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MICROSCOPICAL EXAMINATION OF BLOOD IN ITS  
RELATION TO CRIMINAL TRIALS.

CAN the red blood corpuscles of other animals be distinguished from those of man, so as to warrant a certain conclusion in those criminal cases in which the question becomes of value in deciding the guilt or innocence of the accused?

It has hitherto been a disputed point, whether human blood could be distinguished from other mammalian blood by any means whatever. The object of this article is to show that this may be determined by measurement, based upon the observation that the corpuscles of human blood, in the aggregate, are larger than those of any other mammal.

Blood itself can be told from other substances by other methods, which serve as a resource in those cases where the corpuscular forms have been destroyed; but by this means alone can the different kinds of blood be recognised.

Dr. Joseph G. Richardson, in his work on Medical Microscopy, quotes the following case, showing the value of microscopic examination, not only in the detection of blood stains, but of other suspected matters, which may chance to have a bearing upon the detection of crime:—

“The trial occurred at Norwich, England, about the year 1850, under the following circumstances: A female child, nine years of age, was found lying on the ground in a small plantation, quite dead from a wound in the throat. Suspicion fell upon the mother.

of the girl, who, upon being taken into custody, behaved with the utmost coolness and admitted having taken her child to the plantation where the body was found, whence the child was lost while going in quest of flowers. There was found in the woman's possession a large knife, which was submitted to a careful examination; nothing was found upon it, however, with the exception of a few pieces of hair adhering to the handle, so small as to be scarcely visible. The examination being conducted in the presence of the prisoner, and the officer remarking: 'Here is a bit of fur or hair on the handle of your knife,' the woman replied 'Yes, I dare say there is, and very likely some stains of blood, for as I came home I found a rabbit caught in a snare and cut his throat with the knife.'

"The knife was sent to London, and with the particles of hair submitted to a microscopic examination. No trace of blood could at first be detected upon the weapon, which appeared to have been washed; but upon separating the horn handle from the shaft, it was found that a fluid had penetrated into the socket which was found to be blood, certainly not the blood of a rabbit, but bearing a resemblance to that of a human body.

"The hair was then submitted to examination. This hair was found by the microscopist to be that of a *squirrel*. Now round the neck of the child at the time of the murder there was a tippet of squirrel's fur. This strong circumstantial evidence was deemed by the jury sufficient to convict the prisoner, and while waiting execution she confessed her crime."

Had the woman not convicted herself, in her statement to the officer, and the *blood* on the shaft of the knife been the only evidence of guilt, perhaps this would not have warranted a conviction, even if it could have been shown to be *human blood*, as it might have been of old date and the result of accident; but had human blood been found upon the *blade*, which could not have been fully accounted for in some other way, it would seem to be pretty conclusive evidence.

It will be remembered, in the recent case of Rubenstein, in New York, the defence claimed that the blood found on the prisoner's clothes was *hen's blood*. This blood is easy to be distinguished from human blood by the *form* of the corpuscles, but as Prof. Eaton, who testified in the case, did not claim to be able to distinguish the blood actually found from some other kinds of mammalian blood

(of the dog, for illustration), had the criminal been wise enough, he might have been able to cheat the gallows, perhaps, without having recourse, as he did, to suicide for that purpose.

But can human blood under any circumstances be clearly distinguished from that of other mammals which resemble it in form—the blood of the dog, for instance?

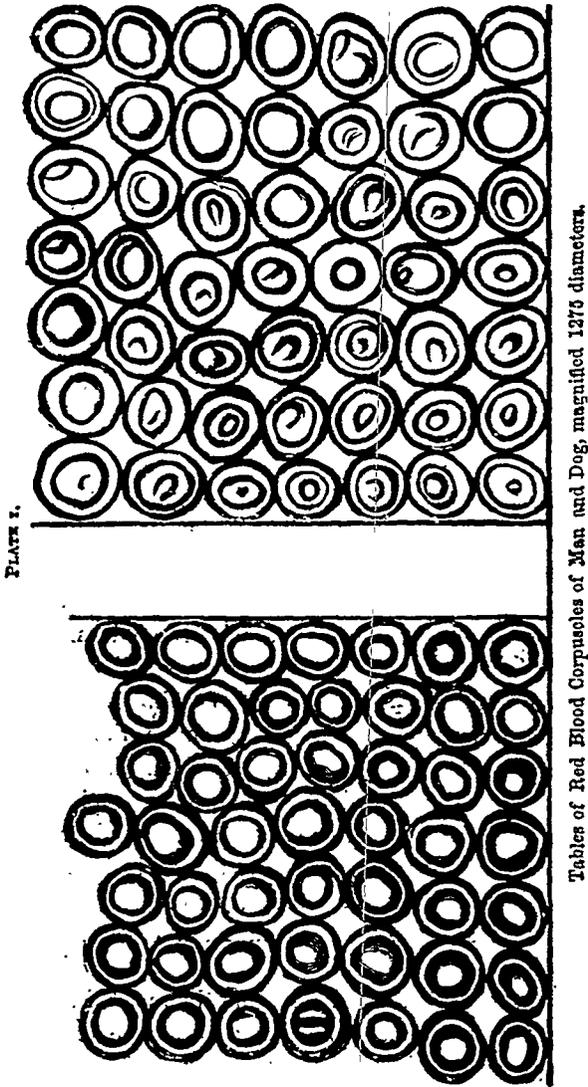
Dr. Richardson claims that it can be certainly known from that of the ox, sheep or pig, but does not speak of the dog.

In a recent work by M. Naquet, "Professor to the Faculty of Medicine of Paris," entitled "Legal Chemistry a Guide to the Detection of Poisons, Examination of Stains," &c., the following statement occurs: "When they" (the *blood-stains*) "are tolerably recent they may be detected by examining the moistened stained cloth directly under the microscope; a discrimination between animal and human blood is then possible."

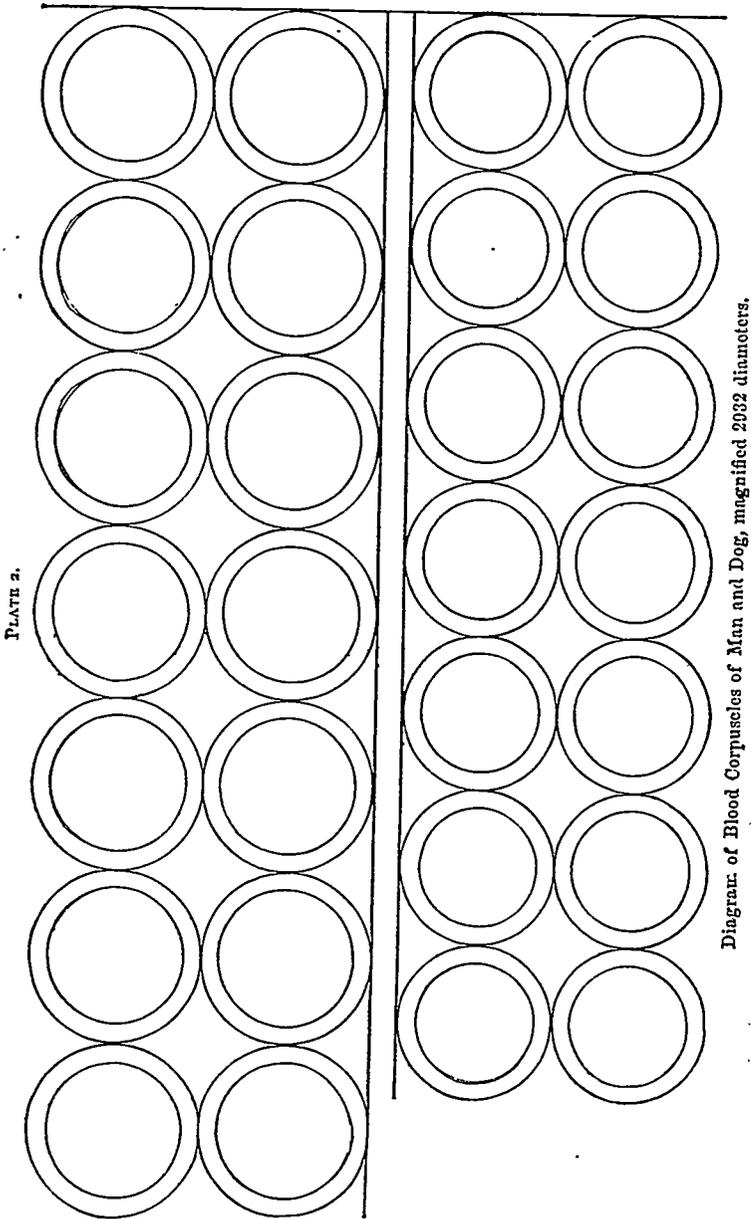
In regard to the recognition of blood stains of *long standing*, "M. M. Briand Choude Claubry" (*Manuel complet de Médecine Légale*, Paris, 1852, page 789), declares that "*however great* may be the *age* of the spots, microscopical examination will nevertheless reveal the *blood globules*; those on which M. Robin made his experiments dated back from eight to twelve years."

On the other hand, Dr. Woodward, of Washington, D. C., in commenting upon Dr. Richardson's paper, "upon the possibility of distinguishing the blood of man from that of the ox," &c., in a communication published in the "London Microscopical Journal," of February 1875, says, "there are certain mammals, among them the dog, whose red blood corpuscles are so nearly identical in *size* with those of human blood that they cannot be distinguished by any power of the microscope, even in fresh blood, much less in dried stains."

Having been myself engaged for some time past, in microscopic and chemical investigations, several of which have brought me as a witness in cases before the courts, and also for a number of months having made the distinguishing between human and other mammalian blood, as well as that of other red-blooded animals, both fresh and in dried stains upon various materials, a careful study, I propose to give the results of these investigations in a journal of the legal profession, to which profession they seem practically to belong, and leave it to them and the scientific world generally to pronounce judgment in the case.



Where the *forms* of the blood corpuscles differ from those of man, as would have been the fact in Rubenstein's case, had the blood found on his garments been, as he alleged, hen's blood, the question would present no other difficulty than the actual recognition and *showing* of the forms of the corpuscles, without regard to their size; but in those cases which depend upon differences of



measurement alone, as between man and the dog, a correct conclusion rests upon the solution of the question, whether we can by any known means ascertain such difference.

I may say in this place that I have made all my measurements with *one* of Hartnack's No. 8 objectives, without collar adjustment. The camera Lucida was placed in every case at the same height from the table (ten inches); the light was also placed at the same angle and distance from the reflector, so that if there was any source of error in any direction it could not have affected the *comparative measurement* of the corpuscles in the least degree.

The blood, which was obtained from some fifteen individuals of both sexes, from children to adults, and from nearly as many dogs, comprising a spaniel, a Newfoundland, two or three terriers of different ages, besides several mongrels of various breeds, was dried upon glass in the usual manner, and then drawn and measured as shown in my figures.

There is no appreciable difference in measurement between *fresh* corpuscles and those dried in thin layers on glass. I have chosen those dried on the glass as being the most convenient to draw from.

Instead of measuring separate corpuscles, as they pass under the micrometer, I have adopted a method which seems not only free from error, but which in criminal trials enables me to *show* the court and jury the result of my investigations, instead of their having, as heretofore, to depend upon the mere abstract statement of numbers.

In every case the microscope might be taken into court to verify the accuracy of the drawings; as I have already done in private before several eminent judges and lawyers of this city, in a case of blood corpuscles scraped from the blade of a knife, and restored and preserved on a glass slide.

On making the drawing, in the first place a horizontal line is drawn along the margin of a piece of thick paper—to this a perpendicular line is let fall, forming with the base line the two sides of a rectangular figure. A spot is next selected on the glass slide where the corpuscles are spread in a single layer and arc as little deformed as may be, and where one of the squares may be filled without the necessity of much change of place of slide or paper. I next proceed to pile up the corpuscles, so to speak, beginning in the angle formed by the meeting of the lines, until I have a pile of seven, and so proceed with pile after pile until I have seven piles, containing forty-nine corpuscles in all; this is shown in the first plate. The glass slide is not moved, the paper being moved only

at right angles to bring the corpuscles into lines. I have drawn some eight or ten thousand blood corpuscles of all kinds, and placed in twenty-four tables 1176 *human* and *dog* corpuscles, giving 1176 measurements of each.

The magnifying power used gives 1275 diameters; that is, a superficial area of 1625625.

Each of the plates are dated when drawn (as, per example, the one engraved) and marked on the back as follows:—

Plate I. “Blood of female forty years old. Corpuscles taken without selecting, as they occur on the slide, 1275 diameters, June 1st 1876.

“Blood of dog terrier, three years old, taken as above.”

The plate shows the relative size of the corpuscles, that of the dog being the smallest.

The average measurement of blood corpuscles from my tables is:

Human blood,	$\frac{32}{55}$	of an inch,	0077.74	millimeters.
Dog's	“	$\frac{35}{57}$	“ “	0068.89

Gulliver, the authority followed by Drs. Carpenter, Flint, Richardson and others, gives:—

Human blood,	$\frac{32}{55}$	of an inch,	0079.40	millimeters.
Dog's	“	$\frac{35}{57}$	“ “	0071.60

Schmidt, another authority, gives:—

Human blood,	$\frac{32}{57}$	of an inch,	0077.76	millimeters.
Dog's	“	$\frac{35}{57}$	“ “	0071.60

In the engraved plate, No. 1, the human blood was from a female of the age of forty, and the dog's blood was that of a terrier three years old, as before mentioned.

The measurement of the seven rows of human blood corpuscles measured both ways—that is, horizontally and perpendicularly, making fourteen measurements—gives an aggregate of 37.5 inches, which is below the average, this being 38.4 inches. The dog's blood measures 34.7 inches, which is above the average, this being 33.9 inches.

I may remark that these drawings were made by me, mathematically accurate on the engraved block; should the print show any difference it will be due to the swelling or shrinking of the paper, and of course this could not affect the proportions.

Divide 37.5 inches by 98, double the number of corpuscles in

the table; this gives .3826, the diameter of one. Divide this sum by the magnifying power 1275 gives  $\frac{1}{3333}$  of an inch = .007614 millimeters. The dog's blood in the plate measured in the same manner gives whole measurement 34.7 inches. One corpuscle,  $\frac{1}{3590}$  of an inch = .007680 millimeters.

I find thus far from all the measurements I have made that if we compare the smallest table of human blood with the largest of the dog's blood, the difference is recognisable at a glance; and if we further, as recommended by Dr. Richardson, use a higher magnifying power, this difference will be still more marked. I give two diagram tables of this kind, showing a magnifying power of 2932 diameters. (Plate II.)

It will be seen how closely my measurements agree with the authorities, and I may say in passing that I had drawn and measured nearly all these tables previous to comparing any of them with these authorities.

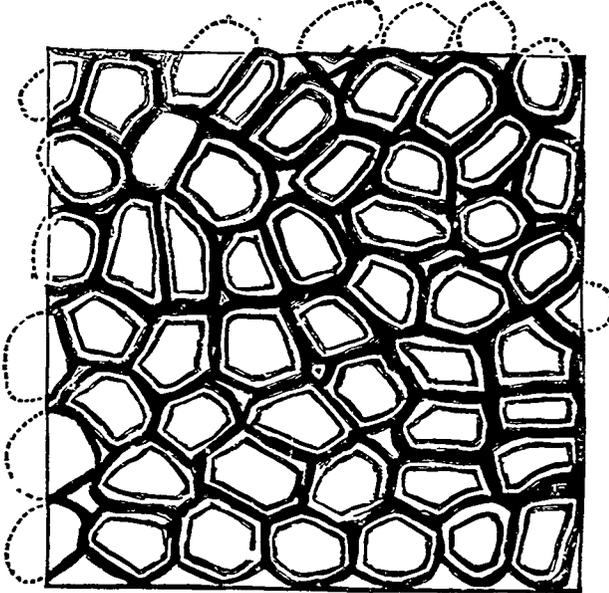
In still further pursuing the subject, I propose to give drawings of different *forms* of blood corpuscles liable to be called in question in criminal trials; and also the result of experiments with reference to distinguishing different kinds of blood taken from spots on various substances; as, per example, from knife-blades, knife-handles, linen, silk, leather, wood, &c., &c., and also to show how far it is possible to distinguish blood spots from other stains, even where the blood corpuscles have been entirely destroyed.

It will be seen at once that by this method of presenting the matter, evidence can be brought in such a manner before those whose province it is to decide, as to preclude the possibility of error on their part.

It will also be seen that, although my *measurements* do correspond closely with the authorities, thus going to prove their general accuracy; still, were not this the fact, it would not affect the result, as this depends upon the comparison of the corpuscles with each other, without regard to their absolute measurement.

The blood slides were all prepared in precisely the same manner; the corpuscles were figured under precisely the same conditions of the instrument, light, &c. As I have mentioned before, I have made nearly ten thousand drawings of blood corpuscles since I began this investigation. These have been made from fourteen different kinds of animals, and certainly the blood corpus-

PLATE 3.



Blood Corpuscles drawn direct from nature, as seen on glass slide.

cles of no one of these approach as near to those of man as do those of the dog.

I here rest the question "whether the red blood corpuscles of man and the dog in their normal condition can by the aid of the microscope be distinguished from each other?" How far this can be done with blood spots scattered on various substances, as mentioned before, remains for future discussion.

The third plate has been drawn since the above was written. It was thought well to give it, as it shows the form the blood corpuscles frequently assume when dried on glass and like substances. The square covers an area about equal to the average of my measurements. If we count *two* of the corpuscles which project *over* the lines as occupying the space of *one* on the *inside* of the square, we shall find that they number forty-nine, as when formed of single corpuscles arranged in order, as in my tables; this fact shows that but little, if any, shrinkage occurs, even when the corpuscles are forced out of shape from any cause.

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