and the official Bureau des Longitudes took the expedition under its motherly wing and has now published the volume of which the title is above cited.

This expedition was scientific in its aims and pole hunting formed no part of its program. The staff comprised five members beside the leader, with a crew of fourteen; all provinces of France were represented.

The plan of the leader was, in brief, to take up the work inaugurated by the *Belgica* expedition and extend it by explorations of the southwest part of Graham Land, investigating in all branches of science as well as geography, so far as their personnel and equipment would permit.

This program was carried out in its main features. The present volume includes an introduction in which a brief résumé of previous researches in the same region is given, after which the hydrography, tides, chronometric record, pendulum observations and the density and salinity of the seawater, are discussed by Lieutenant Matha, atmospheric electricity, meteorology and terrestrial magnetism by Lieutenant Rey. The work is carefully printed and the charts are of the quality one expects from the bureau which issues the volume.

Wm. H. Dall

SPECIAL ARTICLES

A CASE OF SEX-LINKED INHERITANCE IN THE DOMESTIC PIGEON[1]

In breeding work with tumbler pigeons begun at the Rhode Island Agricultural Experiment Station some years ago a careful study was made of the manner of inheritance of certain of the commoner colors of these birds, especially black, dun, red, yellow, blue and silver. This work was referred to in the Twenty-first Annual Report of the Station, 1908, p. 301, and a full report of the results, it is expected, will be published during the present year. These experiments made clear the fact that dun, yellow and silver are dilute conditions of black, red and blue, respectively. Indeed, this might have been surmised from their appearance, but the fact was substantiated by their behavior in the breeding tests. As has been found in other animals, notably in rabbits and mice, the dilute condition depends upon a single factor, or more strictly the absence of a factor, which produces the effect upon whatever color it chances to be associated with. In other words, "intense" is dominant to "dilute," that is, if the factor for the intense condition is present, the color of the bird takes that appearance. This relationship, in the case of blue and silver, has been pointed out by Bonhote and Smalley (p. 603).[2]

Although the earlier experiments showed the general relationships of these characters, it was only by the results of certain experiments of the past year that the interesting relationship of the intense and dilute condition to sex has come to light. No secondary sex characters (in the ordinary sense) exist in pigeons, and as a consequence there is no way of determining the sex of the birds until they are old enough to reveal it by their behavior. In the case of certain crosses made last year, in which the male parent was a dilute (yellow or dun) and the female a black baldhead,[3] both black and dun offspring were produced, and it became evident this spring that all the blacks were males, while all the duns were females. The following examples will serve to illustrate.

Case I.

Parents:	♂ 540 B, dun
	♀ 647 A, black baldhead.
Offspring:	790 A, black, ♂
	790 B, black, ♂
	847 A, dun, ♀
	893 A, black, ♂
	893 B, dun, ♀
	954 A, dun, ♀

[1] Contributions from the Laboratory of Experimental Breeding, Wisconsin Agricultural Experiment Station, No. 1.

[2] Bonhote and Smalley, "On Color and Color-pattern Inheritance in Pigeons," *Proc. Zool. Soc.*, London, 1911, pp. 601–619, Pls. XXIII.–XXVI.

[3] In this discussion pattern is disregarded, since it is due to independent factors with which we are not at present concerned.

Case II.

Parents: ♂ 473 A, yellow
♀ 650 A, black baldhead

Offspring: 799 A, dun, ♀
799 B, dun, ♀
841 A, black, ♂
890 A, dun, ♀
890 B, dun, ♀
938 B, dun, ♀
980 A, dun, ♀

A search of the records for other cases furnishes abundant evidence to indicate that the phenomenon is general, and under certain conditions holds for the intense and dilute factors, whatever the color concerned. The requisite conditions appeared to be the mating of a dilute male to a female showing the intense condition. Further investigation showed that this is a typical case of sex-linked inheritance in that in stock bred pure for the character in question one sex is always heterozygous. In this case it is the female which is heterozygous, the character involved being the intense condition of pigmentation. In respect to the sex concerned this character corresponds to barring in the fowl and to color in *Abraxas,* and differs from color blindness in man and the numerous sex-linked characters which Morgan has found in *Drosophila.* These results have furnished a satisfactory explanation of certain formerly disquieting records in which birds bred "pure" and supposedly homozygous for the intense condition have produced some dilute offspring when bred with heterozygous or with dilute mates. It is now found that in all such cases noted the birds in question were females and, furthermore, that all the dilute offspring, so far as at present observed, were likewise females. A thorough analysis of the subject is now being made and the detailed results will be published in the near future.

The results mentioned above may be satisfactorily represented by either of the accepted modes of symbolism which have been employed in similar cases. Without committing ourselves to any theory, we may here follow the usage of Spillman and of Pearl in explaining the inheritance of barring in poultry. In these formulæ *F* represents femaleness, and the female is always heterozygous (*Ff*) with respect to this factor. Males, on the other hand, are assumed to lack this factor entirely, and are accordingly homozygous *ff*. We may then let *B* represent the factor for black, in the absence of which (*b*) the bird is red. These colors are modified, however, by the presence or absence of *I,* the factor for the intense condition. In the absence of *I* (represented by *i*) black becomes dun, and red becomes yellow. It is now necessary to make only the further assumption that *F* and *I* can not occur together in the same gamete. The cases given may then be represented as follows:

Case I.

Parents: dun ♂ = *fBi.fBi*
black ♀ = *fBI.FBi*
Gametes: ♂, all *fBi*
♀, *fBI* and *FBi*
Combinations: *fBi.fBI* = black ♂♂
fBi.FBi = dun ♀♀

Case II.

Parents: yellow ♂ = *fbi.fbi*
black ♀ = *fBI.FBi*
Gametes: ♂, all *fbi*
♀, *fBI* and *FBi*
Combinations: *fbi.fBI* = black ♂♂
fbi.FBi = dun ♀♀

It will be seen that these expectations accord with the results obtained.

It has been mentioned that this explanation accounted also for certain unexpected results from birds which were at the time supposedly homozygous. A single example will suffice.

Parents: ♂ 681 B, black
♀ 701 A, red

Offspring: 846 B, yellow, ♀
892 A, red, ♂
892 B, dun, ♀
944 A, black, ♂
944 B, black ♂

It was known from his ancestry that 681 B was heterozygous, both with respect to *B* and *I.* But had 701 A been homozygous for *I,* as supposed, all the offspring should have shown the intense condition of pigmentation, namely,

black and red. The unexpected appearance of the dun and yellow birds is satisfactorily accounted for on the assumption that she was heterozygous, as follows:

Parents: black ♂ = *fBI·fbi*
red ♀ = *fbI·Fbi*
Gametes: ♂, *fBI*, *fBi*, *fbI* and *fbi*
♀, *fbI* and *Fbi*
Combinations: *fBI·fbI* = black ♂
fBI·Fbi = black ♀
fBi·fbI = black ♂
fBi·Fbi = dun ♀
fbI·fbI = red ♂
fbI·Fbi = red ♀
fbi·fbI = red ♂
fbi·Fbi = yellow ♀

That is, 2 black males: 1 black female: 2 red males: 1 red female: 1 dun female: 1 yellow female.

While the number of offspring is too small on which to base any conclusion as to proportions, it will be noted that all so far obtained fall in line with the expectations as to color and sex.

The foregoing may provide an explanation of the interesting observations of R. M. Strong on the sex of ring-doves,[4] and those of Bonhote and Smalley (*loc. cit.*, p. 617, footnote), as well as possibly those of Whitman reported by Riddle.[5]

[P. S., July 22, 1912. Since the foregoing note went to press there has appeared in the June, 1912, number of the *Journal of Genetics* (Vol. 2, No. 2, p. 131) a paper by Mr. R. Staples-Browne, in which the relation of blue and silver to sex is amply demonstrated.]

LEON J. COLE

THE INTERTUBERCULAR OR BICIPITAL FORAMEN OF THE HUMERUS OF THE GUINEA-PIG

THE upper extremity of the humerus of the guinea-pig often has an unusual, probably an unique, structure. A broad and thick bridge connects the large and small tubercles and converts the intertubercular sulcus into a foramen through which passes the tendon of origin of the *m. biceps*. At the last meeting of the Association of Anatomists, I reported that among twenty skeletons studied, four humeri from three individuals, two males and one female, were found which had this peculiar structure. Recently, through the kindness of Professor Castle and Dr. Detlefsen, of the Bussey Institution, I have been allowed to study their large collection of guinea-pig skeletons and was surprised to find the remarkable prevalence of the intertubercular foramen. Out of a total of 125 humeri, 17, 13.6 per cent., have complete foramina. Besides these 23 others, 18.4 per cent., have nearly complete bridges over the intertubercular sulci. In six instances, this bridge is formed by a small supernumerary bone which is wedged in between the great and small tubercles; in the others, by small acute processes which project toward each other from the adjacent sides of the tubercles. One or two similar but smaller processes occur upon 50 humeri, 40 per cent. of the total number, the remaining 35 bones, 28 per cent., having no indication of the foramen.

All of the skeletons used are of adult or subadult animals, but as the growth of the guinea-pig continues long after sexual maturity, possibly throughout life, it is probable that had the animals been older, an even larger proportion of complete foramina would have been present.

In all cases, the foramen has the same character. The upper edge of the bridge is convex, its lower edge concave. The canal-like foramen is narrow above, but rapidly widens below and terminates in an oblique, flaring and funnel-shaped mouth which is surrounded by a rough, slightly elevated, lip.

It seems impossible to correlate the occurrence of the intertubercular foramina with sex, age or muscular development. Foramina do not occur in immature animals, but, on the other hand, they are absent in certain very old animals (three or four years old) and furthermore they are occasionally present upon one side only.

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[4] SCIENCE, N. S., Vol. 33, p. 266, 1911.
[5] SCIENCE, N. S., Vol. 35, p. 462, 1912.