there* is a maladjustment to the social environment which may cause the criminal man to seek a remedy for his

grievance, whether it be real or imaginary, in violence and murder rather than by the social method of legal redress.

But in some cases there is conscious social hatred. Peter Kürten said that he wished to be revenged upon society. Jack the Ripper wrote notes to the police, as did Kürten, giving notice of the crimes that he intended to commit. There is here quite obviously a desire to defy society, and an irresistible impulse to risk everything to satisfy that desire.

From the point of view of detection these points are worth noting for two reasons. In the first place, this desire to glorify the crime and defy the police are matters to concentrate upon since they may provide a clue where others are lacking. The criminal may and probably will, even if he has not defied the police directly, have boasted of his crime to some other person or at least hinted at it. It is not by any means easy to obtain evidence of this sort, but if the right sources of information can be found and tapped, the apprehension of the criminal may quickly follow.

The second point is of equal importance. It cannot fail to be remarked as extraordinary that such crimes as those of Jack the Ripper and of Peter Kürten were not brought home almost at once. And, in fact, although the identity of Jack the Ripper is supposed to have been known, this occurred too late to bring him to justice. The murders were committed in circumstances in which it would seem almost impossible that the authors could escape for very long, and yet in spite of this they escaped detection for many months.

It seems that we must seek the explanation in the moral perversion of the criminals. The crimes were committed in cool blood from a desire to satisfy some impulse alien to the normal man. The conduct of the murderer after the crime is not thus such as will excite remark or arouse suspicion. There may be very great difficulty, in fact, in bringing the crime or crimes home even when suspicion is directed to a particular individual.

It is not at all easy to decide how far the investigating officer alone can deal with such cases, which are not so

uncommon as not to merit serious attention. The assistance of the professional psychologist might in some instances be of use. A study of the details of the crime itself may suggest to him the psychological motive which prompted it, and his co-operation in the interrogation of a suspect of this class may be of assistance also.

The psychological aspect of the more commonplace type of murder shows a definite affinity with these examples. There is undoubtedly a considerable amount of truth in the notion that the murderer often returns to the scene of his crime. The explanation is probably to be found in the characteristic of bravado. This is directly traceable to the criminal's contempt for the machinery of law and order. He imagines that he is the exception, and that his crime has been too well planned for detection to be possible. Lack of caution after the event is a common feature of all murders not immediately traceable to a particular individual. From the point of view of detection it is probably the most useful ally of the police.

In this connection it is well to consider the function of the newspapers, and the reports made by them relating to crime. It is well recognised and obvious that the newspaper can be of very great assistance to the police, or on the contrary it may considerably impede an investigation. The last thing which it is desirable to do is to remind the undetected criminal of his danger. His lack of caution, his contempt for the police may be the very means of running him to earth. The newspaper report which asserts or implies that suspicion is directed to a certain quarter may seriously embarrass the detective. In many cases it is desirable to give the reverse impression. It is remarkable that despite the evidence of experience the rudimentary criminal intelligence will often be deceived by a manoeuvre of this kind, and over-confidently give the police just that information which is essential to their case. The advice of Hans Gross in this regard is sound:—

“We do not desire by any means to advise the Investigating Officer to give the papers inaccurate information in

order to baffle the unknown criminal or inspire his accomplices with confidence, etc. But it is not necessary to tell all that one knows or all that one suspects, or, if one wishes to tell it, the propitious moment must be awaited. The manner in which *what* may be told *should* be told is not, speaking generally, easy to indicate, and it is not even easy to express it in a particular case; but it is possible to find the correct method by taking into account all the circumstances accompanying the crime. The best way to proceed will be for the Investigating Officer to himself write out the note for the paper without long hesitation or reflection, *and then consider the consequences which it will have from the point of view of the author of the crime in the event of his reading it,** the same applying to the accomplices, witnesses, etc., if they come to know of it."

It is not difficult to grasp the connection between this and the psychology of the criminal. The object is to cause the author of the crime to give himself away, and the circumstances of the case will determine the method to be adopted. The type of murderer, for example, who communicates with the Press and the police ought to be encouraged to do so, since it is obvious that the letters themselves may, before long, provide a vital clue. A hint that the police are puzzled and have come to a dead end in their investigations will probably stimulate the murderer's pathological vanity. Sooner or later, he will go too far.

The practical application of psychology to the detection of crime must remain for the subsequent chapter, but it will be well to consider the ground covered and if possible to draw some general conclusions.

The examples quoted, if unusual, are typical. They seem to suggest that the psychology of murder, at any rate, presupposes some kind of abnormality. This is, on the whole, borne out by the behaviour of the criminals. In the most extreme cases it is quite clear that a powerful neurosis is at work; and the same symptoms less strongly accentuated seem to be present in the more ordinary cases. *Neuroses

* The italics are mine.

differ in cause and in effect, but those with which we have been concerned all turn upon the conflict of the individual man with his environment. The criminal is in conflict with his environment and the crime of violence in particular is, as it were, a symbol of that conflict.

The criminal, like the insane person, is capable of great ingenuity and cunning, but not of the patience and foresight that is associated with the normal intelligence. His psychology resembles that of the child which, while it may be imaginative and brilliant, never quite operates on the same plane as that of the adult.

To attribute to the individual qualities and characteristics which they do not in fact possess makes it impossible to predict what the individual will do in any given circumstances. It is thus not of very much use in considering a crime, its motives, the probable movements of the author, the means he will adopt to escape detection, for the detective to consider what he would have done in the circumstances. He must understand the criminal point of view besides attempting in other ways to put himself in the criminal's place.

It is by no means easy to do this. Despite much research, we are very far from having reached the final solution of the problem of the criminal mind. But it is legitimate to suggest that the evidence goes to show that it differs from that of the ordinary man or woman. A study both in theory and practice of the problem is quite essential to the police officer. The mere study of the psychology of a mysterious crime will not suffice to solve it, but without an understanding of its psychological aspect it is not too much to say that it would be difficult or impossible to deal with the suspect at all. That is the fact which has to be understood before we dismiss criminal psychology as being of merely academic interest.

CRIMINAL PSYCHOLOGY AND DETECTION (THE RECONSTRUCTION OF THE CRIME).

The term reconstruction of the crime is a perfectly legitimate one which, however, is greatly in need of exact definition. The phrase is very loosely used and this inexactness has had a profound effect upon the practical study of this problem. The reconstruction may be, and very often is, a valuable part of an investigation; but if the principles are not clear-cut, its employment may do more harm than good and lead to serious mistakes.

In order to examine the matter thoroughly, two questions have to be borne in mind which may be considered in their chronological order. There is first the historical aspect, and without a careful consideration of this it is very difficult to understand the meaning of reconstruction at all. Arising out of this is the second point that, as time has advanced the problem has developed in two distinct though related connections.

It will be well to consider this point preliminarily. There are two meanings to the word reconstruction as it relates to criminal investigation, a literal meaning and one which is less direct. This fact is very significant because as a result of this the word stands for two types of technique which may be used separately or in conjunction. Curiously enough, the one which depends upon, and makes the most direct appeal to, psychology is the older method. It was founded, perhaps, upon unsound premises, and upon a very rudimentary knowledge of psychology as we understand the term, but these were fundamentally sound enough to cause a modern technique to be built upon them.

The consideration of an actual case will be the best method of prefacing the historical aspect.

In 1654 Major Strangways was arrested for the murder of a Mr. Fussell, whom it was alleged he had shot with a

carbine from the Strand while his victim had been sitting at the window of his room, which was by Temple Bar, looking over the Strand. By reason of an excellent piece of detective work, it was quickly suspected that the carbine had been in the possession of Major Strangways on the day of the outrage. This is the rudimentary beginning of one kind of reconstruction. It is the literal interpretation, an endeavour by the collection of evidence to reconstruct the probable order of the events. But the importance for us at the moment is not the reconstruction itself, but the use which was made of it. The suspect was taxed with the presumptive evidence of his possession of the weapon at a material time. He expressed amazement that this fact had been discovered, and admitted having been in possession of the carbine. This is an elementary instance, but it establishes the principle of the psychological implications of reconstruction. Major Strangways was surprised into confession, and secondly, conclusions were drawn from his nervous demeanour and embarrassment which were assumed to be due to guilty knowledge. The most significant point is that the investigation had not *proved* that the carbine had been in the possession of the suspect. They acted upon a strong presumption which they hoped to confirm by observation of the psychological reaction produced by it upon the subject.

Having advanced so far, those in charge of the enquiry proceeded to another test. Major Strangways was taken into the presence of the dead body where it lay in the mortuary. He was ordered to take hold of the hand. Another factor is here introduced which illustrates this example as being a very curious mixture of sound procedure and superstitious practice. It was believed at that time that if a murderer touched the body of his victim after death the wounds bled afresh. There does not seem to be much doubt that the traditional procedure was followed with this superstitious belief in mind. The result, however, was negative, a fact which introduced us to the most interesting consideration of all. Despite the fact that the wounds did

not bleed, Major Strangways was committed for trial. This indicates quite clearly that, although such tests were employed in the ordinary routine, their efficiency was greatly doubted. But on the other hand, when in the presence of the corpse the suspected man had shown signs of great emotional disturbance. It was this which finally caused the investigators to decide that a case could be sustained against him.

✓ We have here in embryo one aspect of the modern theory of the reconstruction of the crime. Expressed in modern psychological terms, a procedure of this kind relies upon the theory that if an individual has an incident recalled to his conscious mind which he has tried to forget, or which he actually has forgotten, the memory will be accompanied by strong emotional disturbance. This will vary in intensity more or less directly as the efforts which have been made to dismiss the matter from the mind. Relief from emotional tension will, however, inevitably be sought in acknowledgment. The therapeutic aspect of the modern technique of psycho-analysis relies upon just such a consideration.

Psychological principles of this kind were not understood in the 17th century. It was the judicial view that the soundest evidence against an accused person was his confession, and it was assumed as a matter of certain fact that the confession was necessarily true. All legitimate means, and generally means which were not legitimate also, were employed to induce him to confess.

This does not affect the psychological principles, however crudely conceived, upon which this practice was based. There is a sense in which these early methods have a definite touch with modern means used to induce a suspected person to confess. The difference is apparent when considerations arise as to what constitutes legitimate methods to induce confession, and as to the value to be placed as evidence upon the confession if it is made. This is of very great practical importance for the modern technique of criminal investigation. If an accused person makes an admission or a confession, it obviously cannot be ignored. The problem

which remains is simply this: Are the police entitled to employ means, however indirect, to induce a confession; is such a confession voluntary, and how far is it legitimate to make use of it as evidence?

It may as well be said at once that if the term "voluntary confession" means that the suspected person must not be induced to confess at all, but on the contrary must be discouraged from doing so, the police are deprived at once of a valuable means of assisting them to arrive at the truth. Since the report arising out of the Savage case in England, it has been suggested, and not without some grounds, that the English police are in this position. A suspected person must not be induced to make a statement; if he does, he must write it entirely in his own words, and the police officer may not interrogate him.

In America the conditions are not at all the same. It is the practice of the police in certain cases to drive the suspect in a motor car and discuss the crime with him, either upon the scene of the crime itself or when the car is being driven past it. It is claimed by Carey and others that in these circumstances confessions are often volunteered without any pressure other than that supplied by the conditions of time and place. Practices of this kind may be, and probably are, open to abuse, but it is difficult to see what objection can be raised to them in theory. In practice it lays the police open to the manufactured charge when an accused person is apprehended partly on the evidence of his own alleged statement of extorting confession more or less with menaces. This, as is well known, is a common enough feature of criminal trials.

In many Continental countries the procedure is carried a step further than this. The two methods of reconstruction are applied together. The police in the first reconstruct the crime from the available evidence at their disposal. The accused person is then conducted to the scene of the affair and the whole scene is re-enacted before him in the exact manner in which it is supposed to have occurred. By those

who use this method it is claimed that it will induce confession when all other means have failed.

Leaving aside the question of justification for a moment, it will now be obvious that these modern methods of reconstruction have quite definitely a link with the past. The actual connection between past and present might be sought in an anecdote recounted by Carey concerning the famous High Constable Jacob Hays. It was Hays' method to reconstruct in cases of murder by taking the suspect into a darkened room in which the body lay covered by a sheet. At a given moment the blinds were suddenly drawn up and the body uncovered. In a specific instance a murderer named Johnson was made to confess by this means. Johnson is said to have admitted that he could not lie when Hays' eyes were upon him. Hays was a contemporary of the famous Vidocq.

In any case, the traditional motive is reproduced in these modern examples. The emphasis is quite clearly upon the utility of the confession itself, which is regarded as being evidence of the first class. Deviation from the traditional methods is to be noticed in the more subtle and less brutal methods of extracting confession. It must be borne in mind that in the 17th and even in the 18th century the law did not scruple to use physical torture.

It seems very difficult to rule out these methods as unjustifiable. After all, it is the duty of the police to detect crime, and unnecessary obstacles ought not to be thrown in their way which are likely to hinder the course of justice. The objection to a return to older and more barbarous methods clothed in the new dress of the "third degree" is that an accused person mishandled in this way may well confess to a crime which in fact he has not committed. That in itself is a final condemnation of the abuse of such a technique as we have described. But there is no very satisfactory evidence that in any civilised country the police abuse their powers save in exceptional cases. It is certainly unreasonable to blame the police for a failure to detect crime whilst at the same time certain facilities are forbidden them which may be essential to the prosecution of certain kinds of enquiry.

Nor does it seem reasonable to suggest that because the accused person has been induced to confess by these unaggressive means that the very fact that there has been inducement shows that the confession has not been voluntary.

The next consideration of equal practical importance is much more complex. Is the confession valid evidence in all cases? Is it psychologically true in all instances that in a given set of circumstances a given individual when making a confession is certainly telling the truth?

The answer is in the negative. This is largely because psychological theory and technique are not exact in the sense that are the theory and technique of the physical sciences. There is no satisfactory evidence that the psychologist has yet arrived at the point of devising a method by which an individual can be induced to tell the truth as an inevitable consequence of the situation created by the psychologist. It is quite impossible to predict the future of psychological methods in this direction; but it can be asserted quite definitely that no exact method has yet been evolved.

This is not to say that the psychological theory behind the re-enactment of the crime in the presence of the accused is unsound or useless. The only danger is in the assumption that it is infallible. Common sense, coming to our assistance, convinces us that in the large majority of cases an individual, except under duress of torture physical or mental, does not confess to a crime he has not committed. Civilised justice demands that no sort of duress shall be applied, but it is to proceed too far in the other direction to suggest that the indirect inducement of the methods described is unfair and barbarous.

Of their utility there is no doubt, but it will be evident that the psychological principles have to be understood before they can be applied in all cases with safety. The most interesting aspect of the reconstruction is that it is a safeguard. If the police know enough to reconstruct the crime from circumstantial indications, it is clear that there is already strong suspicion amounting in some cases to a moral certainty. The confession will then merely rank as a supple-

mentary piece of evidence which will confirm the suspicion, but not decide the issue. It is on the other hand psychologically sound to maintain that if the police are mistaken in their reconstruction, or in the alternative, if the suspect who is witness of it was not concerned in the crime, even if the reconstruction is in other respects accurate, he will not react to it in any suspicious manner, assuming that his psychological condition is normal.

It is, of course, in the abnormal examples that a great responsibility devolves upon the police. In crime there are a number of border-line cases who will not react normally to inducements of this kind. Pathological cases of murder are an example. There is, for example, still doubt as to whether Peter Kürten had in fact committed all the crimes to which he confessed. Examples are rare, but not entirely exceptional, where hysterical or pathological subjects will confess to a crime with which they have not been in any way concerned. If reliance were placed upon a reconstruction and a confession resulting from it, a serious miscarriage of justice might result.

In this connection the safeguards associated with modern practice are in great contrast with the ancient methods. Three hundred years ago the confession was considered first as the most important element; to-day the confession arises as the result of the accumulation of facts with which it will, in all cases, have to be compared before its value as evidence can be decided. If it agrees essentially with the collateral circumstances, it may be vitally important confirmatory evidence; if it does not, the confession itself may establish the innocence of a suspected person more eloquently than could a thousand denials.

But there are some cases in which the experience of the medical and psychological expert will be necessary. In instances where the subject actually suffers from delusions regarding the commission of a crime, or if he belongs to that pathological type who find satisfaction in the attention drawn to them by a sensational confession, expert assistance will often be necessary. The account may be circumstantial, the

raconteur may appear perfectly sincere and normal. Curiously enough, however, even in these cases, it has been shown that if there has been an accurate reconstruction, such a spectator of it will often reveal his innocence as flagrantly as the real culprit might demonstrate his guilt. An expert, however, may be required to interpret the results.

In considering, however, the pathological example, a reconstruction may be of great value in another connection. It is a fact which has often been remarked as extraordinary that the "ripper" types of murder—in spite of the openness with which they are committed—seem to give the investigators a great deal of trouble. We have previously suggested that there is a cause for this. The author is not really aware of the nature and quality of his act. He feels neither terror at the thought of detection nor remorse. In fine, his nerve holds and he makes his escape as if nothing had happened. It is well known how such sangfroid assists certain types of thieves.

But it has been suggested, and it is perfectly true, that this type of criminal often possesses a double personality and is veritably in the psychological sense a Dr. Jekyll and Mr. Hyde. The identity of Jack the Ripper was never certainly known. Chapman has been suggested as the author of these outrages and an insane medical man. The writer was, however, once informed by a journalist who had been a London reporter who had dealt with the newspaper accounts of the investigation that an old man well known where he lived for his gentleness and peaceable nature was once under strong suspicion. It was suggested that he committed these atrocities and immediately afterwards forgot all about them.

Even if this were not true, it is not impossible. Modern psychology has made a great contribution to our knowledge of the mind by making it clear that impression and incidents disagreeable to us are often repressed (forgotten) but remain in the subconscious mind. A criminal of this type is not likely to give himself away under ordinary interrogation; he really has no conscious knowledge of the crime. But it is, on the other hand, true that if it is possible to recall the

repressed memory that it will be accompanied by indications which will not leave any doubt as to their significance.

In cases of this kind a reconstruction may be of great value, but it does not necessarily follow that this method will be the right one. When dealing with such cases, the opinions of a psychologist is really required both at the commencement of the enquiry and when suspected persons are to be interrogated.

Taking all these considerations together, there is undoubtedly a case for this application of reconstruction. An example will presently be considered which illustrates its uses in a striking way. There are circumstances in which it would be extremely difficult to complete a case in which some form of reconstruction was not used, and there is evidence that the police are hampered in their work where restrictions in this direction are placed upon them.

There is another form of reconstruction which ought to receive attention. It is that in which a reconstruction is carried out with the assistance of those who took part in the original drama. The method is commonly applied in America. The intention is to recall to the minds of witnesses who were present the sequence of events as they occurred. Psychologically this is extremely sound. The witness who may be uncertain when questioned under ordinary conditions may be able to recall incidents when the whole scene is re-enacted, and even identify individuals with certainty when before he was in doubt. This is to apply the same principle as in the case of the accused person. It will sometimes be more effective in the case of witnesses who will generally be desirous of giving an accurate account.

Finally, it will be well to consider one example of reconstruction which took place more than sixty years ago, which illustrates as eloquently as could any modern example the practical value of this kind of reconstruction.

The Voirbo Case, which created such a sensation in Paris at the time, is not interesting only on account of its sensational features. It is as good an example as any of brilliant and scientific detective work carried out by Macé, the detec-

tive in charge of the case. The affair was one of the murder and dismemberment, and the discovery of the remains was not made until long after the crime had been committed.

A very able reconstruction of the facts was made from small beginnings and meagre and uncertain indications. The wrappings found upon a part of the body suggested that it might have been the work of a tailor. This was afterwards confirmed. The only mistake made in the investigation was that of the medical expert. The surgeon who first examined the remains at first asserted that they were those of a woman. Search was accordingly made quite fruitlessly for some time, and in the wrong direction, to establish identity.

When this mistake had been corrected, the investigation proceeded slowly but with great accuracy. The clothing was traced and through it the identity of the victim was established. His rooms were examined and it was found that he had been robbed. The apartment which Voirbo, a man who had been associated with him, occupied was also carefully examined. Voirbo was ultimately arrested, but he made no admissions under interrogation and there was insufficient evidence upon which to hold him. The detective, however, had come to the conclusion that the murder and dismemberment had taken place in the room, which had a tiled floor. So much time had elapsed since the murder that it yielded no clue whatever; it was not even any longer occupied by the suspected man.

He was, however, taken to the supposed scene of the crime and in his presence Macé poured a jug of water on the tiled floor. The accused man, who up to then had shown no sign of emotional disturbance, immediately went pale and made efforts to escape.

Macé had noted that the tiling in the floor was old and uneven. He had argued that if the body had been dismembered in that room there would have been a great effusion of blood. Where it had formed pools on the uneven floor, the blood might well have soaked through and remained under the tiles. As soon as the water had flowed

over the floor and the position of the pools had been noticed it was mopped up and the tiles were removed at the appropriate points. Underneath was found brown coagulated matter, which was subsequently shown to be blood. As a result of this reconstruction, Voirbo confessed and was convicted upon trial.

No stronger case for reconstruction could be cited. The two branches of the technique, the reconstruction of the facts and their enactment in the presence of the accused person, were both brought to bear upon this investigation with nice judgment and consummate skill. If no other practical illustration could be cited—and this is one of many—it would alone justify the application of this method to criminal investigation.

CRIMINAL PSYCHOLOGY AND DETECTION. (EVIDENCE.)

From the point of view of the investigating officer who has to deal with practical problems, applied psychology is more important than are theoretical considerations. Every scientific theory has to stand the test of experience. Matters of purely academic interest are not held in much esteem by those engaged in the practical business of crime detection. This in no way alters the fact that a scientific habit of mind and point of view make all the difference. The Spaniards have a proverb that "Experience teaches even fools." The saying clearly asserts that the intelligent human being does not learn only by experience, but rather that from the evidence of one experimental fact a number of conclusions can, and ought to be, drawn by the thinking individual all of which are necessarily deducible from that fact. Both theoretical and practical learning are necessary.

Arthur Carey, the late Deputy Chief of The Homicide Bureau of New York, has called one of the chapters in his book of reminiscences, *The Picture of a Thief*. This expression originated with the then famous chief of the Central Office, Thomas Byrnes. Carey thus describes Byrnes' theory.

His first requirement was that a man should have "the picture of a thief" well in mind, a sort of mental picture to fit men and women of the criminal class. The name thief, I might explain, is a generic term applied to all professional criminals, of whatever degree or speciality. Others who have not attained the professional status are just "wrong," yet it was Byrnes' belief that, whether professionals or amateurs, men who committed crime displayed the same characteristics. He believed that a patrol man, if he were at all observant and had the knack, with a memory and ordinary deductive faculties to back him up, could get the "picture of a thief" while walking past. He might also, if he were

interested in carrying the process further, get "the picture of the crime."

Carey proceeds to illustrate this principle by means of an example taken from his own experience. He had visited a certain hotel following complaints made to the management that the rooms of certain guests had been robbed during their absence. He explains that he watched the suspect's room from the only point of vantage which was available—the lift at one end of the corridor. He presently observed a man moving silently and quickly along the passage, and his face and carriage, according to the detective, fitted "into the picture." His movements were suspicious, and he was dressed in heavy underwear, socks and a sweater.

Carey ultimately actually witnessed him using what is known in French as the *pince monseigneur*, a type of forceps used to turn a key in a lock from the outside. When challenged, he had quickly secreted the suspicious instrument under his clothing. He was, of course, arrested, and proved to be a hotel thief who specialised in this type of crime.

This is a very elementary instance, but it does illustrate the definite relation which exists between movement and posture and the mental state to which movement and posture gives rise. It demonstrates very forcibly the uses of minute observation. It is more than probable that an untrained observer witnessing an incident of this kind would merely suppose that the person they observed was one of those—common enough in hotels—who will persist in walking about without their dressing gowns. If the suspicious nature of the movement and posture were overlooked, it is not improbable that even the use of the forceps, if observed, might pass unsuspected. There is a great deal to be said for this theory of "the picture of the thief."

But arising out of this is the much more important question as to whether in fact there is any general relation between posture and character. There is, after all, a great deal of difference between the almost self-evident proposition that a man about to commit a crime will behave in a suspicious manner, and the assumption that one accustomed to commit

crime will inevitably show some indications of his evil propensity. It is, however, a more or less accepted fact that the criminal can be recognised in this way, and it is one which has very great importance for the jurist and the detective.

Despite Lavater's impressive thesis—his works on physiognomy is classical and can be read with profit even to-day—it is not at all an easy matter to interpret the emotions behind facial expression. Still less is it possible definitely to connect a particular facial and cranial formation with a particular character. But it remains true, nevertheless, that there is a relation between facial expression and the mental and emotional processes even if that relation is not completely understood. It is possible, in short, to read a face, and thus to make deductions from the demeanour and posture of a witness. This introduces us at once to the whole question of the criminal as witness. It is a vital question, because sooner or later in any investigation the suspected person and those alleged to be accomplices will have to be interrogated, and much may depend upon the information which can be extracted from them, and the degree of reliance which can be placed upon it.

In an article of this kind it would be out of place to discuss opposing theories of criminal psychology. It is perhaps to go too far to suggest that pathological lying is a necessary part of the psychological make-up of the criminal, that he belongs in plain language to that category of human beings who cannot tell the truth except by accident. But it is of the first importance to bear in mind that the very circumstances of the case predispose to what might be described as instinctive lying. Consciously recognising, as he does, from the very beginning that lies are a necessary complement of fraud, the criminal by mere habit will lose all appreciation of the truth, and at last utter the falsehood for the falsehood's sake. At this point modern psychology comes to our rescue. It has been shown quite conclusively that lying in children always arises out of fear. As often repeated, fear-stimulus may result in pathological lying because the child comes finally actually to fantasy that which it wishes its interrogator to believe.

The criminal is very much in this position. He is perpetually under the influence of the fear-stimulus, so that—*even when the truth is not prejudicial to him*—he may still be unable to tell it. An example of this kind came under the present writer's notice quite recently. In this particular case the individual concerned stood quite definitely to gain by making an accurate statement. He seemed unable to appreciate the fact evident enough to the ordinary mind, that the occasion was one in which honesty was beyond all question the best policy. This is a cardinal point which every interrogator must bear in mind; the pathological inaccuracy of most criminal evidence. It seems not to be much affected by the general intelligence or the educational standard of the criminal witness.

It is interesting to consider at this point how far it is possible to decide by close observation of the face and posture whether or not a particular statement is true. Those who cannot or do not look their interrogator in the face are not necessarily lying. On the contrary, the wavering glance is more often evidence that the speaker is ashamed of the truth, not of the consciousness of falsehood. The unnaturally direct stare is very much more suspicious. There is a psychological reason for this. The speaker is making an effort of will to convince, consciously or subconsciously, and the direct glance is an index of it. But there is at the same time a condition of tension and unease which may reveal itself in the bodily posture. The fingers or the arms will move, the legs or even the trunk. It is not sufficient to watch the face to come to a conclusion regarding the reaction of mind upon body.

The reaction of the untruthful person to the discovery real or supposed that the falsehood is known is also interesting. A person who will quite unblushingly tell a lie and maintain it in the face of incredulity, may entirely give himself away when allusion is unexpectedly made to the matter. But direct accusation is of no use. The interrogated person will hesitate, and in that flash of hesitation build up his defences. The psychologically sound method is the failure in the interroga-

tor to understand how the present statement can be reconciled with the past one. The suspect is thus not suddenly alarmed into a denial; he rather casts about to discover how the statements can be reconciled. He hesitates, but hesitates too long, and so is confused and lost.

Because it is the obvious and often may appear to the criminal to be the only possible line of escape, the alibi is a thing very commonly met with. We shall recall Sam Weller senior's insistence upon it as necessary in the matter of Mr. Pickwick's case of breach of promise, a proof of the fact that the novelist had observed that among the uneducated the alibi was regarded as a panacea for all evils, and a very present help in all times of difficulty.

It may obviously be very difficult to test the truth of an alibi; but it should be noted that if there is fairly strong suspicion against an accused or suspected person, the very appeal to an alibi may be additional evidence against him. Innocent persons will not appeal to it hastily, and sometimes will not appeal to it at all, but will wait, as it were, for the alibi to speak for itself.

A most interesting example of this is to be found in the affair of Mary Ashford, who in 1818 was discovered in a pond near some mills at Erdington, Birmingham. The case is one of the most mysterious and extraordinary which has ever been tried in England. It was never decided at the trial whether the girl had fallen into the pond and been drowned, had been deliberately pushed in, or, if alternatively, she had committed suicide.

But the principle point of interest for us is that Abraham Thornton, who was suspected and afterwards accused of her murder, was interrogated. The questioners began by informing him that the girl's dead body had been found. This was in the forenoon of the day of the murder, the body having been discovered at 6 a.m. Thornton expressed great surprise, and said: "I was with her until four o'clock this morning." He later admitted that he had had sexual intercourse with her at about that time. *Prima facie* these statements were extraordinarily damaging. Many other indica-

tions seemed also to point inevitably in his direction; but it was subsequently proved beyond all doubt that Thornton could not have been in the girl's company at the material time.

This is an example of great significance in connection with the technique of interrogation. The accused was in this case certainly innocent, but he was ready to make an admission which actually brought about his arrest. It was, in fact, perhaps the strongest point in his case that he made no endeavour at that time to produce an alibi, but, on the contrary, made an admission which for anything he knew might have made it impossible for him to substantiate any alibi.

But whatever suspicions may be entertained regarding the alibi, it may not always be possible to prove that it is false. If the accused person has accomplices willing to co-operate with him against their common enemy, the police, the matter may be very complicated. This illustrates how closely circumstantial evidence and that obtained by inquisition are interdependent and inter-related. Ultimately circumstantial evidence has to be brought to the test of interrogation, and the manner in which it is used in this connection may make all the difference between success and failure.

It will now be obvious how necessary it is for the investigating officer to make a thorough examination of all the facts and endeavour to piece them together, so that he can compare the order of the events as they are described by the accused or by witnesses with the reconstruction on the basis of known facts. There are many circumstances in which no false alibi can survive this test. Irrefutable proof may establish that the interrogated person has not told the truth.

On the other hand, even when there is not a great deal of circumstantial evidence, the old proverb can be borne in mind that a liar has to have a good memory. A manufactured alibi presupposes the necessity of conspiracy between two or more persons. Those who are interested in the construction of the alibi are in a very difficult position. The value of the alibi will increase directly as the number of

independent witnesses who support it, but if there is conspiracy to deceive, the chances of a conflict of evidence will increase with the number of people who are concerned in the conspiracy. Hans Gross goes so far as to say that a careful interrogation of all the witnesses separately will always show up the manufactured alibi for what it is.

But this is not always true. An illustration is to be found in an affair of the murder of a young girl which took place in England in the 'eighties. A certain Nonconformist minister was accused of the crime, and he actually stood his trial. The case aroused a great deal of public sympathy with the accused, and a huge subscription list, to which the Prime Minister and many other prominent people subscribed, resulted in the collection of a large sum of money which paid the costs of the defence and a substantial amount in excess which was handed to the minister after his release.

The defence was an alibi, which was successfully sustained, and the accused was accordingly acquitted. In the light of some facts, however, which emerged later, there seems to be no doubt that the alibi had been cleverly faked, and that the accused was, in fact, guilty of the crime.

✓ Two considerations arise in this connection. In this example there is some suggestion that if the circumstantial evidence had been scientifically interpreted, the alibi would have been more closely scrutinized. This is a practical illustration of the importance of checking the evidence of witnesses and the accused against the rest of the available evidence, and making a rigorous examination of any discrepancies.

The second point is more complicated. There are obviously greater difficulties in interrogating the educated witness than in dealing with the ordinary criminal. If the accused has been in the hands of the police before the witnesses he brings to substantiate his story will probably be criminals themselves. In most cases it will not be impossible to find out when they are lying. It is quite another matter when the accused is an educated man suspected of murder. He is quicker witted, and has more imagination. Further, if

the defence is an alibi, those testifying will not be criminal associates, but respectable people who either have been genuinely deceived, or who have some very good reason for shielding the accused person.

As we have already indicated, criminal minds, whether educated or uneducated, seems to have certain things in common which makes it possible to apply certain general principles when dealing with them, but in the case of the alibi, there will be, in the circumstances indicated, persons to be interrogated who are not criminals, and who would perhaps speak the truth if they could.

Here is a case for the application of everyday psychology; an elementary understanding of such matters as observation and memory. The fact that two witnesses give different accounts of the same event does not prove that one or both of them are lying. There may be varying degrees of acuteness and accuracy in observation. Emotional stress may unconsciously deceive. There may even be pathological conditions not easily recognised except by the expert which make the witness's testimony unreliable.

Accuracy of memory arises out of acuteness of observation or the results of it. We may entirely forget, or but vaguely recall, an incident which has not at the time greatly impressed our minds; while, on the other hand, it is important to remember that one which has caused strong emotional disturbance may have impressed quite a false picture upon the memory. It is necessary to accept with great caution such a statement as "I shall never forget it as long as I live" or "It is indelibly printed upon my memory." Certainly there is in such cases something which will never be forgotten, but it may be quite a false picture of what happened in fact.

The famous experiment of Lipmann at Göttingen is an excellent illustration. He staged an incident in which a clown suddenly entered a lecture theatre containing a large audience during the psychology congress. The clown was pursued by a negro who caught and struggled with him. A

fight ensued during which a pistol was fired. The clown rose and rushed from the room pursued by the negro.

The incident had been deliberately staged, but the spectators imagined that it was genuine. They were asked by the President to write a report on the grounds that their evidence might be required at subsequent legal proceedings.

Forty reports were returned. Six were approximately accurate, but not entirely so. Twenty-four contained gross errors as to material fact. Ten were incorrect in all essentials.

In connection with this example it is very important to remember that the audience was composed of educated men who as psychologists were accustomed to observe. The incidents, after all, were not particularly complicated. They were, no doubt, "indelibly imprinted upon the memory." And yet less than twelve per cent. of those who reported them did so with even approximate accuracy. The greater majority were incorrect in many essentials and more than twenty per cent. were incorrect in all.

The circumstances were certainly unusual, and they provide a significant example of how emotional stress may affect accurate observation. It is not difficult to see how, after a lapse of time, a further distortion of the mental image would take place, so that even those observations which were originally correct would cease to be distinguishable as such.

Where a crime is concerned, this is exactly the kind of situation which may arise. For the ordinary man the circumstances were obviously unusual and his account of them, even when he desires to tell the truth, more or less incorrect.

On the other hand, incidents may be forgotten because they have not made sufficient impression upon the memory. It will very often happen that where an accused person appeals to an alibi and to the evidence of other people in support of it, the whole matter may turn upon the recalling of unimportant incidents which will prove or disprove the alibi. Where there is a question of doubt and the person questioned is friendly with the accused, he will probably, without wishing to deceive, give his friend the benefit of the

doubt and perhaps subconsciously but quite sincerely become an advocate in his favour.

There is again the question of what the individual observes. In any given series of events the individual records those which particularly interest him. By way of example it is in general true that in identifying the clothing of a person, the hatter will remember his hat, the tailor his clothes, and the shoemaker his footwear. Observation of details of this kind are automatic and always unconscious. This fact is one which is very useful to the interrogator for there are circumstances in which it may give him a very good idea as to which observations of the witness are likely to be accurate and which may be doubtful.

The interrogation of the honest witness thus presents a very much greater problem than that of the one who deliberately wishes to deceive. Given the necessary skill and patience it is probably true, as Hans Gross has suggested, that falsehoods can be detected as such. It is quite another matter when the witness really believes that he is telling the truth or is genuinely unable to give an account of the events as they occurred.

The success of the interrogation in such circumstances will very largely depend upon the extent to which the investigator has been able from other evidence to make a provisional reconstruction of the affair which he can use judiciously to refresh the witness's memory. But a great deal of caution is necessary. It is very easy to suggest to the person interrogated that things did happen thus and thus, and so to convince him concerning matters of which he is really in doubt. But theoretically the procedure is perfectly sound. If it is possible to recall to the mind of a witness an incident of which the investigator is absolutely certain but which the witness has forgotten, it may result in his being able to recall a whole series of details which were associated with this incident and which were forgotten merely because the original incident had been forgotten. The ultimate appeal is to facts. On a last analysis, the interrogator has to make use of such facts in his possession as are certainly

true to detect the criminal, to confound the lying witness, and to assist the honest one.

To what extent the technique of the new psychology of the school of Freud and Adler can assist in criminal investigation is too large a subject to discuss here. As a matter of fact, the new psychology has not been much applied in this direction and experimental data would no doubt be very interesting from a practical point of view. Allusion has already been made to the fact that the reconstruction of the crime as a means of inducing confession can be explained in terms of modern psychological principles. There is no doubt that an investigator who fully understood the modern psycho-analytic technique might find it very useful for the purposes of interrogation. At the present moment, however, it is very doubtful if the principles are sufficiently well understood to make it justifiable to use these methods for the detection of crime.

There is a further aspect of interrogation to which allusion ought to be made in conclusion. Up to now we have dealt only with the accused and with witnesses who are for all practical purposes normal. But occasions often arise in which it may be necessary to interrogate those who have received wounds of some sort concerned with crimes of violence. In all cases of head wounds and sometimes as a result of other injuries the evidence given by the injured person may be extremely unreliable. It does not by any means always follow that the wounded man will show any incoherence or confusion of mind. This is not to say that a statement taken in such circumstances is useless. It may be that the information supplied is perfectly accurate for it is not necessarily true that a head injury will confuse the memory and the intelligence. But in such instances it is absolutely essential that a medical man should examine the injured person and give his opinion as to whether or not any reliance can be placed upon the statements he makes. There are numerous examples of serious mistakes having arisen by reason of neglect of precautions in these circumstances. The person attacked may give a completely circumstantial

account of the whole incident and a minute description of his assailant, all of which is subsequently proved to be incorrect. On the other hand, there may be a complete gap in his memory of which he is entirely unaware so that gross errors in the matter of time may arise out of his evidence. There are, of course, instances in which an old wound on the head has permanently affected the injured person's mind, and according to Gross the investigating officer should carefully observe the head of the person interrogated for scars. Such old wounds may induce lapses of memory, fits of depression, or sudden violence without there being any of the usual signs of mental disturbance.

