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ADN 2/2/12

THE
SCIENTIFIC PROCEEDINGS
OF THE
ROYAL DUBLIN SOCIETY.

Vol. XIII. (N.S.), No. 14.

JANUARY, 1 .

28
THE INHERITANCE OF
THE DUN COAT-COLOUR IN HORSES.

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[Authors alone are responsible for all opinions expressed in their Communications.]

DUBLIN:
PUBLISHED BY THE ROYAL DUBLIN SOCIETY,
LEINSTER HOUSE, DUBLIN.
WILLIAMS AND NORGATE,
14, HENRIETTA STREET, COVENT GARDEN, LONDON, W.C.
1912.

Price One Shilling.

Royal Dublin Society.

FOUNDED, A.D. 1731. INCORPORATED, 1749.

EVENING SCIENTIFIC MEETINGS.

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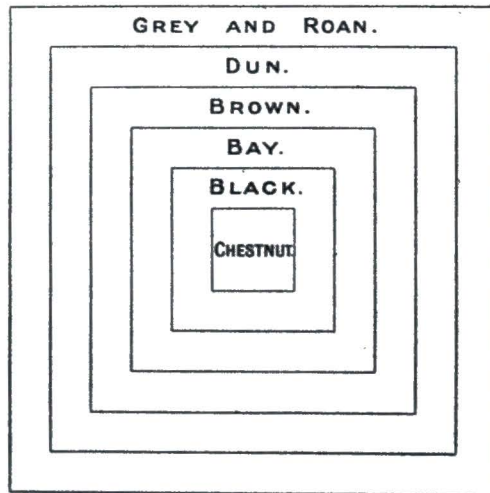
THE INHERITANCE OF THE DUN COAT-COLOUR
IN HORSES.

By JAMES WILSON, M.A., B.Sc.,

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[Read DECEMBER 19, 1911. Published JANUARY 19, 1912.]

IN a previous paper on "The Inheritance of Coat-Colour in Horses"¹ it was shown, from the data then in hand, that the colours fit into each other like a nest of Chinese boxes: chestnut being innermost or recessive to all others; then coming, in succession, black, bay, brown, dun, and finally grey and roan. The following diagram will make the position of each colour clear:—



It was pointed out that the relative positions of bay and brown were not absolutely clear, and that, while grey and roan were each dominant to all the other colours, there was no evidence to indicate their relative positions. Each

¹ "The Inheritance of Coat-Colour in Horses," Scient. Proc. Royal Dublin Society, 1910.

was a distinct variety; but the behaviour of either towards the other was not disclosed.

At the same time the data concerning dun were very few—only twenty-three cases being quoted, in addition to information gathered on Clare Island—and its position was only suggested in a foot-note. Since the publication of the previous paper, search has been made for further dun data, which it is proposed to bring together in the present paper.

The reason for searching specially for dun data is that, for many years, this colour has been looked upon as a reversion, liable to appear among all kinds of horses, but especially among cross-breds, no matter what the colours of the parents, and because this view has been closely connected with the subject of inheritance. It is also desirable to confirm the previous finding.

It would be difficult to say when stock-breeders began to look upon animals unlike their parents but like some remote ancestor as reversions; but, if the matter was not considered previously, it was brought into notice by the publication, in 1821, of Lord Morton's quagga experiments. Lord Morton, as stated in his communication to the Royal Society, read in November, 1820, wished to experiment in domesticating the quagga, and "endeavoured to procure some individuals of that species." He "obtained a male; but being disappointed of a female," he "tried to breed from the male quagga and a young chestnut mare of seven-eighths Arabian blood, and which had never been bred from: the result was the production of a female hybrid, now five years old, and bearing, both in her form and in her colour, very decided indications of her mixed origin." Lord Morton proceeds:—"I subsequently parted with the seven-eighths Arabian mare to Sir Gore Ouseley, who has bred from her by a very fine black Arabian horse. I yesterday morning examined the produce, namely, a two-year-old filly, and a year-old colt. They have the character of the Arabian breed as decidedly as can be expected, where fifteen-sixteenths of the blood are Arabian; and they are fine specimens of that breed; but both in their colour, and in the hair of their manes, they have a striking resemblance to the quagga. Their colour is bay, marked more or less like the quagga in a darker tint. Both are distinguished by the dark line along the ridge of the back, the dark stripes across the fore-hand, and the dark bars across the back part of the legs. The stripes across the fore-hand of the colt are confined to the withers, and to the part of the neck next to them; those on the filly cover nearly the whole of the neck and the back, as far as the flanks. The colour of her coat on the neck adjoining the mane is pale, and approaching to dun, rendering the stripes there more conspicuous than those on the

colt. The same pale tint appears in a less degree on the rump; and in this circumstance of the dun tint also she resembles the quagga."¹

At the time this was held by Lord Morton and others to have been a case of "infection of the germ" or telegony, as we now call it; but, as early as 1839, Dr. W. Macdonald, of Edinburgh, in a paper also read before the Royal Society, doubted this explanation, and suggested that the chestnut mare's foals were reversions. He pointed out that "similar markings are very commonly met with on the Eel-back dun ponies of Scotland"; and, as the chestnut mare "was not pure, she may have inherited the tendency to those peculiar markings." He observed further that the "cross-bar markings on the legs [of the chestnut mare's foals] are not found in the *quagga*, but only in the *zebra*, which is a species quite distinct from the *quagga*"—a fact which he considers as completely overturning the reasoning by which the conclusions stated in Lord Morton's paper were deduced. The facts, he thinks, admit of a more natural explanation, and one more consistent with the known physiological laws of development, by supposing the stain in the purity of the mare's Arab blood to have arisen from the circumstance of an early progenitor of the mare having belonged to the eel-backed dun variety, the peculiarities of which appeared in a later generation.²

Hamilton Smith, whose "Natural History of Horses" was published as one of Jardine's "Naturalist's Library" in 1841, and whose knowledge of the history and distribution of the horse was beyond that of such contemporaries as Youatt and Low, thought Macdonald's "conjecture . . . far-fetched."³ Yet he thought there was a possibility of the colours reverting. He believed that horses were descended from five original stocks, viz., the bay, the white or grey, the black, the dun or tan, and the tangum, piebald or skewbald, which had been mingled together; that, as a result of this mingling, horses were now of many colours; but that all tended to return to the original five. His statement is worth quoting:—"From the different colours of the original stocks, horses are clothed in a greater diversity of liveries than any other animals, cattle and dogs not excepted; they are a natural consequence of interminable crossings of the five great *stirpes* already mentioned, producing combinations which have caused French and Spanish writers to enumerate above sixty: the piebald and dappled find only their counterparts in the forms and shades of colour in some species of seals, and it is there also we find the light blue greys with brown spots, of which we have examples in the New Forest and in Spain: yet excepting the five primitive, all the rest have

¹ Philosophical Transactions for 1821, p. 20.

² Proc. Royal Society, iv., p. 164.

³ "Natural History of Horses," p. 73.

a tendency to return to them, and sometimes it would seem capriciously to resume the bay, dun, grey, or black.”¹ Smith said also that, while the five original stirpes were all represented among tame horses, “the dun is typical of the generality of the real wild horses, still extant in Asia, and the semi-domesticated, both there and in Eastern Europe. Besides the general form, the smaller square head, great length of mane, tendency to black limbs, it is known by the black streak along the spine, sometimes, though very rarely, crossed by a second of a fainter colour on the shoulders, and often marked by black streaks on the hocks and upper arms.”²

It was left to Darwin to set aside all other stirpes, and, after first suggesting the descent of all kinds of horses from a striped race, eventually to suggest them as tracing back to a race that was both striped and dun. In “*The Origin of Species*” (1859) he rejected Hamilton Smith’s theory “that the several breeds of the horse are descended from several aboriginal species,” and went on to say that, although he had “collected cases of leg and shoulder stripes in horses of very different breeds in various countries, . . .” yet “in all parts of the world these stripes occur far oftenest in duns and mouse-duns.” He found them also in mules and in other equine crosses, and mentioned the striped foals of Lord Morton’s chestnut mare. Then, seeing the appearance of such stripes to be parallel to the occasional appearance of “slaty blue birds with two black bars on the wings,” and so on, among pigeons, he summed up thus:—“For myself, I venture confidently to look back thousands on thousands of generations, and I see an animal striped like a zebra, but perhaps otherwise very differently constructed, the common parent of our domestic horse (whether or not it be descended from one or more wild stocks), of the ass, the hemionus, quagga, and zebra.”³ But, in “*The Variations of Animals and Plants under Domestication*” (1868), the dun colour is added to the stripes as a characteristic of the ancestral horse, although the new evidence in support of the addition is not very great. The second chapter of this book is devoted to horses, and consists mainly in an extension of the argument contained in “*The Origin of Species*.” It is stated that duns are barred and striped more frequently than other species—but not that duns only and that all duns are barred—that, in places, duns are not considered pure-bred unless they are striped; and, from the fact that wild and semi-wild horses in Europe and Asia and feral horses in America⁴ are, many of them, dun, it is inferred that dun is obviously the colour of wild

¹ “*Natural History of Horses*,” p. 199.

² *Ibid.*, p. 274.

³ “*Origin of Species*,” 1897 ed., pp. 117 to 122.

⁴ Ridgeway has shown that Cortes took dun horses with him to Mexico: “*Origin and Influence of the Thoroughbred Horse*,” p. 267.

horses. A number of dun horses have been examined and the parentage of some of them looked into, but only three are cited, none of whose parents is dun. Darwin then sums up:—"From reasons which will appear in the chapter on Reversion I have endeavoured, but with poor success, to discover whether duns, which are so much oftener striped than other coloured horses, are ever produced from the crossing of two horses, neither of which are duns. Most persons to whom I have appealed believe that one parent must be a dun; and it is generally asserted that, when this is the case, the dun-colour and the stripes are strongly inherited. One case has fallen under my own observation of a foal from a black mare by a bay horse, which when fully grown, was a dark fallow-dun and had a narrow but plain spinal stripe. Hofacker gives two instances of mouse-duns (Mausrapp) being produced from two parents of different colours and neither duns."¹

On these grounds Darwin adds the dun colour to the stripes of the ancestral horse. But he says that the case for the descent of the horse from a dun and striped ancestor is less clear than that of the pigeon from a blue and barred ancestor:—"The appearance of the stripes on the various breeds of the horse when of a dun-colour does not afford nearly such good evidence of their descent from a single primitive stock as in the case of the pigeon. . . . Nevertheless the similarity in the most distinct breeds in their general range of colour, in their dappling, and in the occasional appearance, especially in duns, of leg-stripes, and of double or triple shoulder-stripes, taken together, indicate the probability of the descent of all the existing races from a single, dun-coloured, more or less striped, primitive stock, to which our horses still occasionally revert."²

Curiously enough, in the argument leading to the statement just quoted, there is no mention of Lord Morton's experiment, from which it might be inferred that the second and third foals³ from the chestnut mare carried weight in Darwin's mind no longer. But this is scarcely possible; for they are cited in a subsequent chapter⁴ in language which suggests that Darwin took them to be more dun than Lord Morton did. Lord Morton spoke of the filly and the colt generally as both resembling the quagga *in their colour*, and particularly, of the filly's *dun tint*, which consisted in the colour of the neck *approaching to dun* and in the *same pale tint in a less degree* appearing on the rump. But Darwin wrote:—"These colts were partially dun-coloured, and were striped on the legs more plainly than the real hybrid, or even than

¹ "Animals and Plants under Domestication" (1868), i, p. 59.

² *Ibid.*, p. 61.

³ There was also a fourth foal born after Lord Morton's communication very like the second and third. Their portraits are in the Royal College of Surgeons Museum in London.

⁴ "Animals and Plants under Domestication," i, p. 403.

the quagga. One of the two colts had its neck and some other parts of its body plainly marked with stripes. Stripes on the body, not to mention those on the legs, and the dun-colour, are extremely rare."¹

However, if Darwin thought the colts—both the colts—to be more dun than Lord Morton's description warranted, some later writers have gone much farther and called them dun altogether. Yet if we are to judge by their portraits, painted by Agasse—"the accurate Agasse," as Hamilton Smith called him—and now in the museum of the Royal College of Surgeons in London, they were not dun at all, but just such ordinary bays, excepting for the extraordinary striping, as might be met with anywhere.

It is also doubtful whether the "black Arabian" was not a very dark brown.

Before discussing the data collected concerning duns, we may first refer to some of the difficulties connected with the question of colour, the most serious of which is the error of description. This applies to all colours, but most of all, perhaps, to grey, since grey horses are not usually born so, and their true colour is not disclosed until one at least, and frequently several, coats have been cast. Other colours may be misdescribed by the describer not knowing them well enough; but, in some cases, those who have a good knowledge of coat-colours may call one colour by another's name when the shade of the one approximates to a shade of the other. Secondary markings help to mark some colours, as, for instance, the lack of black "points" in chestnuts and their presence usually, together with frequent lighter-coloured muzzle-patches, in bays and browns. But these distinguishing marks are not so well known as might be desired, and misdescriptions result in consequence.

As yet no clear distinguishing mark has been found to separate bay and brown; and so these colours are frequently confused. And, since the muzzle-patch, though frequent, is not constant in bays, dun, which has not got it, runs some risk of being called bay, and bay of being called dun, when the shade of the one approximates to a shade of the other. Dun also is liable to be called chestnut: an example being found in Low's "*Breeds of the Domestic Animals of the British Islands*," in which the Connemara breed of horse is represented pictorially by a dun, but is described as "generally of the prevailing chestnut colour of the Andalusian horses."²

¹ "*Animals and Plants under Domestication*," i, p. 403.

² Low repeats the same description in his "*Domesticated Animals of the British Islands*," 1845, p. 523.

The data now brought together come chiefly from stud-books, but also from animals not entered in stud-books. But in neither case is it possible to find many instances of individual animals having a large number of progeny—and such instances are the most desirable—because dun has been an unwelcome colour in all British breeds, not only in stud-book times but before them, and, so, has not been bred from freely. Some breeds, as, for instance, the Suffolks, Yorkshire Bays and Coach Horses, and Shires, have no duns—or at any rate only very few—in their stud-books. The dun colour, which had been receding northwards and westwards, had left the east coast before these breeds were entered in stud-books. Dun entries occur, however, in all our other stud-books, namely, in the Shetland, the Clydesdale, the Hackney, the Polo and Riding Pony, and the Thoroughbred. The last contains a comparatively larger total number of entries concerning dun and also the largest number of individual dun animals leaving a fair number of progeny. Curiously enough, these individual animals, with one exception, *the Gower Dun Barb*, belong all to one family, the explanation being no doubt that this family had racing ability, and so was bred from for a few generations in spite of its colour. The other dun and presumably dun animals which left either only one or two recorded progeny or none at all are these :—the *Darcy Yellow Turk*, presumably a dun of Charles the Second's time which left two sons, viz., Spanker, a bay, and Brimmer, whose colour is not given; *Lord Oxford's Dun Arabian*, imported early in the eighteenth century, which left two daughters whose colours are not given; *Thwaites's Dun Mare*, a daughter of the *Akaster Turk*, living early in the eighteenth century, which left a son and a daughter whose colours are not given; the *Northumberland Golden Arabian*, presumably a dun, which left a daughter, *Leda*, whose colour is not given; and three others which left no recorded progeny, viz., *Morgan's Dun*, a *dun colt* by His Majesty's (George the Second) one-eyed grey Arabian out of young Kitty Burdett, and a *dun filly* by Gregory's Arabian out of Miss Middleton. None of the foregoing is responsible for a dun entry other than its own in the stud-book. In addition to these there was a filly by Young Cade out of Miss Thigh (1763?) entered as dun; but it is doubtful if she was dun, for none of her nine foals was recorded as such.

The following table shows in detail the results of the matings with the dun family above referred to, and also with the *Gower Dun Barb*.

TABLE OF ENTRIES CONCERNING DUN IN THE FIRST VOLUME OF THE
THOROUGHbred STUD-BOOK.¹

FIRST GENERATION.

Sire or Dam.	Colour.	Dam or Sire.	Colour.	Progeny.	Colour.	Date of birth.	Page.
Silverlocks,	ch. [?]	Godolphin Arabian	bay	filly (B.i)	dun	1738	183
do.	.	do.	.	filly (B.ii)	[dun]	1739	183
do.	.	Middleton Saucebox	?	colt, Silvertail	dun	1740	183
do.	.	Godolphin Arabian	bay	colt, Buff-coat (B.iii)	dun	1742	183
do.	.	Whitefoot	?	filly	?	?	183

SECOND GENERATION.

(B.i) mare,	dun	Devonsh. Blacklegs	?	colt, John Trot	?	?	93
do.	.	Crab	gr.	colt, Brilliant (C.iii)	dun	1750	93
do.	.	Oroonoko	blk.	colt	?	1753	93
do.	.	do.	.	filly	?	?	93
(B.ii) mare,	[dun]	Snip	br.	filly	?	1748	93
do.	.	Shock	bay	colt, Ginger	dun	1750	93
do.	.	do.	.	colt, Easby Miller	dun	1751	93
do.	.	do.	.	colt, Silvertail	dun	1753	93
do.	.	do.	.	colt	ch. [?]	1754	93
do.	.	Slouch	ch.	colt, Well-done.	dun	1756	93
do.	.	Shakspeare	ch.	filly	dun	?	93
do.	.	Young Snip	gr.	filly (C.i)	dun	1760	93
do.	.	do.	.	filly	bay	1762	93
do.	.	Young Cade	bay	filly, Isabella (C.ii)	dun	1765	93
(B.iii) Buff-coat,	dun	Somerset Arabian	gr.	colt	gr.	1753	30
do.	.	mare
do.	.	Cartouch mare	?	colt, Creampot	dun	1755	56
do.	.	Cloudy	ch.	colt, Turf	ch. [?]	1755	61
do.	.	Jigg mare	?	colt, Whitefoot	dun	1749	106
do.	.	do.	.	colt	dun	1751	106

THIRD GENERATION.

(C.i) Young Snip	dun	Syphon	ch.	colt	dun	1771	194
mare	.	Nabob	?	colt	dun	1773	194
	.	Sulphur	?	filly	dun	1775	194
	.	Count	br.	colt	?	1779	194
(C.ii) Isabella,	dun	Squirrel	bay	colt, Pierrot	dun	1771	104
	.	Herod	bay	colt, Rebel	bay	1773	104
	.	Squirrel	bay	filly	?	1774	104
	.	Herod	bay	colt	bay	1775	104
	.	do.	.	colt, Golden Dun	dun	1777	104
	.	do.	.	filly	bay	1778	104
	.	do.	.	colt	dun	1779	104
	.	do.	.	colt	?	1780	104
	.	Rutland Arabian	?	colt	bay	1787	104
	.	Wisbech	?	colt	bay	1788	104

¹ The fifth edition (1891) has been used.

THIRD GENERATION—continued.

Sire or Dam.	Colour.	Dam or Sire.	Colour.	Progeny.	Colour.	Date of birth.	Page.
(C.iii) Brilliant,	dun	Lord Oxford's grey	gr.	filly	dun	1771	23
		Babraham mare	gr.	filly, Lily of the Valley	bay	1771	26
		Babraham mare	gr.	filly	?	1763	23
		Blank Mixbury	?	filly	?	1766	39
		do.	?	colt, Spindle	dun	1767	39
		Crab mare	?	filly	[gr.]	1758	43
		Cade mare	bay	colt, Petulant	dun	1767	48
		Cade mare	?	colt	?	1771	48
		Cade mare	gr.	colt	?	1769	50
		Cara	?	colt, Opinion	ch.	1771	54
		Cassandra	bay	filly	dun	1763	56
		Changeling mare	bay	colt, Nabob	blk.	1762	57
		Young Country Wench	?	colt, Amethyst	ch.	1766	65
		Crab mare	gr.	filly	gr.	1758	66
		do.		colt	bay	1766	66
		do.		colt	br.	1767	66
		do.		colt, Gewgaw	bl.	1770	66
		Lady Anne	bay	filly, Virgin	dun	1760	110
		Lath Mare	?	colt, Richmond	bay	1763	114
		Atalanta	bay	filly, Sultana	?	1764	117
		Lovely	ch.	colt, Sparkler	ch.	1770	119
		Miss Modesty	?	colt	?	1776	135
		Miss Vernon	bay	colt	bay	1769	139
		Modesty	ch.	colt, Bellino	bay[?]	1766	142
		Panton Arabian mare	gr.	filly	dun	1771	150
		do.	gr.	colt	gr.	1772	150
		Peggy	bay	colt, Spangle	dun	1769	155
		Pussy	bay	colt	dun	1771	161
		Rachel	?	colt, Dunny	dun	1771	162
		Regulus mare	?	filly	bay	1768	165
		do.		filly	?	1769	165
		Regulus Tartar	roan	colt, Don Dun	bay	1769	171
		Sally	?	colt	?	1770	176
		Shepherd's Crab mare	?	filly	bay	1761	181
		do.		filly	bay	1765	181
		do.		colt	dun	1766	181
		do.		filly (D.i)	dun	1767	181
		do.		colt, Gem	dun	1768	181
		do.		filly	bay	1770	181
		Shepherd's Crab mare	bay	filly, Brillianté	ch.	1766	182
		Wasp	gr.	filly, Catherina	bay	1768	219
		Miss Slammerkim ¹	gr.	colt, Ballario	bay	1763	222
		do.		filly	bay	1764	222
		do.		filly	bay	1765	222
		do.		filly, Laïs	bay	1766	222
		do.		colt, Paris	bay	1767	222
		do.		colt, Dorilas	dun	1768	222
		do.		colt	dun	1770	222
		do.		colt, Ethon	ch.	1771	222
		do.		filly, Loretta	dun	1774	222
		Golden Grove	ch.	colt	dun	1771	274

¹ This mare breeds like a bay.

FOURTH GENERATION.

Sire or Dam.	Colour.	Dam or Sire.	Colour.	Progeny.	Colour.	Date of birth.	Page.
(D.1) Brilliant mare	dun	Eclipse	ch.	filly	?	1772	43
		Vernon Arabian	ch.	colt, Custard	dun	1774	43
		Florizel	bay	colt, Crookshanks	bay	1777	43
		do.		filly	bay	1783	43
		do.		colt	bay	1784	43
		Highflier	bay	colt	dun	1786	43

THE GOWER DUN BARB'S STOCK.

The Gower Dun Barb	dun	Babraham mare ¹	bay	filly, Honeycomb	dun	1760	25
		Cadette	br.	filly	bay	1757	53
		Crab mare	[gr. ?]	filly	br.	1759	68
		do.		colt	bay	1760	68
		do.		colt	dun	1763	68
		Fly	ch.	filly	bay	1758	87
		Godolphin Arabian mare	[bay ?]	filly	bay	1762	92
		Louisa	bay	colt	dun	1757	119
		do.		colt	dun	1758	119
		do.		colt	bay	1759	119
		Partner mare	bay	filly	bay	1761	151
		do.		colt	dun	1762	151

The colours attached to each animal in the above table are those given in the stud-book; but where no colour is given and the colour can be inferred, or where that in the stud-book can be shown to be wrong, the inferred or corrected colour is attached in brackets. Omissions and errors occur in all stud-books; but some corrections can be made by reason of the work already done upon the inheritance of coat-colour in horses.² Few corrections are necessary in the Thorough-bred Stud-book, even in the earliest volumes. Judging by the greys, the errors in the first volume are not more than four

¹ This mare is stated to have had also, in 1759, a dun colt, *Doubtful*, either by Blank, a bay, or the Gower Dun Barb.

² In this connexion, and in addition to Mr. C. C. Hurst's work and to a paper in the second number of *The Mendel Journal* by Mr. Robert Bunsow, the writer of this paper wishes to draw attention to two most valuable papers published in *Landwirtschaftliche Jahrbücher*, vol. xvii, 1888. They are on the colours of the horses of the royal Trakehnen studs in Germany, by Dr. M. Wilckens and Dr. Crampe. The writer saw these articles casually ten or twelve years ago, and, although he has searched for them again and again during the last three years, could not find them, through not remembering where they were published. A few weeks ago his attention was drawn by Mr. Condon, the Librarian of the Royal College of Science, to some "papers on the colour of horses" in an odd back volume of the *Jahrbücher* in the college library. These were the two papers so anxiously sought after. Had these papers been available during the last few years, an enormous amount of very hard labour would have been saved, for from them the relative positions of chestnut, black,

per cent.; for we know grey to be dominant to the other colours (roan, perhaps, excepted), and that, therefore, every grey foal must have at least one parent grey; yet, among 248 grey foals noted in that volume, only nine are entered as having neither parent grey.

Inferences can be made with greatest confidence concerning greys. If a dam whose colour is not given have a grey foal to a horse of another colour, she is presumably grey; if she have several such, she is grey without doubt. As the colour descends towards chestnut, confidence also descends, and greater care must be exercised in drawing conclusions; but help can be got frequently from the colours of parents and progeny, and from those of other near relatives, even though the colours be well down the scale. For example, the colour of the third parent (B 2) in the preceding table is not given in the stud-book; but the fact that six of her foals by five different sires were dun is very strong evidence that she herself was dun; and this inference is confirmed, if that were necessary, by the further fact that one of her sisters and both her brothers, all well-known animals, were of that colour.

From the foregoing tables the position of dun can be worked out by more than one method. We could employ the statistical method, and, by adding up the total results of the matings of dun with other colours, find out which colours it did and which colours it did not include. But, since the total numbers are so small, it will be better, in the first instance, to find the position of dun by considering the gametic composition of some of the best-known animals.

The mother of this dun family, Silverlocks, was described as a chestnut. Let us assume her colour to have been correctly described. She had three dun foals to the Godolphin Arabian, who was a homozygous bay.¹ His foals out of Silverlocks must, therefore, have got their dun colour from their dam, in whom it must have been hidden by chestnut; and, since each of this homozygous bay sire's three dun foals must have carried a bay

bay and brown (these two are not separated), and grey could have been made out easily and clearly. Three of Dr. Crampe's conclusions as to what happens when both parents are of the same colour, which are underlined in his summing-up, might be quoted:—

- i. Chestnuts have chestnut foals exclusively, among which are chestnut-rons and chestnut-greys (darunter stichelhaarige Füchse und Fuchsschimmel).
- ii. Blacks have both black and chestnut foals, and also rons and greys of these colours.
- iii. Browns (that is browns and bays) have foals of all colours.

Crampe points out that the stud-books show exceptions to rule among chestnuts and blacks, but that those exceptions, for the most part, are the result of erroneous entries: "der bei weitem grösste Theil dieser Fälle auf irrthümlichen Eintragungen beruht." Crampe did not discover the position of rons and greys, or he would have seen why they are registered as occasionally occurring from other colours. Rons and greys among browns caused him to say browns have foals of all colours.

¹ The colours of at least fifty-six of his foals are known, and there was not a chestnut among them. From chestnut mares he had thirteen bays, one black, and one brown; from bay mares, sixteen bays and one brown; from grey mares, seven greys and three bays; and from mares of unknown colour, one grey, one brown, and twelve bays. The browns and blacks are just such a proportion as might be expected in view of the uncertainties in descriptions of bay, brown, and black.

gamete, bay must be recessive to dun. Accordingly, bay, being recessive to dun, must also be recessive to chestnut, which, as we know, is absurd. Our assumption with regard to Silverlocks needs revision therefore; and we can only suggest either that she was dun or some colour containing dun, or that she was not the dam of the Godolphin Arabian's three dun foals.

But there is no need to adopt this kind of argument, for the homozygous bay Godolphin Arabian's three dun foals are sufficient proof that dun is dominant to bay. Each of them must have carried a bay gamete from their sire, which was hidden by dun, and, therefore, recessive to it.

The relative positions of dun and chestnut can also be made out from the table. But there is really no need to do this; for, since chestnut is recessive to bay, and bay to dun, therefore chestnut is *a fortiori* recessive to dun. The table may be used in confirmation. Brilliant (C 3), the best-known dun of this Thoroughbred dun family, was the son of Silverlocks' eldest dun daughter and Crab, a very famous sire. Brilliant had a number of chestnut foals, and this colour must have been included in his gametic composition, and is, therefore, recessive to dun. His dam, as we have just seen, was a heterozygous dun, with bay recessive, while his sire was a heterozygous grey, with chestnut recessive.¹ In him a dun gamete from his dam must have united with a chestnut gamete from his sire; for, had a dun gamete united with a grey, Brilliant would have had a number of grey foals, but no chestnuts.

The position of dun relatively to brown and black cannot be made out from the table, because the colour of only one foal from a brown and dun mating is given, and only two black foals appear in the table. Besides, there is uncertainty as to whether brown and black were accurately distinguished from each other. Black, however, may be taken as recessive to dun, since it was found to be recessive to bay in the previous paper.

Nor can the relative positions of dun and grey be made out by an examination of the gametic composition of the animals concerned; for, although the duns in the table have grey foals only when mated with greys, the grey gametes of the foals may all be associated, although this is unlikely, with recessive bay and chestnut gametes from their dun parents. In any case, the numbers are few.

For evidence on this point we must go to the Polo and Riding Pony Stud-book, in which we find the statistical argument suggested in the last paragraph completely confirmed; for, here again, and now over a considerable number of cases, dun does not produce grey unless it be mated with that colour. There are now eleven volumes of this stud-book published, in which 50 matings of dun with other colours than grey are recorded, and in no case

¹ This has been found by working through Crab's progeny in the first volume of the stud-book.

has a grey foal resulted; while, from 35 matings of dun with grey, 10 grey foals are recorded. These 35 foals were 1 chestnut, 3 black, 5 bay, 1 brown, 15 dun, and 10 grey. A very striking case might be quoted from Clare Island, off the west coast of Mayo. A dun pony sire stationed there for a year left about 50 foals, and, according to Mr. Garvey, the Department of Agriculture's officer now on the island, "there were no grey ones, except one from a grey mare." The statistical evidence can be confirmed directly by a few individual cases. A black stallion, The Monk, and a grey polo pony mare, Sibyl, had a dun foal, Hermit¹; Old Highland Laddie, grey, and a grey pony mare had a dun foal²; Shooting Star, a grey pony sire, and Bleddfa Periwinkle, a dark bay mare, had a dun roan foal³; The Chief, a black Clydesdale, and Grey Tess, a Clydesdale mare, had a dun foal, Nell of Haplands⁴; and there is the case quoted in the previous paper from Professor Cossar Ewart: "in one specimen of this variety⁵ met with in Perthshire (a 14-hands grey mare which produced a dun colt to a grey garron) the profile is straight . . ."⁶ There are two cases quoted by Dr. Crampe in the paper referred to in the foot-note on p. 193. A grey horse, Sterling II, sires two dun foals, one from a black mare, Nacht, the other from a brown mare, Galante.⁷

There now remain only the relative positions of dun and brown. In the Thoroughbred, Polo, and Clydesdale stud-books only 23 matings of brown with dun have been found where the colours of the foals are given: but in no case can the gametic composition of the parents be worked out. The colours of these 23 foals are 1 black, 3 bay, 10 brown, and 9 dun; but these, although suggestive, do not admit a clear inference. Evidence on the point has been sought in the west of Ireland, where there is still a very considerable number of dun ponies. Mr. Michael Scully, one of the Department of Agriculture's officials in County Mayo, reports on some dun stock in that county, and mentions two dun mares which have had brown foals to black sires. One of these mares had three foals dun and one brown, and the other mare had one foal dark brown and the other black to black sires.⁸

But the fullest evidence comes from Clare Island. Indeed, it is sufficient to place dun in position with regard to every colour.

This island is one which received special attention from the Congested

¹ Polo and Riding Pony Stud-Book, vol. v, p. 56, Polo Pony Section.

² *Ibid.*, vol. viii, p. 158, Fell Section.

³ *Ibid.*, vol. ix, p. 91, Welsh Section.

⁴ Clydesdale Stud-Book, vol. x, p. 413.

⁵ The long-headed variety.

⁶ Highland Society's Transactions, 1904, p. 267.

⁷ *Landwirtschaftliche Jahrbücher*, vol. xvii, p. 858. Sterling left also two fawns, no doubt shades of dun. Sterling's other progeny mentioned by Crampe were greys.

⁸ Crampe mentions two duns, viz. Culblanc I and Pandora, which had a brown daughter, Antigone. See *Landwirtschaftliche Jahrbücher*, xvii, p. 854.

Districts Board. Pony stallions were sent out by the Board for service on the island from 1895 to 1903; and the practice has been continued by the Department of Agriculture down to the present time. The sires in service since 1895 are as follows:—

1895,	.	.	Movement,	.	Welsh,	.	dark chestnut.
1896,	.	.	do.				
1897,	.	.	do.				
1898 (a part)	.	.	do.				
1898 (a part)	.	.	Bay Prince,	.	Hackney,	.	bay.
1899,	.	.	do.				
1901,	.	.	Oscar,	.	Norse,	.	dun.
1902,	.	.	do.				
1903,	.	.	do.				
1904,	.	.	Norseman,	.	Norse,	.	dun.
1905,	.	.	do.				
1906,	.	.	do.				
1907,	.	.	Express IV.,	.	Welsh,	.	black.
1908,	.	.	Conn,	.	Connemara	.	dun.
1909,	.	.	Movement,	.	Welsh	.	dark chestnut.
1910,	.	.	do.				
1911,	.	.	do.				

At the time the first dun sire was introduced, the mares on the island were chiefly browns and bays, with a very few duns and greys.¹ The annual birth-rate is from forty to sixty foals, the most of which are exported to the mainland in the year of their birth. Accurate figures therefore cannot now be got; but Mr. Garvey, the present agricultural instructor on the island, has made close and careful inquiry; and one or two quotations from his letters will make the question perfectly clear. Information has also been received from Mr. M'Cabe, of the Granuaile Hotel, Clare Island.

"There were three dun stallions brought in by the Department. All the foals of the first two were dun, and the foals of the third were of different colours." (28th October, 1911.)

"There were three-fourths² of the last [dun] stallion's foals dun. The other colours were brown and bright red.³ There were no greys, except one from a grey mare." (19th November, 1911.)

"I have been told by a good many of the islanders, especially the man that kept the stallions, that all the foals got by Norseman and Oscar were dun except one that was rather white." (8th December, 1911.)

Mr. Garvey's earlier statements were seen to be so important that he was

¹ Information supplied by Mr. Garvey and Mr. M'Cabe, of the Granuaile Hotel, Clare Island.

² This, of course, is only an estimate.

³ A reddish bay found frequently among Western ponies.

questioned again and again to see whether his statement that "all the foals of the first two were dun" could be shaken. Additional information, the result of closer and closer inquiry, comes out in every succeeding letter; but the first two sires' foals are always dun. Such cases as "the one that was rather white" are met with occasionally. The foal is a kind of creamy white, which darkens into a dun. Mr. Garvey mentions two such foals by the chestnut sire "Movement," out of dun mares.

Another quotation from Mr. Garvey will show the thoroughness of his inquiries, and at the same time bring out a very interesting point. The Welsh pony "Movement" has been stationed twice on the island—the second time after a lapse of eleven years. Consequently he must have been mated again and again with his own descendants. He has a very peculiar irregular grey splash on the rump and loins. This splash was not noticed in his progeny of 1896 to 1899; but it is noticed in his recent progeny, and Mr. Garvey observes that it does not occur where the foal is dun.¹ "In the majority of cases, black, bay, and red mares served by this horse have produced foals of the same colour as the sire with the white stripe; but it has not occurred on any occasion that the dun foals have the white stripe on their backs." Apparently the splash on the rump is recessive; but it did not get a chance to come to the surface till "Movement's" second visit.

On Clare Island, therefore, there have been two homozygous dun stallions; and their progeny, which must have mounted to about 300, show that their colour is dominant, not only to brown, but to all other colours on the island, excepting grey.

In searching for evidence concerning dun, three other colours have been occasionally met with—namely, piebald and skewbald, fawn, and cream. About thirty of the first kind were seen; and where the parentage was recorded there was no progeny without either a piebald or skewbald parent. Only a few fawns were noticed; but notes were kept concerning about thirty cases of creams. Unfortunately, however, they allow no clear inference to be drawn. Creams are usually found where duns are found; and individuals are described as "cream or dun," "dun cream," "cream dun," and so on. From this, cream might be expected to be a variety of dun, and, when black "points" are present, it probably is so. But occasionally such descriptions as "chestnut cream" and "cream chestnut" are also found. If these are misdescriptions, they have no weight; but if not, there may also be a cream which is a variety of chestnut. Two entries in the Polo Pony stud-book—

¹ The dun foals' dams must have been dun and therefore not "Movement's" daughters.

² Oscar, the Norse sire sent to Clare Island, is recorded as a "dun or cream, with white or cream mane and tail, and black stripe down back," in the books of the Congested Districts Board, although he is clearly a dun to most who have seen him.

namely, Nutmeg,¹ cream, by Woodman, chestnut, out of Meg, cream; and Maev,² cream, by a chestnut horse, out of Baby, dun—place cream somewhere between dun and chestnut; but the remaining data carry us no farther; and there the question must remain for the present.

In the foregoing arguments concerning dun, the gametic composition of well-known animals has been chiefly relied upon. The argument from statistics could also have been used; but these are small. The following is an abstract of them, the Clare Island data not included. Cases the least doubtful are treated as entirely so. For instance, the foals of the filly by Young Cade out of Miss Thigh, which was registered as grey, but bred like a bay, are put in the column for cases in which the colour of one parent is unknown.

ABSTRACT OF DUN MATINGS.

COLOURS OF PARENTS.		COLOURS OF FOALS.						
	—	ch.	bl.	by.	br.	du.	gr.	rn.
Dun × Chestnut,	Thoroughbreds,	1	—	5	—	6	—	—
	Clydesdales,	—	—	1	—	—	—	—
	Ponies,	—	—	1	—	3	—	—
	Non-registered,	—	—	—	—	—	—	—
Dun × Black,	Thoroughbreds,	—	—	—	—	—	—	—
	Clydesdales,	—	—	—	—	—	—	—
	Ponies,	—	5	1	—	2	—	—
	Non-registered,	—	1	—	2	5	—	—
Dun × Bay,	Thoroughbreds,	1	1	6	—	16	—	—
	Clydesdales,	1	—	8	2	2	—	—
	Ponies,	—	—	4	—	7	—	1
	Non-registered,	—	1	—	—	5	—	—
Dun × Brown,	Thoroughbreds,	—	—	1	—	—	—	—
	Clydesdales,	—	—	2	5	3	—	—
	Ponies,	—	1	2	3	6	—	—
	Non-registered,	—	—	—	—	—	—	—
Dun × Dun,	Thoroughbreds,	—	—	—	—	—	—	—
	Clydesdales,	—	—	—	—	—	—	—
	Ponies,	—	—	—	—	6	—	—
	Non-registered,	—	—	—	—	2	—	—
Dun × Grey,	Thoroughbreds,	—	1	4	1	4	3	—
	Clydesdales,	—	—	—	2	—	—	—
	Ponies,	1	2	1	—	9	7	—
	Non-registered,	—	—	2	—	8	2	—
Dun × Roan,	Thoroughbreds,	—	—	1	—	—	—	—
	Clydesdales,	—	—	—	—	—	—	—
	Ponies,	—	—	—	—	—	—	—
	Non-registered,	—	—	—	—	—	—	1
Dun × unknown,	Thoroughbreds,	3	—	14	1	15	1	—
	Clydesdales,	—	—	—	2	1	—	—
	Ponies,	3	—	1	1	8	1	—
	Non-registered,	—	—	1	—	4	—	—

¹ Vol. i, p. 90.

² Vol. vi, p. 121.

But it must not be assumed that no cases were found while data concerning dun were being collected which would suggest the dislodgment of dun from the position in which we have placed it. A few such cases were found; but only three in the stud-books—viz., two Clydesdales and one pony, which indicate an error of only 1·5 per cent. The others are Darwin's three cases and three cited by Mr. J. B. Robertson. These make nine cases in all, and it may be suggested fairly that in all probability they are misdescriptions either of colour or paternity. Darwin's second and third cases ought not perhaps to be quoted, as each may have had a grey parent. The following are the nine cases :—

Progeny.	Sire.	Dam.	Authority.
Dun filly Dolly, foaled 1893	Bay Dartmoor pony, Chagford	Black Dartmoor mare, Black Bess	Polo Pony Stud-Book, vol. v, p. 65
Dun filly, foaled 1878	Brown Clydesdale, Jack's the Laird	Bay Clydesdale, Polly	Clydesdale Stud-Book, vol. iv, p. 51
Dun filly, Kate, foaled 1887	Bay Clydesdale, The Professor	Brown Clydesdale, Love	do., vol. xiii, p. 505
Fallow dun foal	Bay horse	Black mare	Darwin's "Animals and Plants under Domestication," vol. i, p. 59
Mouse-dun foal	Not dun	Not dun	do. (from Hofacker)
Mouse-dun foal	Not dun	Not dun	do., do.
Dark iron-grey foal ¹	Brown Hackney, Handy Andy	Yellow dun Welsh cob	Mr. J. B. Robertson in The Veterinary Record, October 16, 1910
Light grey foal ¹	do.	do.	do.
Bay dun hackney filly, foaled 1898	Brown Hackney, General Gordon	Light yellow bay Hackney mare, with black dorsal band, Fanny Gordon	Mr. J. B. Robertson in Nature, Dec. 1, 1910

To the foregoing cases ought to be added another eight cases cited from the Thoroughbred Stud-Book, first by Mr. J. B. Robertson in "The Veterinary Record" for October 15th, 1910, and afterwards in "Nature" of November 24th, 1910, by Professor Cossar Ewart, as "reversions to dun," and, therefore, exceptions to our placing. Six of these "reversions" are by no means free of the charge of misdescription, and the other two do not interfere with our scheme. To show this we give the cases as described by Mr. Robertson and Professor Ewart, and add in a parallel column such

¹ These two cases, if correct, would place dun dominant to all other colours (roan perhaps excepted), and so demolish its last chance of ever becoming a reversion.

remarks as are necessary to indicate how doubtful are the grounds on which they may be taken as "reversions to dun."

Progeny.	Sire.	Dam.	Remarks.
Dun colt, foaled 1730.	King George II's one-eyed grey, Arabian.	Young Kitty Burdett, bay.	The sire here is grey, and our placing of dun is not interfered with.
Dun filly, foaled 1763.	Young Cade, bay.	Miss Thigh, grey.	The dam here is grey, and the case is referred to in the text.
Dun filly, foaled 1829.	Lottery, brown.	Octavia, bay.	This foal died when two days old. See vol. v, p. 90.
Dun or chestnut filly, Sancta, foaled 1884.	Exminster, bay.	Hallowe'en, chestnut.	The description indicates doubt. This filly had several foals, none of which is entered as dun. See vols. xv, p. 183, and xvi, p. 198.
Light dun filly, foaled 1886.	Lord Gough, bay.	Danseuse, brown.	This filly is entered as bay when a foal in vol. xvi, p. 577, and light dun in vol. xx, p. 499. She had eight or nine foals, but none is entered as dun.
Dun filly, Sarah Curran, foaled 1892.	Robert Emmet, bay or brown.	Cellulites, black.	In vol. xvii, p. 692, Cellulites' foal of 1892 is entered thus: "1892 . . . f. (dead) by Robert Emmet." In vol. xviii, p. 727, her foal of 1892 is entered thus: "1892, dun f. Sarah Curran, by Robert Emmet," and there is a foot-note:—"This mare erroneously appeared in last vol. as dead."
Dun colt, foaled 1897.	Sir Frederick, bay.	Lobelia, bay or brown.	In vol. xix, p. 368, this foal is entered "b. or dun c."
Bay-dun filly, foaled 1907.	Ash, chestnut.	Unexpected, bay.	In vol. xxi, p. 839, this filly is entered as a foal, "b. or dun f."

SCIENTIFIC PROCEEDINGS.

VOLUME XIII.

1. A Seed-Bearing Irish Pteridosperm, *Crossotheca Höninghausi*, Kidston (*Lyginodendron oldhamium*, Williamson). By T. JOHNSON, D.SC., F.L.S. (Plates I.-III.) (March, 1911.) 1s.
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