XXXIII. *On the Figure and Compoſition of the Red Particles of the Blood, commonly called the Red Globules. By Mr.* William Hewſon, *F. R. S. and Teacher of Anatomy.*

Read June 17, and 24, 1773.

THE red particles of the blood in the human ſubject have, ſince the time of Leeuwenhoeck, been ſo generally allowed to be ſpherical, that in almoſt all books of phyſiology they are denominated red globules. A few authors, however, have at different times doubted whether they were ſpheres, and amongſt the reſt Father de la Torré, whoſe curious obſervations, together with his glaſſes, were preſented to the Royal Society, Anno 1766. As I flatter myſelf that I have made ſome new obſervations on theſe particles, I ſhall do myſelf the honour of communicating them to the Society.

It is a curious and important fact, that theſe particles are found ſo generally through the animal kingdom; that is, they are found in the human ſpecies, in all quadrupeds, in all birds, in all amphibious animals, and in all fiſh, in which animals they are red, and colour the blood. The blood even of inſects contains particles ſimilar in ſhape to thoſe of the blood of more perfect animals, but dif-

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fering in colour. In water insects, as lobsters and shrimps, these particles are white; in some land insects, as the caterpillar and the grass-hopper they appear of a faint green, when in the vessels as I am persuaded from experiments. I have seen them in an insect no bigger than a pin's head, and suspect they exist almost universally through the animal kingdom.

What is so generally extended through the creation must be of great importance in animal œconomy, and highly deserving the attention of every enquirer into the works of nature. This subject becomes the more interesting from so much of reasoning in the theory of medicine being built in the properties of those particles.

It is by the microscope alone that we can discover these particles; and as some dexterity and practice is required in the use of that instrument, there have not been wanting men of character and ingenuity, who, having been unsuccessful in their own experiments, have questioned the validity of those made more fortunately by others. Some have gone so far as to assert, that no credit can be given to microscopes, that they deceive us by representing objects different from what they really are. These assertions, though not entirely without foundation, when we speak of one sort of microscopes, are very unjustly applied to them all. In compound microscopes, when the object is viewed through two or more glasses, if these glasses be not well adapted to the focus of each other, the figure of the object may be distorted; but no such circumstance takes place, when we view an object through a single lens. All who use spectacles agree, that the figures of objects appear the same through them, as they do

do to the naked eye. And as the single microscope has, like the spectacle, but one lens between the eye and the object, there is no reason to suppose the one can deceive us more than the other. The compound, having a larger field, is more pleasant than the single microscope for many purposes; but the single should be always preferred by those who wish to ascertain the figures of minute bodies. It was this instrument supported on a scroll, as delineated by Mr. Baker (Microscope made easy, plate II. chap. 3.) that has been used in these experiments: and almost all the observations were made with lenses, as they are prepared by some of our more skilful workmen in London. One observation only was made by means of those globules made of glass, which the ingenious Father de la Torré presented to the Royal Society, and which they were so obliging as to lend to me. Of these globules but two were fit for use, when they came into my hands, viz. that which, according to Father de la Torré, magnifies the diameter of the object 640 times, and that which magnifies 1280 times. The lenses of the greatest magnifying power made in London are those of $\frac{1}{50}$th of an inch focus, which, even allowing eight inches to be the focal distance of the naked eye, magnifies the diameter of the object only 400 times; a power much inferior to what may be obtained by globules, and particularly by that globule, which according to Father de la Torré magnifies the diameter 1280 times; and this globule I have used in some of these experiments. But our lenses, though inferior in magnifying power to these globules, are much superior in distinctness; the

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globules are full of clouds, made by the ſmoke of the lamp uſed in preparing them, and the object can be ſeen only through the tranſparent parts of the globules, which makes it difficult to get a ſatisfactory view of it; this, with the trouble of adapting the objects to the focus of the glaſs, made me prefer our own lenſes for all the experiments mentioned in theſe ſheets, except one; and it is but doing juſtice to the ingenious gentleman abovementioned, to acknowledge, that the greater power of his glaſſes was found in that experiment more than to compenſate for their want of diſtinctneſs.

Theſe particles of the blood, improperly called globules, are in reality flat bodies. Leeuwhenhoeck and others have allowed, that in fiſh and in the *amphibia* they are flat and elliptical; but in the human ſubject and in quadrupeds almoſt all microſcopical obſervers have agreed in their being ſpherical. When we conſider how many ingenious perſons have been employed in examining the blood with the beſt microſcopes, it will appear wonderful, that the figure of theſe particles ſhould have been miſtaken; but our wonder will be leſſened, when we conſider how many obvious things are overlooked, till our attention is very particularly directed to them; and beſides, the blood in the human ſubject and in quadrupeds is ſo full of theſe particles, that it is with great difficulty we can ſee them ſeparate, unleſs we find out a method of diluting the blood. It is to ſuch a diſcovery that I attribute my ſucceſs in this enquiry; for, having examined the blood as it flows from the veſſels of the human body, it appeared a confuſed maſs, notwithſtanding

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I ſpread it thin on a glaſs, or a piece of talk. It then occurred to me to dilute it, but not with water, for this I knew diſſolved the particles; but with ſerum, in which they remain undiſſolved. By the ſerum I could dilute it to any degree, and therefore could view the particles diſtinct from each other; and in theſe experiments I found that theſe particles of the blood were as flat as a guinea. I likewiſe obſerved that they had a dark ſpot in the middle, which Father de la Torré took for a hole; but, upon a careful examination, I found it was not a perforation, and therefore that they were not annular. I next made experiments by mixing theſe particles with a variety of other fluids, and examined them in many different animals; and the reſult of theſe experiments was, that their ſize is different in different animals, as is ſeen in plate XII, where they are repreſented of the ſize they appeared to my eye, when viewed through a lens of $\frac{1}{23}$ of an inch focus, which, allowing eight inches to be the focal diſtance of the naked eye, magnifies the diameter 184 times.

It may not be improper to obſerve here, that the accurate Leeuwenhoeck not having diluted the human blood, or that of quadrupeds, ſo as to ſee theſe particles ſeparate from each other, was thence not qualified to deſcribe them from his own obſervation, as he has done thoſe of fiſh and of frogs; and, ſuſpecting a round figure was more fit for circulating in our veſſels, was thence led to ſuppoſe theſe particles ſpherical in the human ſubject. But I ſhall hereafter be able to ſhew from his own words, that it is not his obſervations, but

his ſpeculative opinions, or his theory, that differs from what I have diſcovered by theſe experiments.

In plate XII. it appears, that of all the animals which I have examined, the particles are largeſt in the fiſh called a ſkate; next to the ſkate they are largeſt in a frog and a viper, and other animals of this claſs; they are ſomewhat ſmaller in the common fiſh, as the ſalmon, cod, and eel. In birds they are ſmaller than in fiſh; in the human ſubject ſmaller than in birds; and in ſome quadrupeds ſtill ſmaller than in the human ſubject. Leeuwenhoeck, ſpeaking of their ſize, ſays, he is confident the red particles of the blood are no larger in a whale than in the ſmalleſt fiſh *. And others have, ſince his time, ſaid they are of the ſame ſize in all animals; but it is evident, from comparing their ſize, as delineated in the abovementioned plate, that it differs conſiderably, and that they are not largeſt in the largeſt animals; for we find that in an ox they are not ſo large as in a man; and ſo far are they from being larger in the whale than in the ſmall fiſh, it appears probable, from comparing their ſize, as delineated plate XII. N° II. from a porpus, which belongs to the ſame genus as the whale, that they are ſmaller in thoſe animals than in fiſh. Neither is their ſize inverſely, as the ſize of the animal; for they are as large in an ox as in a mouſe. The difference in their ſize therefore depends on ſome other circumſtance than a difference in the ſize of the animal.

* Conſ. Arcan. Nat. p. 220.

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As to their ſhape, I have already mentioned that they are flat in all animals, even in the human ſubject; of which any one may be convinced by repeating the following experiments.

EXPERIMENT I. Take a ſmall quantity of the ſerum of human blood, and ſhake a piece of the craſſamentum in it, till it is coloured a little with the red particles; then with a ſoft hair pencil ſpread a little of it on a piece of thin glaſs, and place this glaſs in the microſcope in ſuch a manner as not to be quite horizontal, but higher at one end than the other, by which means the ſerum will flow from the higher extremity to the lower, and as it flows, ſome of the particles will be found to ſwim on their flat ſides, and will appear to have a dark ſpot in their middle; others will turn over from one ſide to the other as they roll down the glaſs. No perſon who ſees them turn over can doubt of their being flat; he will ſee them in turning have all the phaſes that a flat body has; firſt he will ſee them on one ſide, then riſe gradually upon their edge, and turn over to the other ſide. I have in this way ſhewed their figure to a number of curious perſons, and particularly to many ſtudents of anatomy, who have attended lectures in London within the laſt ſix years.

If, inſtead of ſerum, the particles ſhould be diluted with water containing rather more ſalt than ſerum does; or if, inſtead of human blood, that of an animal with larger particles be uſed: then they will ſometimes be ſeen not only flat, but a little bended, like a crooked piece of money.

These experiments not only prove that the particles of the blood are flat, and not globular; but likewise, by proving that they are flat, they shew that they are not fluid, as they are commonly believed to be; but, on the contrary, are solid; because every fluid swimming in another, which is in larger quantity, if it be not soluble in that other fluid, becomes globular; this is the case where a small quantity of oil is mixed with a larger quantity of water, or if a small quantity of water be mixed with a large one of oil, then the water appears globular. And as these particles are not globular, but flat, they must be solid; a circumstance that will appear still more evident from future experiments.

It is necessary to remark, that in a few minutes after the particles are spread out on a glass, they run in clusters, and stick to each other, and then they appear confused.

When one of these particles is attentively examined, while separate from the rest, it appears, as it lies on its flat side, to have a dark spot in the middle, and round that dark spot it is more transparent. This dark spot was believed to be a perforation, or the particle was supposed to be a hollow ring, by the ingenious Father de la Torré. But I find, from a great number of experiments, that the dark spot is a solid particle contained in a flat vesicle, whose middle only it fills, and whose edges are hollow, and either empty, or filled with a subtile fluid. This will be evident to every one who will carefully make the following experiments.

Experiment II. Take a drop of the blood of an animal that has large particles, as a frog, a fiſh, or, what is ſtill better, of a toad; put this blood on a thin piece of glaſs, as uſed in the former experiment, and add to it ſome water, firſt one drop, then a ſecond, and a third, and ſo on, gradually increaſing the quantity; and in proportion as water is added, the figure of the particles will be changed from a flat to a ſpherical ſhape. When much water is added, the veſicle will by degrees become thinner, and more tranſparent, and will at laſt be diſſolved. When the veſicle has thus aſſumed a ſpherical ſhape, it will roll down the glaſs ſtage ſmoothly, without thoſe phaſes which it had when turning over whilſt it was flat; and as it now rolls in its ſpherical ſhape, the ſolid middle particles can be diſtinctly ſeen to fall from ſide to ſide in the hollow veſicle like a pea in a bladder. Sometimes, indeed, inſtead of falling from ſide to ſide, the ſolid middle particle is ſeen to ſtick to one part of the veſicle; and in proportion as the veſicle, inſtead of being flat, aſſumes a ſpherical ſhape, its longeſt diameter is ſhortened as might be expected, on the ſuppoſition of its being hollow and flat.

After this experiment has been made on the blood of ſuch animals as have large veſicles, it may be made on human blood, where the water will be found to have the ſame effect; the veſicles will become ſpherical, the diameters of theſe ſpheres will be leſs than the largeſt diameter of the veſicle was, in its flat ſtate.

It is remarkable that more water is in general required to produce this change on the veſicles of the human blood than on thoſe of frogs, or other amphibious animals; and thoſe of the amphibia require ſtill more than thoſe of fiſh; for the ſubſtance of theſe veſicles being thicker and more coloured in man and in quadrupeds than in the amphibia, is therefore later in being diſſolved in water; and being thinneſt in fiſh, it thence moſt readily diſſolves. Thoſe who are deſirous of repeating theſe experiments had beſt begin with the blood of toads and frogs, whoſe veſicles are large, and remain ſome time without diſſolving in the water (when that is uſed with the abovementioned precautions); by which means any one accuſtomed to microſcopical experiments may readily be ſatisfied of theſe curious circumſtances.

From the greater thickneſs of the veſicles in the human ſubject, and from their being leſs tranſparent when made ſpherical by the addition of water, and likewiſe from their being ſo much ſmaller than thoſe of fiſh or frogs, it is more difficult to get a ſight of the middle particles rolling from ſide to ſide in the veſicle, which has become round; but with a ſtrong light *, and a deep magnifier, I have diſtinctly ſeen it in the human ſubject, as well as in the frog, toad, or ſkate.

Since water makes theſe particles round, and makes the dark ſpot in their middle diſappear, it is evident the red particles of the human blood are not perforated, but that dark ſpot is owing to ſomething elſe than a hole: and this is likewiſe con-

* Theſe experiments were all made with day-light, in clear weather.

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firmed by obſerving that although the particle does in an obſcure glaſs appear only to have a dark ſpot which might be ſuppoſed to be a hole, yet, with a very tranſparent lens, and a good light, after diluting the blood with ſerum, that middle part can be diſtinctly ſeen to be only of a deeper red than the reſt of the veſicle, and thence appears darker.

In theſe experiments, made by adding water to the blood, the middle particles appear to be leſs eaſily ſoluble in water than the flat veſicle which contains them; ſo that, a little time after the proper quantity of water has been added, the flat veſicles diſappear, leaving their middle particles; which ſeem to be globular, and very ſmall.

That theſe red veſicles of the blood, although flat, are not perforated, is evident likewiſe from a curious appearance which I have repeatedly obſerved in blood that has been kept three days in the ſummer ſeaſon, ſo that it was beginning to putrefy; the veſicles of this blood being diluted with ſerum, and examined with a lens $\frac{1}{50}$ of an inch focus, but more particularly when examined with M. de la Torré's glaſs, which, by his computation, magnifies the diameter 1280 times, were found to have become ſpherical; the diameter of theſe ſpheres was leſs than their largeſt diameter when flat, and their external ſurface was corrugated in ſuch a manner as to make them appear like ſmall mulberries.

I have ſeen the ſame appearance on mixing ſerum that had been kept three days in a warm place, and ſmelt putrid, with freſh-drawn human blood; the veſicle aſſumed this globular and mulberry-like appearance.

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In theſe experiments on human blood beginning to putrefy, I have likewiſe obſerved ſome of theſe veſicles break into pieces without becoming ſpherical; and I have diſtinctly perceived the black ſpot in the center fiſſured through its middle, another proof that it is not a perforation.

In the blood of an eel, which was beginning to putrefy, I have ſeen the veſicles ſplit and open, and the particle in its center come out of the fiſſure.

As the putrefaction advances, thoſe veſicles which had become rough ſpheres, or like mulberries, and thoſe which had been merely fiſſured, each break down into ſmaller pieces. M. de la Torré ſeems to think they have joints, and break regularly into ſeven parts; and Leeuwenhoeck ſuſpected theſe globules, as he called them, were conſtantly made of ſix leſſer globules. But from obſervations I am convinced there is nothing regular or conſtant in the number of pieces into which they break. I have ſeen them fall into ſix, ſeven, eight, or more pieces, by putrefaction; for putrefaction breaks them down in the manner it deſtroys other animal ſolids.

I need hardly take notice, that the ſmall pieces into which the veſicles break are equally red as the veſicle itſelf. The theory of the red globules being compoſed of ſix ſerous ones compacted together, and the ſerous globules of ſix of lymph, has not the leaſt foundation, and is intirely overthrown by the ſimple experiment of mixing the blood with ſix or with thirty-ſix times its quantity of water; for the water diſſolving the globules ought to reduce them to yellow ſerum, or colourleſs lymph *; but it does

* See Gaubii Pathologia.

not; on the contrary, it is coloured red by these particles, even when used in much greater proportion than thirty-six parts of water to one of blood.

These red vesicles of the blood have not only been commonly supposed globular and fluid, but they have with equal injustice been imagined to be oily and more inflammable than the rest of the blood. That they are not oily is evident from their so readily dissolving in water; and that they are not more inflammable than the rest of the blood is manifest by burning them after they are separated them from the rest of the blood, which separation may be effected by shaking the crassamentum in the serum so as to diffuse the particles through it; and then, by pouring off the clear serum, when they have subsided in it. I have separated them in this manner, and compared their inflammability with that of inspissated serum, and of dried coagulable lymph, and have not observed them more inflammable than the serum or the lymph; nor do they melt like oils, as some have suspected, but burn like a piece of horn.

Some authors, who have written on the figure of these vesicles in quadrupeds, and in the human subject, have expatiated on the great advantages of their (supposed) spherical shape, in order for their more easy circulation; as it is probable that no form is preferable to a spherical one for easy motion. But as these vesicles are evidently not spherical but flat in all animals, we must believe that nature has some good purpose to answer by making them of that form.

It has been objected, that, notwithstanding they appear flat out of the body, they may possibly be

globular in the body, while circulating; and it has been ſaid, that it is almoſt inconceivable that ſo many ingenious men ſhould at different times have viewed them through a microſcope, and have concluded them ſpherical, if they be really flat. But, however that may have happened, it is a fact that they are as flat in the body as out of it. Of this I am convinced by having repeatedly obſerved them whilſt circulating in the ſmall veſſels between the toes of a frog, both in the ſolar microſcope, and the more ſimple one abovementioned. I have ſeen them with their ſides parallel like a number of coins laid one againſt another. I have likewiſe in that animal, where they are elliptical, ſeen them move with one end foremoſt, and ſometimes with an edge turned towards the eye. I have moreover ſeen them, when entering a ſmall veſſel, ſtrike upon the angle between it and the larger trunk, and turn over with the ſame variety of phaſes that they have when turning over upon a piece of glaſs.

Upon this occaſion I may remark, that it has been ſaid by ſome microſcopical obſervers, that in paſſing through very ſmall veſſels they ſeem to alter their ſhapes, and to be lengthened. This concluſion, I ſuſpect, has taken its riſe from the obſerver having ſeen them with their edge turned towards his eye; in which caſe they would appear long and ſmall, as if lengthened by compreſſion, eſpecially to one who ſets out with the notion of their being globular. I have ſeen them in blood veſſels, which would admit only ſingle veſicles, move with difficulty, as if ſtreightened for room; but never ſaw them altered in their ſhape by the action of the veſſels.

If then they really be not globular but flat, and if water ſo readily alter their ſhape, whence is it that the ſerum has the property of preſerving them in that form which ſeems ſo neceſſary, becauſe it is ſo general through the animal creation?

It is principally by the ſalts of the ſerum that this effect is produced, as is proved by adding a ſmall quantity of any neutral ſalt to water, when the water is no longer capable of diſſolving thoſe particles, nor does it alter their ſhape when the ſalt is uſed in a certain proportion.

EXPERIMENT III. If a ſaturated ſolution of any of the common neutral ſalts be mixed with freſh blood, and the globules (as they have been called, but which for the future I ſhall call flat veſicles) be then examined in a microſcope, the ſalt will be found to have contracted or ſhriveled the veſicles, ſo that they appear quite ſolid, the veſicular ſubſtance being cloſely applied all round the central piece. In proportion as the ſolution of ſalt is diluted with water, it has leſs effect; and, when diluted with ſix, eight, ten, or twelve times its quantity of water, it produces no change in the figure of the veſicles, whoſe flat ſhape can then be ſeen even more diſtinctly than when mixed with ſerum itſelf.

The neutral ſalts, which, when diluted with water, have been obſerved to have the effects above-deſcribed, are Glauber's ſalt, Epſom ſalt, a ſalt formed of the volatile alkali and the vitriolic acid, common nitre, cubic nitre, a ſalt made with the volatile alkali and the nitrous acid, as well as the ſalts made with the nitrous acid and magneſia, or

with the nitrous acid and chalk, and alſo common ſalt, digeſtive ſalt of Sylvius, and a ſalt made with vinegar and the foſſil alkali. Theſe experiments were ſufficient to convince me, that this property was very general among thoſe ſalts which conſiſt of acid and alkali; and therefore it ſeemed unneceſſary to proſecute this enquiry farther *.

But acids and alkalies have different effects on theſe veſicles from what neutral ſalts have.

The fixed vegetable alkali, and the volatile alkali, were tried in a pretty ſtrong ſolution, and found to corrugate the veſicles; and in proportion as they were diluted, their effects became ſimilar to water alone, but it is not eaſy to find the point of ſtrength where the veſicles would remain unaltered in the ſolution. And here we may obſerve, that ſince theſe veſicles are found to diſſolve ſo readily in water, and not to be diſſolved in theſe ſolutions of alkali, it is a ſtrong argument againſt their being either oily or ſaponaceous, as they have been ſuſpected.

The effects of acids are very different. I have tried the vitriolic, nitrous, muriatic diſtilled vinegar, and the acid of phoſphorus; theſe, when much diluted, have the ſame effects as water in making the veſicles ſpherical; and, in proportion as they are leſs diluted, they diſſolve the veſicles without making them ſpherical, as water does. I never

* Theſe experiments were made by putting one drop of the ſaturated ſolution of the ſalt into a tea cup, and then adding diſtilled water by a few drops at a time; and to this mixture the ſerum of the blood, highly tinged with the red veſicles, was added.

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could find any point of dilution where the acids like the neutral falts produced no change on the figure of the vesicles. This experiment is the more to be attended to, as these vesicles have been supposed to be oily and saponaceous, which is improbable, since they dissolve more readily in acids than in alkalies.

Salts made with earth of alum, and any of the acids, always corrugate those vesicles, unless they be very much diluted; when their effects are similar to those of the water alone, that is, they make the vesicles assume a spherical shape. I could not discover any point of strength in these solutions where the particles would remain in them without being changed in their shape.

The same was observed of spirit of wine: some of the metalline salts, as copperas, sublimate, and Roman vitriol, were tried; and when much diluted, their effects were not different from those of water; but in proportion as the solution was stronger, they corrugated the vesicles more and more.

Urine, when containing much of its salts, has effects similar to the serum; but in proportion as it is weaker, its effects are more like those of water.

The use therefore of those salts which enter into the composition of the blood is probably to preserve the red vesicles in their flat form; for we must suppose some advantages attend that shape, since nature has made use of it so generally in the blood of different animals. And as both a very strong solution of neutral salts and a very diluted one alters the shape of the vesicles, it is probable nature has

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limited the proportions of the water and the ſalts in our blood. A degree of latitude in theſe proportions however ſeems to be admitted; for I obſerved the veſicles equally unchanged when mixed with a ſolution of ſalts conſiſting of eight drops of water to one of the ſaturated ſolution, and when added to a mixture of fifteen drops of water to one of the ſame ſolution.

Not only the neutral ſalts in the blood are capable of preventing the ſerum from diſſolving the veſicles; but the mucilage or lymph with which the ſerum is ſo much impregnated, ſeems to contribute to the ſame effect.

When the veſicles have been made ſpherical, by being mixed with water, if a ſmall quantity of pretty ſtrong ſolution of a neutral ſalt be added, they are immediately ſhriveled, a few of them recover their former flat ſhape, but the greateſt part are contracted irregularly into ſmaller ſpheres. When theſe veſicles thus recover their ſhape, after having been a ſhort time mixed with water, they are generally more tranſparent, and appear thinner, a part of their ſubſtance having been diſſolved in the water; and thence it is more eaſy to diſtinguiſh the little ſolid particle which is contained in them. By this experiment I have had the pleaſure of convincing many curious perſons of the compoſition of this part of the blood, who were not quite ſatisfied from ſome of the other experiments.

I have mentioned above, and have ſhewn in plate XII. that theſe veſicles are of different ſizes in different animals. I have likewiſe obſerved, that they are not all of the ſame ſize in the ſame animal,

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ſome being a little larger than others; and ſome diſſolve in water more readily than others. In the ſame ſpecies of animals they even differ in ſize in the different periods of life. In a chicken on the ſixth day of incubation I found them larger than in a full-grown hen, as is repreſented in the plate; and I found them larger in the blood of a very young viper than in that of its mother, out of whoſe belly it was taken. I have not however been convinced from experiments, that there is any difference in ſize between thoſe of a child at its birth and thoſe of an adult perſon.

In the blood of ſome inſects the veſicles are not red, but white, as may eaſily be obſerved in a lobſter (which Linnæus calls an inſect); one of whoſe legs being cut off, a quantity of a clear *ſanies* flows from it; this, after being ſome time expoſed to the air, jellies, but leſs firmly than the blood of more perfect animals. When it is jellied, it is found to have ſeveral white filaments; theſe are principally the veſicles concreted, as I am perſuaded from the following experiment.

EXPERIMENT IV. If one of the legs of a lobſter be cut off, and a little of the blood be catched upon a flat glaſs, and inſtantly applied to the microſcope, it is ſeen to contain flat veſicles that are circular, like thoſe of the common fiſh, and have each of them a leſſer particle in their center as thoſe of other animals. But there is a curious change produced in their ſhape by being expoſed to the air; for ſoon after they are received on the glaſs, they are corrugated; or from a flat ſhape are changed into regular ſpheres, as is repreſented in plate XII. N° XII.

This

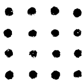
This change takes place ſo rapidly, that it requires great expedition to apply them to the microſcope ſoon enough to obſerve it.

I have obſerved the *ſanies* or blood of a ſhrimp, by cutting off its tail, and found veſicles in it ſimilar to thoſe of the lobſter, which have been a ſhort time expoſed to the air. But I never could apply the blood ſo as to ſee them in their flat form; but, ſince they changed by expoſition to the air, I conjecture that like them they were flat in the blood veſſels; but being more ſuſceptible of changes from the contact of air, they were corrugated before I could get them applied to the microſcope.

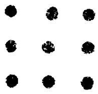
The ingenious Leeuwenhoeck has obſerved that in the blood of a graſhopper, its veſicles or globules, as he calls them, are green. I have ſeen the ſame circumſtance in the white caterpillar, whoſe ſerum appeared green when in its veſſels; but when let out from this animal or from a graſhopper, the colour cannot be diſtinguiſhed.

The ſmalleſt animal in which I have diſcerned theſe veſicles is an inſect no bigger than a pin's head, that is ſeen almoſt conſtantly in the river water which we have in London. This inſect, which is a ſpecies of the *Monoculus*, being put into a concave glaſs with a little water, and the rays of the ſun being made to paſs through it, the heart may be ſeen to beat, and the tranſparent blood or *ſanies* found to have a few veſicles, which appear to move one after the other; being made viſible, though tranſparent, by the light paſſing in ſuch a manner as to be refracted by them.

A comparative view of the **FLAT VESICLES** *of the Blood a*
appear thro' a Lens $\frac{1}{23}$ of an Inch Focus.

Fig. I.  *Their Size in an Ox, a Cat, an Ass, a Mouse, & a Bat.*

VII.

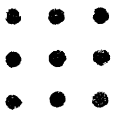
II.  ——— *in Man, in a Rabbit, a Dog, & a Porpus.*

VIII.

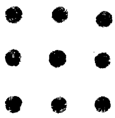
IX.

III.  ——— *in Birds, - viz a Pigeon, a Hen, a Chafinch, & a Duck.*

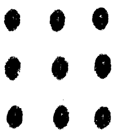
X.

IV.  ——— *in a Chick from the Egg, on the 6th day of Incubation.*

XI.

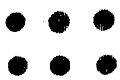
V.  ——— *in the common Fish, as the Salmon, Carp, Eel.*

XII.

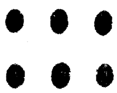
VI.  ——— *in a full grown Viper, & in a Turtle.*

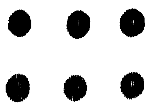
XIII.

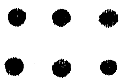
lood in different Animals, exhibiting their size & Shape as they

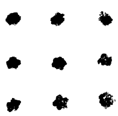
VII.  Their Size in a small Viper taken from the Belly of its Mother.

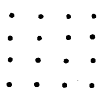
VIII.  ——— in a Slow Worm.

IX.  ——— in a Frog.

X.  ——— in a Skate.

XI.  ——— in a Lobster.

XII.  The Vesicles of the same Lobster, as they appear, after being a short time exposed to the Air.

XIII.  The size of the Globules of Milk.

J. Basire Sculp.

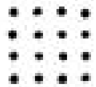
Since ſo ſmall an animal as this has theſe curious veſicles equally as the larger and more perfect animals, is it not probable that they are diffuſed through the whole animal creation? And what is found ſo generally amongſt animals muſt be of great uſe in their œconomy.

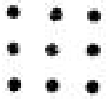
P. S.

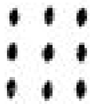
Mr. Hewſon begs leave to add, that ſince theſe experiments open a new field for enquiry; and as he has already ſo far proſecuted the ſubject as to be perſuaded that he has thereby diſcovered not only the uſe of the lymphatic glands and of the Thymus, but alſo of the ſpleen: in order to have the opinions of the ingenious concerning the facts mentioned in this paper, he ventures to ſolicit, that ſuch gentlemen as are curious in natural knowledge, and particularly the Members of the Royal Society, would honour him with their company, at his houſe in Craven-ſtreet, in the Strand, where he will repeat the experiments before them.

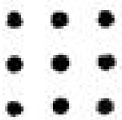
 XXXIV. *Ac-*

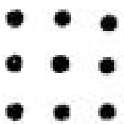
A comparative view of the **FLAT VESICLES** *of the Blood in different Animals, exhibiting their size & Shape as they appear thro' a Lens $\frac{1}{23}$ of an Inch Focus.*

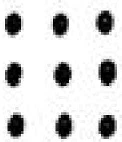
Fig. I.  *Their Size in an Ox, a Cat, an Ass, a Mouse, & a Bat.*

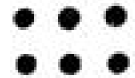
II.  ——— *in Man, in a Rabbit, a Dog, & a Porpus.*

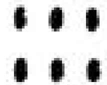
III.  ——— *in Birds, viz a Pigeon, a Hen, a Chafinch, & a Duck.*

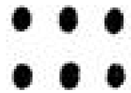
IV.  ——— *in a Chick from the Egg, on the 6th day of Incubation.*

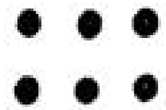
V.  ——— *in the common Fish; as the Salmon, Carp, Eel.*

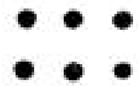
VI.  ——— *in a full grown Viper, & in a Turtle.*

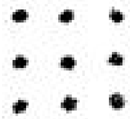
VII.  *Their Size in a small Viper taken from the Belly of its Mother.*

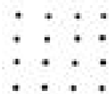
VIII.  ——— *in a Slow Worm.*

IX.  ——— *in a Frog.*

X.  ——— *in a Skate.*

XI.  ——— *in a Lobster.*

XII.  *The Vesicles of the same Lobster, as they appear after being a short time exposed to the Air.*

XIII.  *The size of the Globules of Milk.*

J. Basire sculp.