

IV. *Observations and Experiments with Madder-root, which has the Faculty of tinging the Bones of living Animals of a red Colour,* by M. Du Hamel du Monceau, F. R. S. &c. communicated in a Letter to Sir Hans Sloane, Bart. Pr. R. S. Translated from the French by T. S. M. D. F. R. S.

IN the Month of *February* 1737. (N. S.) Monsieur *Geoffroy* communicated to the *Royal Academy of Sciences* at *Paris*, the following Observation, extracted from a Letter of Sir *Hans Sloane*, Bart. President of the ROYAL SOCIETY of *London*, to him.

“ Mr. *Belchier*, a Surgeon, and Member of that
 “ SOCIETY, dining one Day with a Callicoe-printer,
 “ remarked that in a Leg of fresh Pork, the Flesh of
 “ which was well-tasted, the Bones were red. He
 “ asked the Cause of so singular a thing, and was
 “ told, that these Callicoe-printers make use of the
 “ *Rubia Tinctorum*, or *Madder-root*, to fix the Co-
 “ lours printed on the Cloth. Some of these Colours
 “ are made with Preparations from Iron, others with
 “ a Mixture of Alum and Sugar of Lead. The Parts
 “ printed with the Preparation of Iron, produce
 “ Black and Purple; those printed with the Mixture
 “ of Alum, Red of different Degrees. These Cal-
 “ licoes are afterwards boiled in a Copper with Bran,
 “ in order to clean them from a dirty red Colour
 “ occasioned by an Infusion of *Madder-root*. In
 “ fine, that this Bran should not be lost, though
 “ charged

“ charged with a red Colour, it is mixed with the
 “ usual Food of these Hogs; and this is what pro-
 “ duces this Effect on their Bones, without causing
 “ the least Alteration either in the Flesh, Membranes,
 “ Cartilages, or any other Parts of the Body. Mr.
 “ *Belchier*, whose Observation here related has been
 “ communicated to the Public in N^o 442. and 443.
 “ of the *Philosophical Transactions*, desiring to be
 “ assured whether the *Madder* alone, or all the In-
 “ gredients blended together, produced this Colour
 “ in the Bones, made some other Experiments.

“ He mixed some of the *Madder-root* with the
 “ Food with which he intended to feed a Cock.
 “ The Cock dying within 16 Days after his first
 “ feeding on the *Madder*, he dissected him, and was
 “ surpris'd to find, that the Root had produced its
 “ Effect in so small a time; for he found the Bones
 “ universally of a red Colour. Whence he con-
 “ cludes, that the *Madder* alone causes this Altera-
 “ tion; as he had not mixed either the Iron, Alum,
 “ or any of the other Ingredients of the Dyer, with
 “ the Cock's Food. He remarked, that the red Co-
 “ lour penetrated into the internal Parts of the Bones,
 “ and that the hardest Bones took more of this Co-
 “ lour than the softer ones; excepting the enameled
 “ Part of the Teeth, which in the Hog retained its
 “ Whitencfs.”

Mr. *Belchier* promises, at the Close of his Obser-
 vation, to try further Experiments, in order to know
 with Certainty, why this Change of Colour takes
 place only in the Bones. But as he has not published
 any thing more than what I have above related, I
 think myself at Liberty to communicate to the Public
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the Experiments I began to make in the Country, soon after the Observation came to my Knowledge. They are a Confirmation of it, and diminish nothing of the Merit of the first Discovery.

It is proper to observe, that *Mizaldus*, in a Work published in 1566. with this Title, *Memorabilium, utilium ac jucundorum Centuriæ novem*, (Cent. 7. No.) has these Words: “ Erythrodanum, vulgo
 “ Rubia tinctorum dictum, ossa pecudum rubenti
 “ & sandycino colore imbuat, si dies aliquot illud
 “ depastæ sint oves, etiam intacta radice, quæ rutila
 “ existit, &c.”

First, I took Four strong Pullets, which I shut up in Coops. I fed them with a Paste made of Wheat-meal and Powder of *Madder-root*; and gave them an Infusion of the same Root to drink, which I was in hopes they would have no Dislike to. The first Days they eat their Paste pretty well; but I found, that the Addition of the *Madder* rendered it much less agreeable to them than that made of the Meal alone, on which they fell with much greater Eagerness than on the other, when, to try their Relish, I now-and-then gave them some of it. As to the Infusion of the *Rubia Tinctorum*, they never would drink it, and I was obliged to give them pure Water, which they drank plentifully; for this Root made them thirsty. In short, at the End of some Days they could not relish the Mixture, of which they eat but very little, and wasted away visibly.

On the 10th Day, one of them died; and another Two Days after: and both of them had their Bones tinged of a Rose-colour. In order to prolong the Lives of the other Two, I diminished the Dose of the
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the *Madder*, and from time to time I gave them the Paste without it. The Root had already produced its Effect; for notwithstanding the new Regimen, they continued to waste; which obliged me to kill the Third Five Days after the Death of the first Two. The Colour of its Bones was not different from that of the Two, who died Five Days before. As to the Fourth Pullet, which seemed not quite so sick, I marked it on the Leg with a Bit of Cloth tied round, and set it at Liberty. It recovered by degrees, by choosing Food to its Taste in the Yard. But at the same time the Tincture its Bones had received, went off gradually, and almost intirely disappeared in a Month's time. For I took care to observe the Change every second or third Day, by looking at the Bones on the Under-side of the Wing, which have no other Covering than a thin Skin.

From this Experiment, as from that of Mr. *Belchier's* Cock, it appears, that the *Madder-root* is alone sufficient to tinge the Bones of Animals red, which eat it. The Bones of my Pullets had taken no more than a Rose-colour; because these Creatures, being disgusted with their Food, never eat of it, but when urged by extreme Hunger: And I had never been able to tinge them of a fine red Colour, had I not repeated the Experiment on such Animals as I could feed with the Paste, and had it in my Power to make them swallow *Madder* in large Quantities.

For that Purpose I chose young Pigeons, the strongest of a whole Pigeon-house. Two of these had no other Food given them but Wheat-meal, others were fed with the Meal and *Madder* mixed
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and made into Pellets of a convenient Size, given them Three times a Day till their Crops were full. I endeavoured to make the young Pigeons drink of the Infusion of *Madder*, which were fed with the Root and Meal; but I could never succeed, and was obliged to give them Water alone, as to the Pullets of the First Experiment. The Two young Pigeons fed with the Meal alone were lively and fat, digested their Food, and throve as well as if fed by the old ones. But on the contrary, those that were fed with the Paste of Meal and *Madder*, took this Food only by Force, digested ill, were dull and very thirsty. And though Care was taken to keep their Crop constantly full, as well as the others, yet they grew leaner daily. They were always shivering, and endeavouring to get into the Sun, or near the Fire, to warm themselves: And the strongest of them was very sick by the 10th Day. I got the Two killed, that had fed on the Meal alone, as well as the others that had the *Madder* given them; and I preserved but Two, which appeared to me to have better borne the Effect of it than the rest, and had the Bones of the Wings already tinged red.

One of the Two was intended to be recoverd by a simple Diet, in order to see, if, by prolonging its Life, the Colour, which was already very visible in the Wing-bones, would wear off: But in Three Days time it was killed accidentally. However, I thought I perceived the Colour weaker than before the Change of Diet: And the same Experiment, repeated some time after, confirmed me (in the Notion) that the Change of Food makes the Colour disappear by degrees. I continued to feed the other remaining
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young Pigeon with *Madder*, but in small Quantities, for fear of killing it too soon. It lived Eight Days longer without any Appearance of the Bones being deeper coloured than the first that were killed.

All these Creatures, that had been fed with the Mixture, were dissected; and I made the following Observations on them.

Neither the Feathers, the Horn of the Bill, nor Claws, had changed their Colour, even where they are inserted into the Skin. The Skin of the whole Body had preserved its natural Colour. The Brain, Nerves, Muscles, Tendons, Cartilages, *Epiphyses*, and Membranes, afforded nothing to the Sight contrary to the usual State of these Parts. But the long bony Tendons, that run along the great Bone, which is improperly called the Leg of Fowls, were red about the Middle of their Length, which is their hardest Part. All the true Bones, even to the very thinnest of them, were as red as Carmine; and in some Places this Red was so deep, that they appeared almost black.

In these young Birds, all the Bones do not take the red Tinge alike. The hardest are generally more coloured than those that are tenderer. A Difference of this kind is perceivable even in the same Bone; for the Middle, which has more Solidity than the Ends, is almost always the reddest. Not but there are sometimes found little pale Spots in the Part where the Red is deepest; and sometimes Spots of a very deep Red in those Parts which have taken but a Carnation Tinge.

I have always found, that the great Bone of the Foot, which is commonly called the Bone of the
 E c c Leg,

Leg, was visibly less red than the others. I have found the little Bones of the *Larynx* and of the *Apophyses* tinged of a fine Red, though these are as small as a Thread in young Pigeons. The Rings of the *Trachea*, which are intirely cartilaginous, had not taken the least Tinge; but the Ring nearest the Division of the *Trachea* was red in these Pigeons; and even the First Ring of each Branch of the Bifurcation had in several taken the Tincture, in the Middle at least of its Outside.

The other Parts of the Thorax, *viz.* The Heart, Lungs, *Mediaſtinum*, *Pleura*, and Diaphragm, remained of their natural Colour. There was nothing remarkable in the Liver, Spleen, Kidneys, nor on the Outside of the Gizzard; but the inner Membrane of the Crop and Intestines, especially the large ones, appeared red. Having washed Pieces of these Crops and Intestines, I found that their outer Membrane continued white, and that the inner, or *Tunica Villosa*, only was tinged by the *Madder*. At first Sight it appeared to me as if injected; but upon examining it with a Glass, I saw distinctly, that it was not a coloured Liquor that was contained in Vessels, as in Parts injected; but that it was only a sort of *Facula* detained in the villose Part of these Membranes. It is doubtless the Adhesion of these tinging Particles of the Root to the small *Villi* of the inner Membranes of the Organs of Digestion, that is the Source of all the Distempers with which these Creatures appeared to be seized, while I fed them with the *Madder*. Their Crop especially was relaxed and flabby, as if it had been macerated several Months in Water; it was easily torn, and its inner or villose Membrane

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adhered so little to the others, that it was detached from them in Pieces. It is very probable, that the coloured *Fæcula* detached from the *Madder*, that is, the Part of the Root which gives the Tincture, had obstructed the small Vessels and Glands of the Stomach, which might possibly occasion a *Sphacelus* therein. However that be, a certain Quantity of this *Fæcula*, being accumulated there, retarded Digestion, and those Animals died hectic, though with a full Stomach.

The Eyes of these Animals, while alive, seemed as red as those of some Parrots. I thought, after having dissected them, that no other Part was coloured but the *Capsula* of the Crystalline: But Monsieur *Morand*, to whom I had sent a Turkey fed with the *Madder*, observed that the vitreous *Capsula* was of a crimson Red, though neither the vitreous Humour nor the Crystalline were dyed: The Eye of this Turkey being larger than those of the Pigeons, the Hand that dissected it much more dexterous than mine, and the Anatomist more knowing, I willingly come into his Opinion. This then is the only soft Part, that is really tinged in these Animals; for I do not look on those Parts as such, which appear so only by their immediate Contact with those Parts that are charged with the Colour: Monsieur *Morand* having, in the Notes he sent me of his Observations, confirmed all that I had before observed, there ought to remain no Doubt of what I have here related.

I come to the Examination of the Skeletons, and of all the coloured osseous Parts of my Pigeons; in order to compare them with the Skeletons of the Two Pigeons fed with Wheat-meal alone without

the *Madder*. The Bones of the first were, as I have said above, of a very lively Carmine-red, in some Places of a Crimson; and I have some of them of the Colour of yellow Okre; but whence this Difference arose, I could not discover. These tinged Bones being broke, while fresh, or before drying in the Air, seemed to me somewhat bigger and fuller of Marrow; but also more spongy, or of a looser Texture, and easier to break, than the white Bones of the Pigeons fed with Meal only. The Parts of these Bones that had the least Degree of Hardness, broke between the Fingers, which remained coloured from them: And this Tincture does not come from the Marrow, which continues in its natural State, like all the other soft Parts. The same Parts in the white Bones were not to be broke in this manner.

If we recollect, that the Pigeons fed with the Mixture of Meal and *Madder* are always in a languishing Condition, in a continual Decay; it will be easy to judge, that this is the only Reason why the red Bones must be not so well formed, nor so hard, as the white Bones of the Pigeons fed with good Aliments. But why are they bigger, and, as it were, puffed up? It is hard to suppose any other Cause of this, but the Interposition of the colouring *Facula* of the *Madder* between the *Lamella* of the Bones. These heterogencous Particles hinder the immediate Contact of these *Lamellæ*; and thence proceeds the preternatural Increase of their Size, and their little Solidity. Upon viewing these Bones with a good Glass, their smoothest Surface appears bored with a vast Number of small Holes, in which the colouring *Facula* is perceived. And with a Microscope that mag-

magnifies still more, there appears a sort of Net-work of Fibres, which divide, and reunite, to form this Net. Under the first Order of this Net-work, which appears white, another is seen somewhat red, and under this a Third and a Fourth, still deeper coloured: In fine, the Ground under all these reticular *Strata* is of a very deep Red; and the Whole may be justly enough compared to a Piece of Wood stripped of its Bark. It is probable, that this sort of Injection, made by the way of Digestion, might lead an able Anatomist to some very useful Discoveries on the Nature and Formation of the Bones. Nay, I think I have already found out something new on this Head; but, as I have still some Scruple remaining on my Observations, I will not venture to communicate the Consequences drawn from them.

In order that the *Madder* should produce the above related Effect on the Bones, its Tincture must have such a Degree of Fixity, (according to the Dyers Term) as not to be changed by the dissolving Action of the *Saliva*, of the Juice of the Stomach, of the pancreatic Juice, of the Bile, &c. nor by the peristaltic Motion of the Stomach and Intestines; and yet these Juices act so powerfully on common Aliments, that after Digestion they are not to be known either by their Smell, Taste or Colour. This is not all: These colouring Particles must be small enough to pass with the Chyle into the Blood, and circulate with it through a great Number of Strainers or Vessels, without being separated, and without being deposited either in the Liver, Spleen, or Pancreas.

I strongly suspect that Portion of the Lymph of the Blood, which is fit for nourishing the Bones, might
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be the true Dissolvent of the Tincture of the *Madder*, and might convey it to the Place whither it carries Nourishment to the solid Parts of the Body of these Animals. In consequence of this Conjecture, which I shall resume in the Sequel, I thought that the Skeletons of young Animals ought to take a stronger and quicker Tincture, than those of full-grown Animals; because the Bones of young Animals are in a State of Growth, which requires a greater Quantity of ossific Juice. It is likewise true, as above said, that it is the hardest Bones of young Animals, that imbibe most of the Colour. All these Considerations gave Rise to a Difficulty, which was to be cleared up.

Wherefore, in the Beginning of last *October*, I chose Two Turkeys of the Year, the strongest I could find, and young Pigeons in their first Hair or Down. I could wish to have made the Experiment on Animals of the same Species; but it was impossible to find young Turkeys in their first Down at that Time of the Year: And besides, these Animals being extremely tender during the first Months, their Stomach would never have been able to bear the Effect of the *Madder*. As to old Pigeons, I had no tame ones: The wild are difficult to be fed with the Paste; and if they were suffered to feed at Discretion, they would not have been sufficiently *maddered*, if I may be allowed this Expression. However, the Bones of my Two Turkeys were very hard, in comparison of those of the young Pigeons: And thus I had in these Animals, though of different Kinds, all that was of Importance for my Experiment.

My young Pigeons, fed with the Paste mixed with *Madder*, died the Third Day; yet all that had the Consistence of Bone in their Skeletons, was become as red as Scarlet. Mr. *Belchier* was surpris'd to see the Bones of his Cock tinged red in Sixteen Days, and here are Bones so coloured in Three Days. But all that should in Course of Time have turned to Bone in One of my young Pigeons, and as yet was but Cartilage, as the *Epiphyses*, the great *Apoophysis* of the *Sternum*, &c. had not taken the least Colour. In the other, there were some Spots of a very weak red on the Cartilage of the *Sternum*, which probably began to ossify. Other Experiments, since tried, have taught me with greater Certainty, that the Cartilages in general are not tinged red by the *Madder*, but when they begin to acquire the Consistence of Bone.

If, as I suspect, it is the lymphatic Part of the Blood that is the *Menstruum* of the colouring Particles of the *Madder*; if this Lymph contains the nutritious Juice of the Cartilages and Bones; why does it not, in carrying with it the colouring Particles it has extracted from the Root, why does it not, I say, tinge the Cartilages as well as the Bones? In my Opinion this Difficulty cannot be solved but by the Difference of the Pores. In the Cartilages they are too large, the colouring Matter passes through them too easily, and finding no osseous *Laminae* yet formed, for want of a Surface sufficiently extended to retain it, it passes with the superabundant Lymph through the Pores of the Cartilages. When these Cartilages begin to take a proper Consistence, where there are *Strata* of osseous *Laminae* already formed, the Ob-
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stacle exists, the colouring *Fæcula* is detained and deposited there. When the ossifying Juice is no longer necessary for repairing a daily Loss of Substance, as in Animals arrived at their full Growth; besides that probably this Juice is then much less abundant, and consequently, in proportion, less charged with the colouring Parts of the Root; it must necessarily result thence, that the Bones of an adult Animal will be much weaker coloured. And this is what happened to my Two Turkeys, which, though fed for Fifteen Days with the Paste of Meal and *Madder*, had their Bones tinged but of a Rose Colour, which appeared to me somewhat deeper towards the Ends than the Middle, which, having too much Consistence, could not admit or retain the same Quantity of the colouring *Fæcula* as the tender Bones of the young Pigeons. Therefore the Bones of Animals that are still growing, are dyed better and quicker than those of full-grown Animals; and, in my Opinion, for the Reasons already given. My Two Turkeys had the same Ailments with the Pullets of the First Experiment, they fell into a Decay like those, and I was obliged to have them killed in Fifteen Days time.

Here we see young Pigeons, whose Bones were dyed of a fine Carmine-red in three Days; which is nearly the Time they must have for acquiring this Degree of Tincture. By other Experiments on young Pigeons of the same Age, I have found, that in Thirty-six Hours their Bones were of a lively Rose-colour, and in Twenty-four Hours they were at least of a Flesh-colour.

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These last Experiments prove with what Expedition the Distribution of the nutritious Juice is performed in Animals of this kind, which acquire all their Growth in a few Months; and how rapid the Distribution is, even in those Parts where the Blood's Circulation meets with the greatest Obstacle, as in the Substance of the Bones.

As one ought likewise to infer from these Experiments, that there are vegetable Medicines whose chief Tendency is to the Bones, and which consequently might remedy many of their Distempers, I looked on myself obliged to employ the *Madder* with this View; but not having it in my Power to raise Diseases of different kinds in the Bones of my Animals, I confined myself to the Examination of what Effect it would have in a Fracture.

I chose Four very vigorous young Pigeons: A Thigh-bone of each of them was broke; the Reduction was immediately performed, and secured by a proper Bandage. Two of these Pigeons were fed with the Meal and *Madder*, and the other Two with the Meal alone. These last, notwithstanding the Pain the Fracture must have given them, had always a good Appetite, and in Eight Days they began to walk with their Dressing, which was a little loosened. The others fell into the Accidents already mentioned, and died, one on the Tenth, the other on the Fourteenth Day. The Two Pigeons that had recovered were killed, in order to compare the *Callus*.

That of the Pigeons which had not taken any *Madder*, was little, close, and very even: That of those fed with this Root, was large, spongy, and uneven: There shot out of it a sort of Vegetation: It

broke between the Fingers, and crumbled into small Grains. It is true, that the State of Suffering of these Animals, occasioned by the Hurt, and increased by a Food improper for them, might retard the perfect Reunion of their Bones; yet I think, it certainly results from this Experiment, and others which I suppress, because they prove nothing more, that the *Rubia Tinctorum*, taken inwardly, is rather prejudicial than beneficial in the Case of Fractures; and it is not without its Use to know what is to be avoided.

The *Rubia*, probably, is not the only vegetable Substance that can change the Colour of the Bones; and yet I have tried the Log-wood, the *Anchusa* and *Curcuma*, without Success. In all Likelihood, it must be a Substance less susceptible of Alteration; and it is well known, that the *Rubia* is of that sort, seeing the Cloths dyed with this Root bear very well the Action of the Air, and that of boiling.

I have put the coloured Bones of my Animals to several Proofs: First, as Mr. *Belchier*, to that of boiling Water, and of Spirit of Wine, without the least Change of Colour. It also resisted Soap-suds. A strong Lixivium of Salt of Tartar discharged a little of the Colour, and made it look brighter. Vinegar made it take a yellowish brown and obscure Tinge. In fine, Alum-water discharged the Colour pretty considerably, and the Water remained somewhat vinous. Thus these Bones perfectly well resist the same Boilings as the Cloths dyed with the same Root; but the Air acts upon them much sooner than on these Cloths: For the Bones of the Pullets in the First Experiment, those of the Turkeys in the Third, and those of the young Pigeons, that had eat of the
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Madder but Three Days, became intirely white in less than a Year; and the reddest Bones lost much of their Colour. And I am of Opinion, that the Dew, to which I have exposed some of them for a few Days, will finish the Whitening of them.

As there is a sort of Analogy between the Nutrition of Animals and that of Vegetables, I have not neglected trying, if the Tincture of the *Rubia* would introduce itself into the Vessels of some Plants; which would, perhaps, contribute much to lay open their Organization.

For the First Experiment, in which indeed I had no Hopes of Success, I planted Two Bulbs of Tuberoses in Earth, with which I had mixed a good Quantity of *Madder*: But I found nothing, either in the Leaves, Stalk, or Flowers, but what was in the common and natural State. And this must have been so: For since it is only the Bones that take the Tincture in Animals, the Tuberosc, having all its Parts soft, is in the State of an Animal without Bones: Such as a Leach, an Earth-worm, a Lamprey, which would probably continue in their natural State, whatever Quantity of *Madder* were given them, supposing it could possibly be done.

Wherefore I resolved to try the Experiment on a Tree. I planted a Paradise Apple-tree in a Box, which I had filled with Earth mixed with a great deal of *Madder*; and I covered the Upper Surface of the Earth with a Layer of *Madder* Two Inches thick. This Layer was renewed several times for near Two Years that my Tree is under the Experiment; but I have not as yet been able to examine if its Wood is coloured by this Root. In case the Experiment

does not succeed, as it is very likely it will not, it will serve at least to expose the Vanity and Uselessness of all those Receipts and Processes of Vegetation, that are to be found printed in *Mizaldus*, *Porta*, and other more modern foreign Compilers.

V. *A Catalogue of the FIFTY PLANTS from Chelsea Garden, presented to the ROYAL SOCIETY by the Company of Apothecaries, for the Year 1739. pursuant to the Direction of Sir Hans Sloane, Bart. Med. Reg. & Soc. Reg. Præf. By Isaac Rand, Apothecary, F. R. S. Hort. Chel. Præf. ac Prælec. Botan.*

851. **A** Carna major; caule folioso. C. B. 379.
 852. **A** Astragalus, perennis hirsutus, Alopecuroides; Galegæ foliis; floribus luteis.
 853. Bauhinia non aculeata; folio subrotundo, bicorni; floribus albis. D. Houston.
 854. Bidens Americana; flore albo radiato; foliis inferioribus trilobatis; superioribus subrotundis, acute crenatis.
 855. Bidens latifolia, hirsutior; femine angustiore, radiato. H. Elt. P. 51.
 856. Bidens scabra; flore niveo; folio Panduræformi. Ibid. P. 54.
 857. Bignonia Americana; Fraxini folio; flore amplo phoeniceo. T. 164.