A TEXT-BOOK OF

MEDICAL JURISPRUDENCE

TOXICOLOGY

AND

PUBLIC HEALTH

BY

JOHN GLAISTER, M.D., D.P.H. (CAMB.), F.R.S.E.

Professor of Forensic Medicine and Public Health in the University of Glasgow; Fellow of the Faculty of Physicians and Surgeons of Glasgow; Licentiate of the Royal Colleges of Physicians and Surgeons of Edinburgh; Examiner in Medical Jurisprudence and Hygiene to the Royal Colleges of Physicians and Surgeons of Edinburgh, and the Faculty of Physicians and Surgeons of Glasgow for Diplomas in Medicine and Surgery, and Examiner in Public Health for the Diploma in Public Health of these United Corporations; Senior Medico-Legal Examiner in Crown Cases for Glasgow and Lanarkshire, etc.

With 238 Illustrations

EDINBURGH
E. & S. LIVINGSTONE
1902

CHAPTER XI.

BLOOD-STAINS, AND EXAMINATION OF BLOOD.

CLOSELY associated with the subject of Wounds is that of blood-stains. As has already been pointed out, in every case in which a dead body with wounds upon it is examined *in situ*, examination should be carefully made for the presence of blood-stains and their incidence upon the body and in its vicinity, within or near the place in which it is found. The examiner must expect to meet with every possible variety of stains, both in respect of character, incidence, and magnitude; as (*a*) sprays, spirts, or jets; (*b*) smears of various forms; or (*c*), pools of blood.

The relation of the direction of a spray of blood to the position of a wounded body when found, and the presence of such in the vicinity of the body or the place where the body is found, ought to be carefully noted on a rough plan sketched upon the spot, after measurements have been duly taken, because such may indicate the position of the person at the time of wounding, or the place where a given wound might have been caused. The cases already narrated illustrate these points. This is especially important where, in a charge of homicidal assault, a plea of accident is set up. In a case recorded by Ogston,[1] he was able to locate the place where the violence had been offered, although the body was found in a field about thirty yards away, by the fact that on the side-posts of the door of the house and on the wall-plaster adjacent, he found jets of blood at a height of four or five feet from the ground. The attack had been made by a weapon, such as the back of an axe, and although the victim had died at the spot where the body was found, judged by the large quantity of blood found, it was evident that he had been able to flee from his adversary before succumbing to the effects of the violence. In the cases already given (pp. 213, 216), it was quite evident that. in the former, the only place where the only wound found on the body could have been produced was the wooden facing of the window of the bedroom, and in the latter that the violence had been inflicted upon the victim while her assailant, chasing her round the apartment, was battering her head and face with a brick. In the examination of blood-stains on wood or on any other surface, any hairs or other substances present ought to be taken possession of for future examination, as they may prove of value in elucidating certain points. Loudon[2] affirms that with some experience it is not difficult to differentiate between the hairs of Man and those of the lower animals, nor even to decide to what species of animal a given specimen belongs. This we can corroborate; but it

[1] *Op. cit.* p. 468.
[2] *Archives d. Sciences Biolog.*, vol. vii. No. 2.

can only be accomplished after careful and deliberate study of a great variety of different animals' hairs. He declares that if a hair-bulb has been forcibly extracted, the bulb will be irregular, will possess an undulating surface, and will show excrescences of different shape and thickness; and that a naturally-shed bulb will be small with a rounded extremity, and will have a smooth surface. On the other hand, in addition to the appearances microscopically of the bulb itself, we attach more importance to the condition of the sheath of the bulb. In a forcibly-plucked bulb the sheath will be found ruptured, as shown in Fig. 50. Hassall[1] gives a drawing

[1] "The Microscopic Anatomy of the Human Body," vol. i. Plate xxviii.

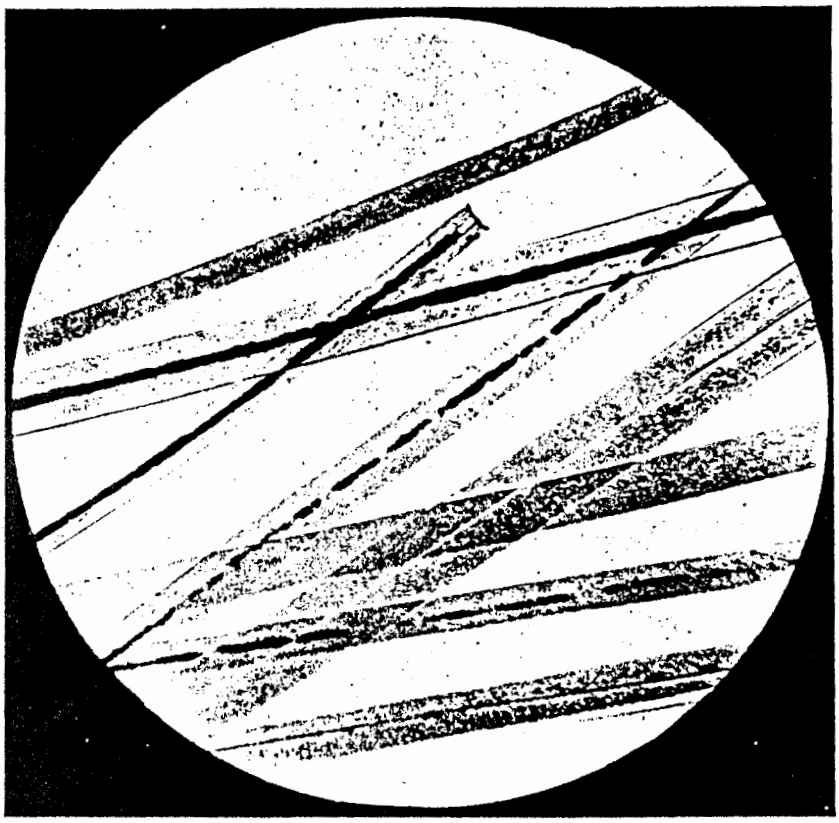

FIG. 66.—Photo-micrograph of Human Hair becoming Grey from Age. Pigment is disappearing from medulla. × 500 diameters. (Author.)

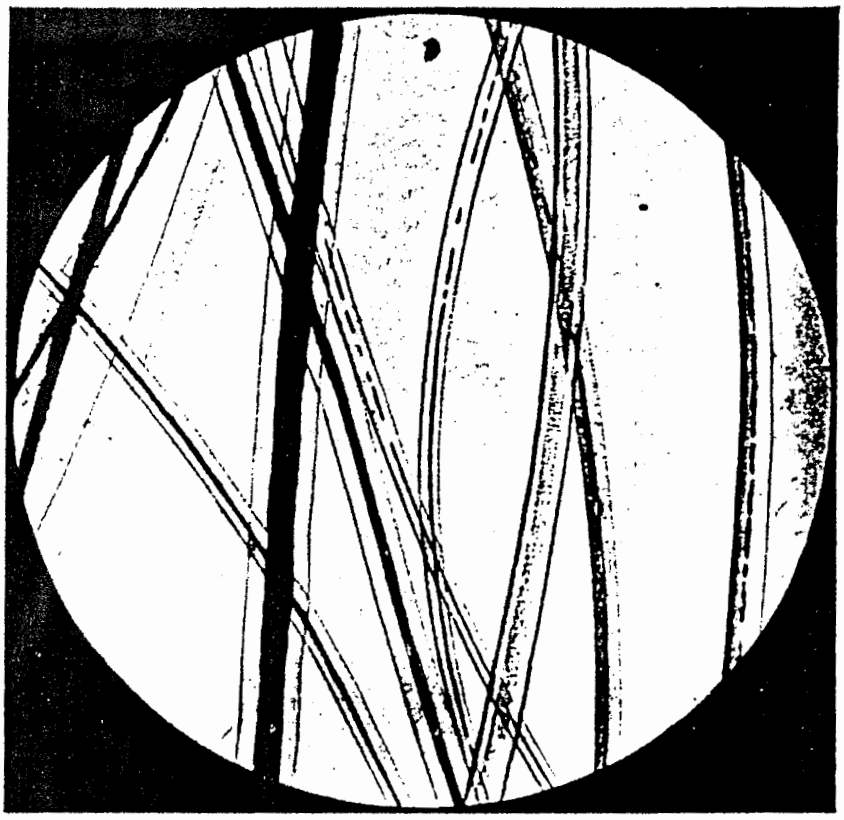

FIG. 67.—Photo-micrograph of Hair of Polar Bear. × 500 diameters. (Author.)

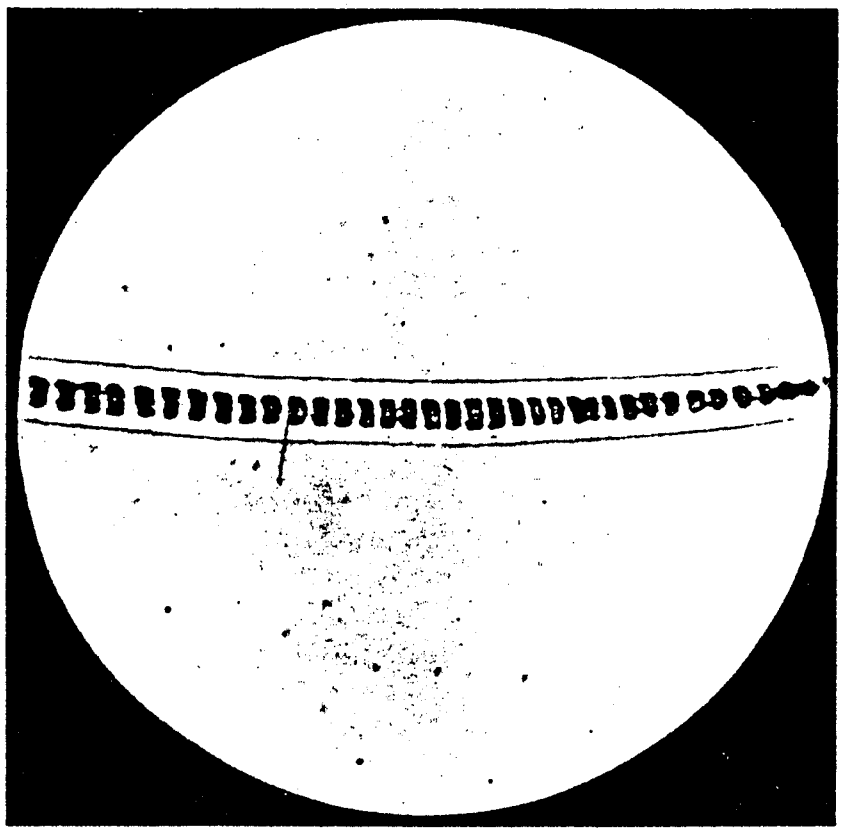

FIG. 68. — Photo-micrograph of a Hair of the Rat; magnified 500 diameters. (Author.)

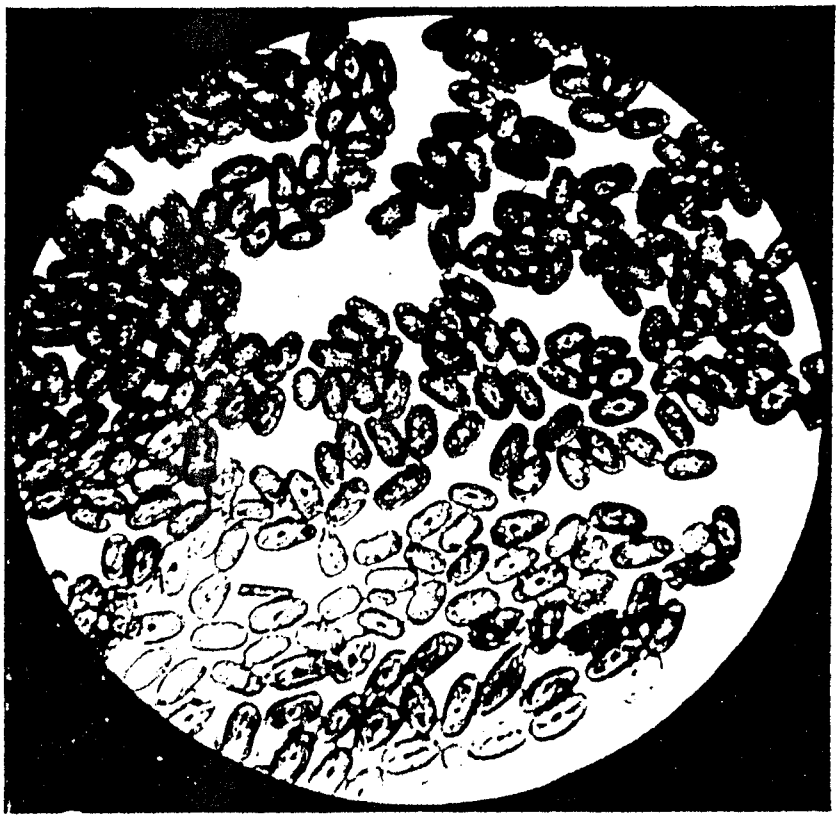

FIG. 69.—Photo-micrograph of Cross Sections of Human Hair, showing pigmented medulla. × 500 diameters. (Author.)

of the sheath of a hair which was forcibly extracted, which shows the rupture of the sheath as seen in the above figure. It ought to be noted that polarised light is absolutely necessary to distinguish fine differences in hairs. So, likewise, bloody foot-prints, or foot-prints in blood, ought to be carefully measured in view of the possible raising of questions having reference to the identity of an assailant or assailants. This question, however, rises to higher importance, probably, in the detection of blood-stains upon clothing or other fabrics, weapons, leather, plaster, or wood, for in this way a suspected person may occasionally be associated with a given crime, while the evidence, otherwise, is circumstantial.

The colour of blood-stains varies, and de-

pends upon a number of circumstances, the principal of which are the following, viz. :—

1. The age of the stain.
2. The amount of blood composing it.
3. The nature and colour of the material upon which it has been effused.

Generally speaking, recent stains are reddish in colour, old stains, brownish. On certain cloth-fabrics, stains of blood are less visible in daylight than by artificial light, as, for example, on brown, blue, and dark-coloured stuffs generally; whereas on others, they are best seen in good daylight, as on light-coloured fabrics, on leather, wood, iron, or stone. By reason of their albuminous composition, blood-stains, when dry, impart a stiffened or starchy feel to thin fabrics, such as those composed of cotton, wool, silk, or linen; and even on thick worsted or woollen tweed-stuffs, blood mats together the fibres, as seen through a hand-lens. On iron, steel, or metal generally, they look like dark, shiny spots or smears, and when desiccated, are often found fissured or cracked.

EXAMINATION OF BLOOD-STAINS.

What course ought to be systematically followed in the Examination for Blood-stains, and in the Identification of coloured stains with Blood? In the first place, caution and carefulness must be exercised throughout the whole inquiry, for, if possible, and an opportunity offers, a guilty person will attempt to wash away the evidences of his guilt. In the examination of clothing, therefore, it is very necessary to examine especially those parts of the clothing which are most likely to be overlooked in the cleansing process, or those parts of articles of attire which may entirely be overlooked, such as seams of clothing, soles of boots, etc.

A. **Physical Examination.**—Given. then, certain spots or marks of stains on cloth-stuffs which may be blood, the following is the course which ought to be pursued in their examination :—

I. Examine them critically with a good hand-lens. By this means, matting of fibres, or even minute coagula may be discovered.

II. Note accurately the positions on the garment of the stains examined.

III. Cut out the piece of cloth on which the stain is found (or, where several stains are found, some of the stains), for the purpose of noting the solubility of the colouring-matter in a solution composed of water and some other substance. It is always advisable, where multiple stains are found, to leave some of them untouched for the use, it may be, of another examiner. The solubility of a blood-stain depends upon two main factors, viz. (*a*) the composition of the stain in respect of its age, and (*b*) the material upon which it is found. The following general proposition may be affirmed: the more recent the stain, the greater its solubility; and the converse is equally true. In recent stains, the hæmoglobin is more or less soluble, but in very old stains, solution is not effected, because

the soluble hæmoglobin has been converted into insoluble hæmatin. In trying to obtain a solution of the blood-stain, the object is not to obtain a coloured solution for chemical and spectroscopic purposes only, but, if possible, to obtain the contained corpuscles for microscopic examination in as natural a form as possible, so as to identify the class of animals to which the corpuscles belong; therefore, the solvent used should simulate as nearly as possible the specific gravity of the *liquor sanquinis*. The best solvent for this purpose is one composed of seven parts of water and one part of glycerine (sp. gr. 1030), Pacini's solution which is made up of one part of chloral hydrate dissolved in ten parts of water, or normal saline solution. Where water alone is used the corpuscles appear swollen like globules, due to endosmosis, because of the water being less in specific gravity than the serum of the blood; where, on the other hand, a solvent of higher specific gravity than that of the serum is used, the corpuscles appear misshapen, crenated, or punctated at the edges, due to exosmosis.

Stains may have to be examined upon any of the following substances, viz.:—

1. Cloth-fabrics.
2. Wood.
3. Plaster.
4. Metal.
5. Leather.

The following procedure, in respect of each, is recommended, in order to obtain a solution, if such be possible.

I. *Cloth-fabrics.*—Cut out the stain, moisten it in one of the foregoing solvents, and assist maceration by gentle bruising of cloth with a piece of glass rod. This procedure is applicable to large stains; but where the stain is small, and the quantity of colouring matter available is also small, it may be necessary, after moistening the stain in the solvent, to squeeze out with flat-pointed forceps tiny drops on a series of glass slides for examination by the microscope, and to reserve the remainder for the spectroscopic test. In dyed fabrics, the mordants used may so fix the blood-stain that solution fails, and this is especially true when it has been attempted to wash away the stain with soap and water. To obtain a blood-solution in such cases, it is necessary to digest the cloth in either a weak solution of citric acid or of ammonia—which of them can be ascertained by parallel experiment—when the blood-colouring matter will readily yield to solution.

II. *Wood.*—Cut off a thin shaving of the wood, noting, if possible, the kind of wood, especially if oak or elm, and treat the stain, if on ordinary wood, with the solvent, but if on oak, with a 2 per cent. solution of hydrochloric acid. The reason for this will be discussed later.

III. *Plaster.*—Scrape off plaster with stain, and proceed as for cloth or wood.

IV. *Metal.*—If on a clean, unrusted weapon, and the stains are

thick like a spot of dried jelly, then gently heat, over a spirit flame, the opposite side of the blade to that upon which is the stain, when, if the stain be recent, it will probably peel, curl up, and fall off, or may be easily loosened. This must be done with great care. But the same end may be attained without the risks attending the foregoing, by scraping the stain into a watch-glass. Where the stain is thin, or mixed with rust, scraping is the only available method for detaching it. Where the weapon is rusty, or the stain is apparently mixed with rust, a preliminary test, based upon the behaviour of blood toward hydrogen peroxide, may be employed to a small corner of the stain. An account of it is given by Ganttner,[1] and it may, therefore, be called by his name. The test, which we have corroborated several times on old rusty instruments known to be blood-stained, is best carried out thus: it may be performed on the weapon itself, or, better, if the weapon has to be more fully examined, by scraping off a part of the rusty deposit into a watch-glass, placed on top of a piece of black paper, then to drop on the scrapings, after adding a drop of water made feebly alkaline, a tiny drop of hydrogen peroxide, and watch the result. If blood be present even in the slightest trace numerous comparatively large bubbles of gas are developed, which, gradually becoming more numerous, give a white, beady appearance to the surface of the material. According to Ganttner, this frothy appearance develops from the outside of the drop toward the centre. But this is only seen where the scraped material is mainly composed of blood. Where the rust only contains blood in some of the particles, the gas only shows in those particles which contain blood. There is little fear of mistaking this frothy appearance for air-bubbles, but lest this might be a source of confusion, it is better, after adding the alkalinised water, to dissipate any air-bubbles which may form round the particulate matter with a piece of sharp-pointed glass rod, and thus have the mixture clear before adding the hydrogen peroxide. Should the above reaction not take place on the addition of the peroxide, then it can safely be affirmed that no blood is present. It is, therefore, an excellent negative test. But it is not an equally safe positive test of the presence of blood, because other fluids of the body when mixed with rust, such as saliva or pus, give equally well the same reaction; so that other tests, such as Teichmann's, must be applied to another portion of the scrapings, in order to obtain, if possible, hæmin crystals. The age of any stain, however, is no bar to its employment from the negative side, but where response is given to the test, positive proof of the presence of blood must be given in other ways, as that of Teichmann, or by the spectroscope.

[1] *Zeitschrift für Anal. Chem.*, 1895, Zweites Heft, pp. 159–160; also *The Analyst*, vol. xx. p. 186.

V. *On Leather.*—Special care must be exercised in the examination of stains upon this medium, owing to the fact that the tannic acid in the leather forms a compound with blood which is insoluble in either of the solvents named; and for the same reason, this applies to oak, or any other wood, which contains much tannin. But if a long, thin shaving of the leather bearing the stain be sliced off with a sharp knife, and the shaving be doubled so that the stain is upon its convex side, and if the surface of the stain be made just to touch the water-glycerine solvent without coming in contact with the leather, a coloured solution may be obtained if the stain be recent. Should this fail, Sorby recommends that the leather-shaving should be placed in a small quantity of a 2 per cent. solution of hydrochloric acid in water—no more, and no less.

B. **Chemical Examination.**—Having obtained a coloured solution, to a certain portion of it, depending upon the total quantity at disposal, certain chemical tests should be employed, viz.:—

1. To a small portion of the coloured fluid, add a drop or two of a weak solution of ammonia and water. If the colour be due to blood, it will either become slightly more red, or it will remain practically unchanged. If, however, it be due to the red juices of fruits or jellies, or jams, the colour will be changed to green, and if due to logwood, madder, cochineal, or Brazil wood, to crimson in colour.

Note. If the ammonia used be too strong, a brown colour may be produced in the case of blood.

2. To a second portion, apply heat to boiling, when the following three changes will happen, if it be due to blood:—
   (*a*) The colour disappears.
   (*b*) The colour becomes milky from coagulation.
   (*c*) A precipitate falls, which may vary in colour from a dirty-grey to brownish, depending upon amount of blood-colouring matter present.

   To the precipitate add Caustic Potash and apply gentle heat, when the precipitate will dissolve, and the resulting solution will show a different colour depending upon whether it is viewed by transmitted or by reflected light. This phenomenon is called the *dichroism* of the blood. Respecting the colours as seen, authorities differ: some declare that the colour by reflected light is green, and by transmitted light, red, while others affirm the opposite. As a matter of fact, the phenomenon is chameleon-like as regards colour, so that both sets of observers may be considered right or wrong.

3. To a third portion, add a drop or two of fresh Tincture of Guaiacum (upon which the fluid will become white owing to the deposit of the guaiac resin by the water of the solution) and, thereafter, a few drops of ozonised ether or turpentine, or peroxide of Hydrogen, when, if blood be present, a blue colour more or less marked, depending upon the amount of blood-colouring matter present, will develop at the junction of the fluids. This colour may vary from a very pale shade of blue to a distinct sapphire blue.

   This test is known as Day's test, from Dr. John Day of Geelong, or Schönbein's test, from this observer having proposed its use for this purpose in 1861. There is no other coloured substance which gives this reaction, and this test, moreover, is an exceedingly delicate one.

4. Concentrate a portion of the coloured solution, place a drop upon a microscopic slide, add and mix a drop of glacial acetic acid and a tiny crystal of chloride of sodium, beat gently to dryness, and examine, thereafter, microscopically; if blood be present, crystals of hæmin, which is the hydrochloride of hæmatin, will be found, which may vary in colour from faint yellowish-red to brownish-black, and which may be rhom-

boidal, or six-sided in shape, and may be found in clusters, as separate crystals, or in masses. This is called Teichmann's test. The formula for hæmin, according to Mörner, is (C_{35} H_{35} N_4 Fe ClO_4). It is well to verify the crystals as those of hæmin, which may easily be done by placing over them a tiny drop of hydrogen peroxide, upon which the evolution of gas-bubbles of oxygen will take place, as already described. (Fig. 70.)

C. Spectroscopic Examination.—To a second portion of the coloured fluid, the spectroscopic tests should be applied.

Before doing so, however, there are two or three points respecting the nature of the blood-colouring matter with respect to its varied states of oxygen-combination, which must be stated for the clear comprehension of what is to follow:—

1. The colouring-matter of fresh blood is called *hæmoglobin*, and we may leave out of count the name *cruorine* which Stokes gave it. It may exist as

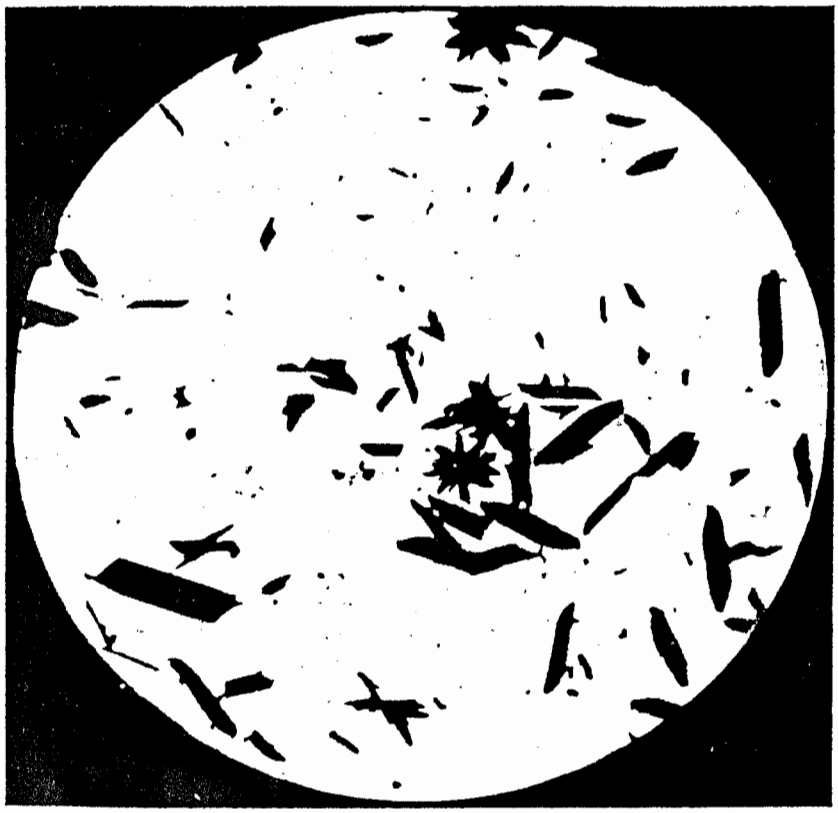

FIG. 70.—Photo-micrograph of Crystals of Hæmin. × 500 diameters. (Author.)

oxidised hæmoglobin, as in arterial blood, or blood which has been exposed to the air, or as deoxidised hæmoglobin, as in venous blood, more especially when taken, under certain precautions against aëration, from the heart cavity of an animal newly asphyxiated.

2. If the stain has become dry, as it is likely to do quickly upon various media, and if it has been exposed to an atmosphere in which the products of coal combustion are present, the hæmoglobin becomes changed into *met-hæmoglobin*, a body which seems to be composed of hæmoglobin and loosely-combined oxygen, and which may be considered as the first stage of the hæmoglobin-deoxidising process. This conversion does not take more than a few weeks at the outside, under the circumstances named.
3. If the stain has been kept damp, by lying in a damp place, it becomes gradually converted into *hæmatin*, which, according to Nencki and Sieber, has the chemical formula (C_{32} H_{30} N_4 FeO_3).