



IV. Observations on the blood corpuscles or red disks of the mammiferous animals

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seen by transmission, the light twice reflected causes rings which are easily visible, although one portion of the interfering light is less than $\frac{1}{800}$ th part of the other by the undulatory formulæ, and about $\frac{1}{900}$ th by my experiments; also, in the former experiment, the polarizing angle for glass ($56\frac{1}{2}^\circ$ nearly) is approaching towards the polarizing angle for diamond (about 68°), therefore, the whole light reflected by the diamond would be only a small fraction of the incident light, and that by the glass, according to Mr. Green's formula, would bear a considerable ratio to it, and therefore the rings should be very distinct, in place of which none are to be seen at all; so that Mr. Green's formula neither represents the facts nor agrees with Fresnel's.

Professor Forbes also says, in the second sentence of his memorandum, "but the chief evidence for the truth of this remarkable law rests on the indirect observation of the change of the plane of polarization of an incident ray after reflexion." He here alludes to a series of valuable experiments made by Sir David Brewster, and published in the *Phil. Trans.* for 1830. If we look over Sir David's table at page 75, we see the results of the experiments on the change of the plane of polarization after reflexion by diamond, affording errors of observation, although, from the nature of the experiment necessarily large, (averaging $46\frac{1}{2}^\circ$) yet all lying on one side of the calculated results. When the theory is true we naturally expect the errors of observation to fall sometimes on one side and sometimes on the other side of the calculated place. Hence, it is clear, that the undulatory theory, even in this vaunted case, does not give the accurate results.

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IV. *Observations on the Blood Corpuscles or Red Disks of the Mammiferous Animals.* By GEORGE GULLIVER, F.R.S., Assistant-Surgeon to the Royal Regiment of Horse Guards*.

A COMPLETE history of the blood corpuscles of the mammalia would be a very acceptable addition to anatomical science, and probably no less advantageous to zoology. To accomplish this work, however, the co-operation of so many circumstances is necessary, that the contributions of different observers are especially desirable. I have long been engaged in the inquiry; and, as I have been favoured with the liberal permission of the Council of the Zoological Society† to avail myself of the advantages of their collection, I

* Communicated by the Author, Nov. 23, 1839.

† In returning my best thanks on this occasion to the Council, I cannot

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propose to give an account of the blood corpuscles of such animals as I have had an opportunity of examining. Of many of these particles I believe no description has hitherto been published; and some others which have been previously described I have examined anew with a view to more accurate comparisons. I am not aware that the peculiar form of the corpuscles in certain species of the genus *Cervus* has been hitherto observed in any class of animals.

The general results appear interesting to me in many points of view, particularly in respect to certain differences in the size of the corpuscles in the same individual at different periods of existence, as well as in nearly allied species of the same genus; and the resemblance, on the other hand, of the blood disks in some groups of the animal kingdom. The connexion, too, between the size and form of the blood particles and the respiratory organs, I have found to be remarkable. But before entering into conclusions it will be necessary to give the observations in detail, reserving a summary arrangement of them, and the deductions which they appear to warrant, for a future section of this memoir, when an opportunity will be afforded of reference to the labours of others in this field.

The instrument made use of in these observations is a compound microscope, with an achromatic object-glass of one-eighth of an inch focal length, made by Ross, and furnished by him with a micrometer eye-piece divided into spaces corresponding to 1-4000th of an inch. The magnifying power afforded is exactly 800 diameters with a clear definition.

If one space and a quarter of this micrometer were occupied by a single globule, this would of course measure 1-3200th of an inch; if three equally-sized particles lying in a line, and touching at their edges, covered three spaces and a half, the diameter of each of these would be 1-3429th,—if four spaces, 1-3000th of an inch. Now these measurements are mentioned because they are very frequently obtained from the average-sized human blood disks, which are to be distinguished from the remarkable varieties which Mr. Bowerbank has observed among them, and which I have also witnessed, though I think in a less degree than he mentions, in man and various animals. In the human blood corpuscle, the diameter last mentioned is not so common as the two former. In the absolute accuracy of any micrometer applied to objects so extremely minute, it is difficult to place implicit reliance; but

avoid acknowledging the kindness and urbanity of Mr. Ogilby, who entertained my application with his usual zeal in the promotion of zoological inquiries. I have also repeatedly been indebted to the kind assistance of Mr. Youatt, the excellent medical superintendent of the Gardens.

in the relative exactness of the instrument I am disposed from long experience to put much confidence, which is of the greatest importance where the results are to be obtained chiefly by comparisons.

The corpuscles were examined thinly spread on glass and quickly dried, also floating in their own serum, and diluted when necessary with weak saline solutions, or sugar and water, or with urine. The objection to these substances is, that they all more or less alter the figure of the globules, generally rendering many of them cup-shaped and diminishing their size slightly. Indeed, the disks kept in their own serum often appear a little smaller in a very short time after they have been removed from the vessels, as if they possessed some degree of contractility. It might be supposed that the particles rapidly dried on glass would shrink a little; but this is not the case, for they retain a remarkably clear and regular outline, and are commonly, to a small extent, larger than those of the same blood exposed to the air in their own fluid.

In some instances there was certainly a slight enlargement in the dried corpuscles, as compared with those seen in their own serum immediately after they were taken from the animal. In the greater number of trials, however, the sizes of the wet and dry disks corresponded accurately. In most cases the measurements were repeated by Mr. Siddall, an experienced micrographer, with another instrument by Ross, so as to avoid as much as possible accidental inaccuracies. The measurements are always expressed in fractions of an English inch.

As the corpuscles are very liable to change in size and form from very trivial causes, the extreme measurements in no case include those large or small particles which occur but sparingly, and which, perhaps, are not identical with the common red disks. Neither the large white globules nor the granulated particles are estimated, because, independently of their spherical shape, the former are almost uniformly larger and the latter smaller than the blood disks. As noticed by Hewson, the common corpuscles become mulberry-shaped when, from incipient putrefaction, their colouring matter begins to dissolve in the serum. But I have observed the granulated particles in great numbers, both in their serum and in the dry state*, in blood examined immediately after it was obtained from the veins of various animals, particularly young kittens. The nature of these particles is worthy of further and special inquiry. They are to be found plentifully during

* I gave Mr. Owen specimens of these granules in September last, mentioning this fact to him, as he considered the granulated appearance to be the effect merely of drying.

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digestion; but, in their deep-red colour and chemical properties, they differ remarkably from the granules observed in the chyle.

1. Dog-faced Baboon, hardly half-grown, (*Simia Cynocephalus*). Blood from the right ventricle of the heart. Corpuscles generally 1-3192nd of an inch in diameter; extreme sizes 1-4000th and 1-2666th of an inch, the largest more frequent than the smallest.

2. Green Monkey, adult, (*Cercopithecus Sabæus*). Average-sized corpuscles 1-3200th to 1-3000th of an inch in the dry state, 1-3600th in their own serum. Extreme sizes 1-4000th and 1-2666th. Thickness of the corpuscles as seen on their edges 1-12,000th to 1-10,000th of an inch, i. e. a rouleau of five or six filled two of the micrometer spaces. The blood examined was obtained from both ventricles of the heart, from the vena cava, and vena portæ, no appreciable difference appearing in the corpuscles.

3. White Monkey, adult, (*Macacus radiatus*, albino var.). Corpuscles from the right ventricle generally 1-3200th of an inch in diameter.

4. Rhesus Monkey, old male, (*Macacus Rhesus*). Size of disks very variable from 1-4572nd to 1-2666th of an inch: most common diameter 1-3200th. Blood of both ventricles examined.

a. In a young male the same measurements were obtained.

5. Capuchin Monkey, adult, (*Cebus Capucinus*). Most common diameter of corpuscles 1-3428th and 1-3200th of an inch dried; in their serum, exposed to the air some hours, 1-4000th was a more frequent diameter. Extreme diameters 1-4572nd and 1-2910th of an inch. Blood from both ventricles of the heart examined.

6. Mangabey Monkey, adult male, (*Cercocebus Æthiops*). Common sizes 1-3200th and 1-3000th. Extreme sizes, also common, 1-4000th and 1-2666th. Blood examined from both ventricles of the heart, from the portal and renal veins.

7. Grivet Monkey, (*Cercocebus griseo-viridis*). Most frequent sizes 1-3200th and 1-3000th. Extreme diameters 1-4000th and 1-2666th of an inch. Blood from both ventricles of the heart.

8. Slow Lemur, full-grown, (*Loris tardigradus*). Most common size 1-3552nd. Extreme diameters 1-4000th and 1-3000th. Blood from a prick of the fore-hand.

9. Common Bat, (*Vespertilio murinus*). Blood from right ventricle. Common diameter of corpuscles 1-4365th to 1-4000th of an inch.

10. Common Squirrel, adult male, (*Sciurus vulgaris*). Cor-

puscles from the right ventricle, dried, all about 1-4000th of an inch in diameter.

11. Water Rat, adult, (*Mus amphibius*). Blood from both ventricles, examined dry; average-sized corpuscles 1-4000th and 1-3600th of an inch diameter.

12. Common brown House Rat, a male, nearly full-grown, (*Mus decumanus*). Common size of corpuscles from right ventricle 1-4000th to 1-3554th of an inch.

13. Common Mouse, (*Mus musculus*). 1-4000th and 1-3600th common sizes. Extreme diameters 1-5333rd and 1-3000th. Blood from heart and vena cava.

a. Fœtus, about half an inch long, from the uterus of the above mouse. 1-2666th the most frequent size, and many smaller corpuscles from 1-5333rd to 1-4000th, the latter being numerous. Many of the corpuscles more globular than usual, that is, more like spheres than disks,—a common appearance in the fœtal blood of mammals at an early period.

From this and several other observations, the comparatively large size of the blood corpuscles in the fœtus becomes manifest. The fact is important, because it is connected with the comparative condition of the respiratory organs, and, moreover, illustrates the difference between the blood of the parent animal and that of the fœtus; so that if there be any communication between the vessels of the placenta and uterus, the blood of the mother and fœtus is at all events different. I have examined the fœtal blood of the human subject, obtained from the heart, placenta, and umbilical vessels, with the same result as above; and it appears to me to be of considerable interest*.

14. Common Guinea Pig, adult male, (*Cavia Cobaya*). Corpuscles from the right ventricle, generally measuring from 1-4000th to 1-3200th of an inch.

15. Domestic Rabbit, adult female, (*Lepus cuniculus*). Most common diameter 1-4000th; extreme sizes 1-5000th and 1-3200th of an inch.

16. Golden Agouti, adult male, (*Dasyprocta aurata*). 1-3600th the most common diameter. Extreme sizes 1-5333rd and 1-3200th. Blood from a vein of the ear.

17. Acouchi, full-grown, (*Dasyprocta acouchi*). 1-3600th a common diameter, as was also 1-4000th. Extreme sizes 1-4572nd and 1-3200th.

18. White-whiskered Paradoxure, adult, (*P. Leucomystax*). Size of corpuscles very variable; most commonly 1-4365th and 1-4000th. Extreme diameters 1-6000th to 1-3200th. Blood from a prick of the tail.

* The accurate Hewson observed the same fact in a fowl and in a viper. (Exp. Inquiries, part iii. p. 39.)

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19. Paradoxure Gennet, adult, (*Paradoxurus typus*). Most frequent size 1-5331st. Extreme diameters 1-6600th and 1-4572nd. Size of corpuscles more regular than in the preceding. Blood from a prick of the tail.

20. Gray Ichneumon (*Herpestes griseus*), adult male. Most frequent diameter 1-4572nd of an inch. Extreme sizes 1-6000th and 1-3554th. The dried disks had more distinct central marks, or appearance of nuclei, than usual. Blood from a prick of the tail.

21. Domestic Dog, old mongrel, (*Canis familiaris*). Common diameter of corpuscles 1-4000th to 1-3200th of an inch.

a. Fox-hound Puppy, one day old, a bitch. 1-3000th and 1-2666th the most common diameters of the corpuscles. In the blood of the vena portæ they were generally of the latter size.

b. Fox-hound Puppy, twelve days old, a bitch. Most common diameter of the corpuscles 1-3000th and 1-2885th of an inch. Extreme sizes 1-4000th and 1-2666th.

c. Mongrel Puppy, four months old, a bitch. All the following diameters common, viz. 1-3693rd, 1-3554th, 1-3429th and 1-3200th.

22. Australasian Dog, aged four or five years (*Canis Australiensis*). Most common size of corpuscles 1-3200th and 1-3000th; 1-4000th and 1-2666th were seen, but rarely.

23. Fox, old bitch, (*Canis Vulpes*). The following sized corpuscles were frequent, viz. 1-4572nd, 1-4365th, 1-4000th, and 1-3653rd; the third diameter (1-4000th) was the most common. Besides blood from the heart, corpuscles were examined from the cava and splenic veins.

24. Red American Fox, half-grown dog, (*Canis Vulpes*, var. *Americanus*). Common-sized corpuscles 1-4000th and 1-3693rd of an inch in diameter. A few were observed of 1-5333rd; and 1-3200th was rather a frequent diameter.

25. Black American Fox, a dog, about two-thirds grown, (*Canis argentatus*). 1-4000th of an inch most common diameter of corpuscles: extreme sizes 1-5333rd to 1-2666th. ('This animal and the succeeding one came to England together from Hudson's Bay.)

26. White Arctic Fox, about two-thirds grown, (*Canis lagopus*). Same sizes as in the preceding.

The measurements in the genus *Canis* were all made from dried corpuscles obtained from the right ventricle of the heart.

27. Domestic Cat, adult female, (*Felis Catus*). Blood from right ventricle. Most common diameter of disks 1-4000th of an inch; a few were 1-4572nd.

a. A Kitten one day old, female. The common size of

disks was from 1-4000th to 1-3564th, and 1-3000th to 1-2666th were frequent sizes. Corpuscles in the blood of vena portæ and right ventricle of the heart apparently identical.

b. A Kitten sixteen days old. The most frequent size of corpuscles 1-4000th. From Mr. Siddall's observation.

28. Serval, adult female, (*Felis Serval*). 1-4000th of an inch the most common diameter of the corpuscles. They were very irregular in diameter, 1-5000th and 1-3000th being frequent sizes. Blood from all the chambers of the heart examined, as well as from the renal vein.

29. Asiatic Leopard, adult male, (*Felis Leopardus*). Disks very variable in size; 1-4800th the common diameter, many varying from 1-5333rd to 1-3200th. The blood was obtained from the ventricles of the heart, from the renal vein and artery, and from the splenic vein, no difference being apparent in the corpuscles.

30. Lynx, nearly full-grown, male, (*Felis Caracal*). Most common diameter of corpuscles 1-4800th to 1-4365th of an inch. Very variable in size, extending from 1-6000th to 1-4000th. Blood from both ventricles examined.

31. Norway Lynx, about two years old, (*Felis Lynx*). Most common sizes 1-4365th to 1-4000th. Extreme diameters 1-5333rd to 1-3554th. Blood from both ventricles.

32. Coati Mondí, old male, (*Nasua fusca*). 1-3200th the most frequent diameter. Extreme sizes 1-4572nd and 1-2666th: the former extreme most common.

33. Red Coati Mondí, adult female, (*Nasua rufa*). 1-4000th and 1-3554th the most common diameters of the corpuscles. Extreme sizes 1-5333rd and 1-3200th of an inch. Blood from both ventricles and from the abdominal aorta, in this and the preceding species.

34. Horse, gelding, aged three years, and another aged five (*Equus Caballus*). Blood from jugular vein. The average-sized corpuscles in both 1-4800th and 1-4572nd of an inch.

a. Gelding, twenty-six years old. Same size generally, but more irregular, many being seen as large as 1-4000th of an inch. In this and the preceding, when collected into rouleaux, the edges of the corpuscles were from 1-12,000th to 1-14,000th of an inch, that is, a rouleau of six or seven disks occupied two spaces of the micrometer.

35. Ass, old female, (*Equus Asinus*). Most common diameter of corpuscles 1-4000th of an inch. Blood obtained from the jugular vein.

36. Dromedary, full-grown male, (*Camelus Dromedarius*). Disks oval. Long diameter: the most frequent was 1-3200th of an inch, and the following were seen, viz. 1-4000th,

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1-3000th and 1-2666th. Short diameter, 1-6000th, the most frequent, and the following were seen, viz. 1-6600th, 1-6400th, and 1-5333rd, and 1-4800th. Thickness of the edges of the disks 1-16,000th to 1-12,000th of an inch. A very few circular corpuscles, about 1-6400th of an inch in diameter, were observed. Blood obtained from a prick in the skin.

37. Vicugna, adult male, (*Auchenia Vicugna*). Disks oval. Long diameter most frequently 1-4000th of an inch; and the following long diameters were observed: 1-5333rd, 1-3200th, 1-3000th. Short diameter; the most frequent 1-6400th; also many varying from 1-8000th to 1-5333rd of an inch. A few circular corpuscles observed, as in the Dromedary. Blood obtained from skin of the leg.

38. Paco, male, nearly full-grown, (*Auchenia Paco*). Disks oval. Long diameter generally 1-3200th of an inch; some 1-4000th, others 1-2666th of an inch. Short diameter, most commonly 1-6400th and 1-6000th; some of 1-8000th, and 1-5333rd. A few circular particles observed, as in the Dromedary and Vicugna. Blood obtained by pricking the ear.

39. Guanaco or Wild Lama, adult female, (*Auchenia Glama*). Blood obtained from the ear. Disks oval, and not differing appreciably from those of the Paco.

Thus in the Vicugna, Paco, and Wild Lama, the blood corpuscles are elliptical*, as the interesting discovery of M. Mandl has shown them to be in the Dromedary. In the Vicugna the disks are rather smaller than in the Dromedary. They all appear to be very thin or flat in relation to their size, their edges in the Dromedary being not more than 1-16,000th or 1-20,000th of an inch thick. I could see no indication whatever of a nucleus in any of the corpuscles; and those of the Dromedary were subjected to the action of water, acetic acid, and various reagents, with a view to determine this point.

40. Goat, adult female, (*Capra Hircus*). Common diameters of corpuscles 1-6400th and 1-6665th of an inch; the following sized globules are also very frequent, viz. 1-7108th, 1-5333rd, and 1-6000th. Blood from a wound in the neck.

41. Cashmere Goat, old male, (*Capra Hircus*, var.). Average-sized corpuscles 1-7200th to 1-5858th. The corpuscles very irregular in size; all the following sizes were very frequent, viz. 1-8000th, 1-6400th, 1-6000th; there were also a few disks 1-5333rd of an inch in diameter. Blood from the vena cava and from the renal artery.

* As announced in the Phil. Mag. for December 1839, and in the Dublin Medical Press, No. 47. Some observations on the blood and pus of these animals were read at the Royal Med. Chir. Society, Nov. 26, 1839.

42. Common sheep, adult, (*Ovis Aries*). Corpuscles remarkably irregular in size, most commonly 1-6000th and 1-5333rd of an inch. All the following measurements taken from corpuscles which were abundant: 1-8000th, 1-5142nd, 1-4800th, 1-4221st. Blood from right ventricle, and from vena portæ.

43. Bearded Sheep, an old male, (*Ovis tragelaphus*). The most common diameter of corpuscles 1-6000th and 1-5333rd of an inch; extreme sizes, 1-6400th and 1-4000th, the former much more frequent than the latter.

44. Philantomb Antelope, adult male, (*Antilope Philantomba*). Average-sized corpuscles 1-6000th and 1-5333rd of an inch. A large number 1-4365th. Extreme diameters, 1-6400th and 1-4200th. Blood from a prick of the ear; disks examined dry, in their own serum, and diluted with urine. A very few distinct oval or spear-shaped corpuscles were seen, both in the wet and dry specimens.

45. Gazelle Antelope (*Antilope Dorcas*). Most common sizes 1-5333rd and 1-4800th. Extreme diameters 1-6000th and 1-4000th. Thickness of the edges of disks 1-16,000th of an inch. Blood from a vein of the ear.

46. Calf at the seventh month of utero-gestation, (*Bos Taurus*). Most of the corpuscles 1-4000th and 1-3428th of an inch. Extreme diameters 1-6000th and 1-3200th. Blood from jugular, umbilical, and portal veins.

a. Cow, adult, giving milk. Size very variable, from 1-5333rd to 1-3555th. Average size, 1-4268th and 1-4000th of an inch diameter. Blood from jugular vein.

b. Brahmin Cow, adult, (*Bos Taurus*, var.). 1-4572nd and 1-4800th very common sizes. Extreme diameters 1-6000th and 1-3557th.

47. Fallow Deer, full-grown buck, (*Cervus Dama*). Average-sized corpuscles 1-4572nd of an inch. Extreme measurements 1-6000th and 1-3200th. Several corpuscles 1-5333rd. Blood from jugular vein.

a. A buck Fawn, four or five days old. Average-sized corpuscles 1-4365th of an inch. Extreme diameters 1-4000th and 1-5333rd. Blood from jugular vein.

48. Mexican Deer, adult female, (*Cervus Mexicanus*). Circular corpuscles generally 1-6000th of an inch in diameter; oblong corpuscles, most frequently from 1-3200th to 1-2400th long, and from 1-12,000th to 1-8000th broad, at their gibbous part.

The blood of this animal contains a large quantity of lunated or crescentic corpuscles, besides many of the ordinary circular form. The singular lunated corpuscles are remark-

ably distinct and characteristic, and I believe unlike any hitherto described in the animal kingdom. They are generally acutely pointed at the ends and gibbous in the middle; sometimes they are not curved, and then, to use a botanical term, they present a lanceolate figure. A more particular description of them, with drawings, is in preparation.

49. Napu Musk Deer, adult female, (*Tragulus Javanicus**). Average size of disks 1-12,000th of an inch. Extreme diameters 1-15,000th and 1-9600th. Blood examined from a prick of the ear, also from a small vein of the leg.

Hence the blood disks of this beautiful little animal are smaller than those, hitherto described, of any other mammal. They were remarkably distinct, and very well seen in dry specimens, also diluted with serum or urine.

50. Pig, about half-grown, (*Sus Scrofa*). Common diameters 1-4000th and 1-3728th. Extreme sizes 1-5333rd and 1-3200th, and the corpuscles generally very variable. The blood examined was arterial and venous mixed.

51. Elephant, male, apparently an adult, (*Elephas Indicus*). Most frequent diameters of disks 1-3000th, 1-2666th, and 1-2462nd of an inch. Other sizes, 1-3329th, 1-2910th, 1-2823rd, and 1-2286th. Blood obtained from a vein in the ear.

Consequently the blood corpuscles of this animal are larger than any hitherto described in the mammalia, being considerably larger than in man. But a reference to the comparative magnitude of the blood disks of the horse and the bat, and some species of *Mus*, will show how little relation there is between the size of the animal and the diameter of the red particles. In the mouse for instance they are larger than in the horse.

52. Rhinoceros, full-grown male, (*Rhinoceros Indicus*). Common size of disks 1-4000th and 1-2554th. Many were observed with diameters of 1-4572nd and 1-3200th of an inch, with of course every intermediate gradation of size. Blood from a prick in the nose.

53. Common seal (*Phoca vitulina*), 1-3200th the most frequent diameter. Extreme sizes 1-3554th and 1-2666th. The disks very regular in size. Blood from prick of caudal fin.

The particles are slightly larger than in the adult human subject, and approach in appearance to corpuscles of the monkey's blood.

* See Phil. Mag. for Dec. 1839, and Dublin Medical Press, No. 47. *Moschus Javanicus* of Pallas. Since my observation of the singular blood-disks of this animal was published, Professor Owen has given an account of them in another species (*M. pygmaeus*), in which they seem to be equally small, as he remarks he had anticipated.

54. Common Otter, full-grown, (*Lutra vulgaris*). Most common sizes 1-3600th and 1-3200th. Extreme diameter, 1-4572nd and 1-2910th of an inch. Blood from right ventricle, and from renal artery and vein.

55. Kangaroo, adult male, (*Macropus Bennettii*). Most common diameters 1-3600th and 1-3432nd of an inch; and the following sizes were rather frequent: 1-4000th, 1-3200th, and 1-3000th. Blood from a prick at the end of the tail.

56. Flying Opossum, adult female, (*Petaurus Sciurus*). Average-sized disks 1-3600th. Extreme diameters 1-4800th and 1-3000th of an inch. Blood from a prick in the nose.

57. Ursine Opossum, adult male, (*Dasyurus Ursinus*). Most frequent sizes 1-3428th and 1-3600th. Extreme diameters 1-4365th and 1-3000th. Thickness of the edges of the disks from 1-10,000th to 1-12,000th of an inch. Blood from a vein in the ear.

58. Another species, (*Dasyurus viverrinus*). 1-4000th a very common diameter of the disks; 1-4800th and 1-3554th were also the sizes of several of the disks. Blood from the left ventricle.

59. The Perameles, (*Perameles lagotis*). Common sizes 1-4572nd and 1-4000th of an inch. Several disks were seen of the following diameters: 1-4800th, 1-3428th, and 1-3200th. Blood from a prick in the ear.

Thus the blood disks of these five Australasian animals agree in form and size with the red particles most common in other mammals.

Since the foregoing paper was printed I have examined the blood of some other mammiferous animals. I subjoin the notes in the order they happen to have been made. All the observations will soon be systematically arranged, so as to exhibit in some measure the relation between the blood corpuscles and the organization of the animal. The blood particles of the different species of the genus *Cervus*, Antelope, and the congeners of the Napu Musk Deer, appear to me to be especially deserving of further observations; and it is very probable that any physiologist who may prosecute the inquiry will be rewarded with some interesting results.

60. White-fronted Lemur, adult male, (*Lemur albifrons*). Size of corpuscles very variable, from 1-4800th to 1-3000th. The most frequent diameter 1-3600th. Blood from both ventricles, from the splenic and portal veins, and the disks apparently identical in all.

61. Sambar Deer, adult buck, (*Cervus hippelaphus*). Dry; size very variable, 1-4000th and 1-3600th most common.

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Extreme diameters, rather frequent, 1-4572nd and 1-3200th. Blood from a prick of the nose.

62. Moose Deer or Elk, adult hind, (*Cervus Alces*). Average-sized corpuscles, 1-4000th and 1-3764th. Extreme diameters 1-5333rd and 1-3200th. Blood dried, from a prick of the nose.

63. Barbary Deer, adult hind, (*Cervus Barbarus*). Dry; most frequent diameters 1-4800th. Extreme diameters 1-5333rd and 1-4365th. Blood from the upper lip.

64. Wapiti Deer, full-grown hind, (*Cervus Wapiti*). Dry; 1-4363rd most common size. Extreme diameters 1-5333rd and 1-3554th. Blood from the upper lip.

Carefully compared with the blood of the preceding, and the corpuscles generally pretty regular in size, and certainly larger than in the Barbary Deer.

65. Hog Deer, adult male, (*Cervus porcinus*, albino var.). Common size of corpuscles 1-5333rd and 1-6000th. Many oblong lunated corpuscles, corresponding in size and form to those observed in the blood of the Mexican deer.

66. Gnu, adult female, (*Antelope Gnu*). Dry; corpuscles varying much in size, 1-4800th most common. Extreme diameters 1-6000th and 1-4000th. Blood from prick of upper lip.

67. Indian Antelope, male about two-thirds grown, (*Antelope cervicapra*). Dry; most frequent diameter 1-4800th and 1-5000th. In their own serum the corpuscles were very irregular in size and shape, and certainly smaller than when dried. The extreme sizes of the dried disks 1-6000th and 1-4000th; in their serum or diluted with urine 1-8000th and 1-5000th.

68. Giraffe, adult male, (*Camelopardalis Giraffa*). Most frequent size of corpuscles 1-4572nd. Extreme diameters 1-5333rd and 1-4000th. Blood from a prick of the lip.

69. American Buffalo, full-grown female, (*Bos Bison*). 1-4000th of an inch, a very common diameter of the corpuscles. Extreme sizes 1-4572nd and 1-3554th. Blood examined dry, from the nose.

70. Weasel-headed Armadillo, adult male, (*Dasypus sexcinctus*). Most frequent size of corpuscles 1-3429th, and the following common, viz. 1-3692nd, 1-3552nd, 1-3368th, 1-3330th. Extreme diameters 1-4000th and 1-3000th. Blood from a prick of the ear.

71. Lesser American Flying Squirrel, adult, (*Pteromys volucella*). Dry; 1-3600th the most common size of disks, and 1-4000th not uncommon. Extreme diameters 1-4800th and 1-3428th. Blood from a prick of the ear.

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72. Palm Squirrel, adult, (*Sciurus palmarum*). Dry; most commonly 1-3692nd, extreme sizes 1-4800th and 1-3000th. In their own serum or in urine they seemed contracted, the corpuscles often cup-shaped, bent, or shrunk, ranging from 1-4800th to 1-4000th. Blood from a prick of the tail.

73. Furnier's Capromys, adult, (*Capromys Furnieri*). Dry; common diameters 1-3530th and 1-3429th. Extreme sizes 1-4000th and 1-3000th. Blood from a prick of the ear.

74. Bandicoot Rat, adult, (*Mus giganteus*). Corpuscles in their own serum very irregular in size, most frequently 1-4000th of an inch, and many from 1-5333rd to 1-3200th. There was evidently considerable shrinking of the corpuscles while under examination, as observed in several trials. In dried specimens the disks were generally from 1-4000th to 1-3600th. Extreme sizes 1-4800th and 1-3200th. Blood from a prick of the tail.

75. Hoary Marmot or Whistler, an old animal, (*Arctomys pruinosa*). Dry; most commonly 1-3600th. Extreme sizes 1-4000th and 1-3000th. Blood from a prick of the upper lip.

Regent's Park Barracks, Nov. 22, 1839.

V. On the Employment of Carbon in Voltaic Combinations.

By MR. JOHN THOMAS COOPER, *Lecturer on Chemistry, &c. &c.*

To Richard Phillips, Esq., F.R.S., &c.

DEAR SIR,

IT occurred to me on reflecting upon the use of the platinum as employed by Mr. Grove in the construction of his very energetic voltaic combination*, as it was only to conduct the electricity from the decomposing nitric acid, that any cheaper substance which conducted electricity, and upon which nitric acid had no action, might be employed with equal advantage, and probably supply the place of the more expensive material. With these views I was induced to make trial of *charcoal*, and the other forms of carbon, viz. plumbago, and a peculiar kind of carbon which is frequently met with as an incrustation in the retorts in which coal is decomposed for the purpose of gas lighting; and was gratified on making the experiments in finding my anticipations fully realized. In order to show the comparative value of each of the substances, I here subjoin the results of some of the experiments made with acids of the same strength, and with amalgamated zinc cylinders, each presenting to the action of the dilute sulphuric

[* See Lond. & Edinb. Phil. Mag., Oct. 1839, vol. xv. p. 287.]