as you term it, to the free expression of our own opinion.

Very respectfully,
(Signed) GEO. OTIS SMITH,
Director

LOS GATOS, CAL., July 17, 1907.

DR. GEO. OTIS SMITH,
Director.
U. S. Geological Survey,
Washington, D. C.

Sir: I am in receipt of your letter of June 11 acknowledging my resignation from the survey, and referring to the protest accompanying it. I had intended to write to you to assure you that nothing in that protest referred to you personally; but, from your last letter, I am sorry to learn that your attitude in the matter is apparently hopelessly opposed to mine.

You mention, somewhat vaguely, "administrative responsibility," "official oaths" and "congressional enactments." Now, in my conception, the supreme responsibility of the scientist is to discover the truth and to tell it, in accordance with the clearest vision vouchsafed him; and this responsibility can not be superseded by the demands of any administrative position nor abrogated by any official oath. As for the "letter and spirit of the congressional enactments," if these should ever happen to come into conflict with scientific truth (which does not seem to me a very probable contingency, so long as congress and the Geological Survey confine themselves to the accepted limits of their respective fields of work), I would venture to suggest that congressional enactments are more easily changed than the facts of the universe, and that it is not necessary, in the interest of the former, to suppress or falsify even an individual conception of the latter.

But you say that in joining the survey the individual surrenders a part of the "inalienable right" of the scientist. Here, apparently, is the crucial point of the whole discussion. If this were generally accepted as a basic principle of the survey, it could not long support the claim of being a scientific organization, for no scientist with the highest conception of his calling would ever voluntarily accept such conditions of service; and the organization would speedily become, what your principle would logically make it, an artificial structure of red tape, reared by "administrative responsibility" (which easily becomes a synonym for autocratic privilege) on the foundation of "congressional enactments," and inspired by nothing higher than the ambition to secure more appropriations. In contrast to this bureaucratic conception, let me quote President Eliot's words with reference to scientific investigators: "They must set their own standards of excellence; for society can not supply men capable of supervising, regulating or stimulating them. . . . The scientific investigator must be a law unto himself. The utmost that governments or universities can do for him is to provide suitable facilities and conditions for his work, and to watch for results."

Since your letter was written in your official capacity, I suppose that you will not object to its being published, together with mine, as a contribution to a discussion of general interest to the scientists of the country.

With sincere regret for the difference of opinion which has developed between us, I am

Very respectfully,
(Signed) W. S. TANGIER SMITH

TYPE OF THE GENUS ASTACUS

TO THE EDITOR OF SCIENCE: Within the last decade, a good deal of controversy has been engaged in anent the type of the crustacean genus *Astacus*. These differences of opinion have arisen owing to authors having disregarded Degeer 1778 ("Mem. Ins.," VII.), who fixed as type *A. fluviatilis* Fabr. (= *Cancer astacus* Linné).

G. W. KIRKALDY

SPECIAL ARTICLES

COLOR VARIETIES OF THE RABBIT AND OF OTHER RODENTS; THEIR ORIGIN AND INHERITANCE[1]

IN the issue of SCIENCE for January 25, 1907, I have shown that the agouti, or wild type of coat of the guinea-pig, results from the simultaneous presence of three factors, which are separately heritable unit characters, namely, black pigment, yellow pigment and a factor causing the two pigments to be disposed in bands. In uniformly colored (or self) varieties of the guinea-pig, at least one of these three factors is wanting. If the lacking factor is supplied by a cross with a variety which possesses it, then reversion is obtained, that is a return to the wild type of coat.

It is the purpose of the present note to

[1] Published by permission of the Carnegie Institution of Washington.

point out that the same general explanation which was given for the color varieties of the guinea-pig is applicable likewise to the rabbit, but with certain interesting differences.

The gray coat of wild rabbits contains (1) black pigment and (2) yellow pigment (3) arranged upon the hair in bands, most conspicuous of which is a subapical band of yellow. The belly and under surface of the tail are white, due to entire absence of pigment from the terminal portions of the hair in those body regions. Whenever in rabbits the fur above is barred, the belly and lower surface of the tail are white. Three separately heritable factors, which conform with Mendel's law of heredity, are involved in the gray coat. These are *B*, black pigment; *Y*, yellow pigment, and *A*, the barring arrangement of the pigments, which includes absence of pigment from the hair-tips of the belly, as already explained.

Color varieties other than gray lack one or more of these factors more or less completely.

Varieties which lack the factor *A* have unbarred hair, in which the black and yellow pigments are intimately mingled together. Several different shades of color are produced by such combinations of the two pigments, in different proportions. In *black* individuals black pigment is in excess, in *sooty yellow* individuals yellow pigment is in excess, in *blue* individuals the black pigment exists in a dilute form, while the yellow apparently remains scanty in amount. But all three varieties alike, namely, black, sooty yellow and blue, have unbarred hairs and lack the white belly and tail found in wild rabbits. What they all in common have lost, as compared with wild rabbits, is the barring factor, *A*.

Rabbits which retain this factor are readily recognized by the white belly and tail. Such of them as have little or no black pigment in their fur are known as *yellow;* such as have black pigment of the dilute sort found in blue individuals are known as *blue-gray,* and such as have abundant black pigment of the ordinary intense sort are known as *gray;* their coat corresponds in every respect with that of wild rabbits.

Accordingly we can recognize among rabbits two parallel series of color varieties, which differ only in this respect, that in one series the factor *A* is present, while in the other series it is absent.

COLOR VARIETIES OF THE RABBIT

Series 1	*Series 2*
Gray, *BYA*	Black, *BY*
Blue-gray, *B* (dilute) *YA*	Blue, *B* (dilute) *Y*
White-bellied yellow, *B* (traces only) *YA*	Sooty yellow, *B* (traces only) *Y*

Any member of series 1 is dominant in heredity over the corresponding member of series 2, as might be expected, since series 2 is derivable from series 1 by loss of a single unit-character, *A*.

Within series 1, gray is dominant over blue-gray as well as over white-bellied yellow, both these conditions being derivable from gray by modification of the black pigment, in one case in quality, in the other case in quantity.

Similar relations exist between the corresponding members of series 2, black being dominant over its derived conditions, blue and sooty yellow.

Knowing the unit-characters borne by each variety (its gametic formula), one can readily predict the result of crosses between the several varieties. Any cross which brings together the three factors, *B*, *Y* and *A*, will give reversion, *i. e.*, a return to the wild type of coat, gray.

Thus, grays are obtained from mating white-bellied yellow or blue-gray with black. White-bellied yellow mated with blue gives sometimes gray, sometimes blue-gray, depending on the quality of the black pigment transmitted (in traces) by the yellow parent.

Similarly, sooty yellow mated with blue-gray may give either gray or blue-gray. But a mating of sooty yellow with homozygous white-bellied yellow produces nothing but the last named sort, since the black pigment transmitted in traces only by both parents is insufficient in amount to produce the gray coat.

The foregoing statements apply, of course, only to crosses between homozygous individuals of the varieties named. In accordance with the general principles of Mendelian inheritance, it is found in these two series that any variety, which contains a dominant character, may be, as regards that character, either homozygous or heterozygous. Thus, heterozygous gray animals might produce any of the forms included in either series; indeed, in our experiments, all the forms except blue were so obtained, and blues were obtained in the following generation from the blue-grays.

Blue-grays, bred *inter se,* may, when heterozygous, be expected to produce also blue, white-bellied yellow and sooty yellow; blacks may give blue, as well as sooty yellow; blues and white-bellied yellows may each give sooty yellow; but sooty yellow is apparently incapable of producing any other variety enumerated in either series; it is recessive with respect to those varieties.

Accordingly, as regards breeding capacity (*i. e.,* gametic formula), we may distinguish six different sorts of gray rabbits, three of black ones, three of blue-gray ones, two each of white-bellied yellow and blue ones, but of sooty yellow one sort only, if we disregard qualitative differences in the traces of black pigment borne by sooty yellow individuals. An enumeration follows of these various sorts of individuals, most of which, as will be seen, have already been identified. In the enumeration, B will be used for black pigment, B' for the same in minute quantities only, Y for yellow pigment and A for the barring factor.

Gray

1. $BYA \cdot BYA$ breeds true. Found in wild rabbits and in the "Belgian hare" used in our experiments.

2. $BYA \cdot BY$ gives also black. This condition is often found in Belgian hares supposed to be pure, but really not pure as regards color characters. Produced in our experiments.

3. $BYA \cdot B$ (dilute) YA should give only gray and blue-gray. Not certainly known.

4. $BYA \cdot B$ (dilute) Y gives, in addition to gray, black, blue-gray and blue. Observed except as regards the production of blue young; observations not very extensive.

5. $BYA \cdot B'YA$ gives, in addition to gray, white-bellied yellow only. Observed.

6. $BYA \cdot B'Y$ gives, in addition to gray, black, white-bellied yellow and sooty yellow. Observed.

Black

1. $BY \cdot BY$ breeds true. Known to exist.

2. $BY \cdot B$ (dilute) Y gives black and blue. Observed.

3. $BY \cdot B'Y$ gives black and sooty yellow. Observed.

Blue-Gray

1. B (dilute) $YA \cdot B$ (dilute) YA should breed true. Not yet obtained.

2. B (dilute) $YA \cdot B$ (dilute) Y gives also blue. Observed.

3. B (dilute) $YA \cdot B'Y$ should give blue-gray, blue, white-bellied yellow and sooty yellow. Not observed.

White-bellied Yellow

1. $B'YA \cdot B'YA$ breeds true. Observed.

2. $B'YA \cdot B'Y$ gives white-bellied yellow and sooty yellow. Observed.

Blue

1. B (dilute) $Y \cdot B$ (dilute) Y should breed true. Not yet certainly known.

2. B (dilute) $Y \cdot B'$ (dilute) Y gives blue and sooty yellow. Observed.

Sooty Yellow

$B'Y \cdot B'Y$ breeds true, so far as tested.

All of the numerous color varieties mentioned have arisen by *loss,* partial or complete, of one or more of the three independent factors which contribute to the production of the gray coat of wild rabbits.

It may be of interest to compare with the case of the rabbit, the evolution of color varieties among guinea-pigs, mice and rats, which, like the rabbit, are rodents more or less completely domesticated.

The agouti (or wild) type of coat of the guinea-pig is produced by the same three factors as the gray coat of rabbits, *viz.,* black pigment (B), yellow pigment (Y), and a barring factor (A). But in guinea-pigs there occurs also a third pigment of a chocolate-brown color, which is usually associated with black pigment, but has in recent years been obtained entirely separate from black pigment in the variety known as "chocolate." For this factor of the pigmented coat we may use the symbol Br, signifying brown. The homozygous color varieties of the guinea-pig may then be designated as follows:

COLOR VARIETIES OF THE GUINEA-PIG

Series 1	*Series 2*
Agouti, *BBrYA*.	Black, *BBrY*,
	Chocolate, *BrY*.
Yellow (black-eyed), *YA* (*BBr* in eyes and skin only), gives agouti in crosses with black.	Yellow (black-eyed), *Y* (*BBr* in eyes and skin only), does not give agouti in crosses with black.
	Yellow (brown-eyed), *Y* (*Br* in eyes and skin only).

As in rabbits, the color varieties fall into two parallel series, in one of which the factor *A* is present, while in the other it is wanting.

The chocolate variety was first obtained, in the experiments under discussion, from animals of other colors. Later, with the kindly assistance of Mr. Bateson, a chocolate male was obtained in England, where the variety has apparently originated recently. It is not mentioned by Cumberland (see bibliography) in his well-known work on the cavy.

The brown-eyed yellow variety I have obtained only recently in the second generation (F_2) from a cross between black-eyed yellow and chocolate. Its existence elsewhere is unknown to me.

We may confidently expect the production by appropriate matings of two varieties which will fall into series 1, opposite the newly obtained varieties of series 2, chocolate and brown-eyed yellow, from which varieties they will differ only by the addition of the factor, *A*.

The coat pigments of mice are similar to those of guinea-pigs, viz., black, brown and yellow. All three are probably present together in the coat of the gray house-mouse, along with a barring factor, *A*. Loss of *A* produces the black variety, precisely as in rabbits and guinea-pigs; loss of *B* produces the cinnamon agouti variety (a combination unknown as yet in guinea-pigs, as already stated); loss of both *B* and *A* produces, as in guinea-pigs, the chocolate variety. The yellow variety, we must believe, results from the suppression in the coat of both black and brown pigment, but this loss-condition, curiously enough, is dominant in crosses over the more inclusive combinations which contain *B* and *Br*.

Davenport (1904) and Cuénot (1905) have recorded observations upon yellow mice which manifestly bore the factor *A*, since they gave reversion in crosses with black and with chocolate individuals; but it is evident that the yellow mice used in my own experiments (Castle, 1906) lacked this factor completely, for neither grays nor cinnamon agoutis were obtained in crosses with black or with chocolate individuals. Further, Cuénot's black-eyed yellow mice were heterozygous, bearing black as a recessive character; my own, likewise heterozygous, so far as tested, bore in most cases chocolate as a recessive character. The yellow mice of Steer (mentioned by Bateson, 1903), which gave chocolate young, were evidently of this same sort. I have examined the eye pigments of one of the chocolate-producing yellow mice and find it to be brown, as in chocolate guinea-pigs, not black, as Cuénot states the eyes of his yellow mice to have been.

From these scattered observations we may infer that the gametic formula of yellow mice is varied; sometimes they lack *B*, sometimes they lack *A*, sometimes they lack both *B* and *A*; sometimes still other modifications seem to be involved which cause absence of pigmentation from the eyes, or eyes and belly both.

The wild rat doubtless has the same three factors involved in the production of its gray coat, as do the other rodents already discussed, those factors being *B*, *Y* and *A*; but the only one of these which has yet been lost so as to produce a self-colored variety is the barring factor, *A*. Loss of this produces the well-known black variety.

For the sake of simplicity, no reference has been made in the foregoing discussion to albino individuals, which may occur in any or all color-varieties. They are individuals which lack some *activating* substance necessary to make pigments visible. They carry color potentialities precisely as pigmented individuals do, as is clearly shown by the results of crosses between albinos and pigmented individuals. Further, they are differentiated, precisely as pigmented individuals are, in respect to the intensities of the pigments transmitted, and even in respect to color-patterns (spotting and the like). All that the albino seems to lack in comparison with a pigmented animal, is an activating substance, and even this may be present in small amounts in the albino, as, for example, in the Himalayan rabbit and in the similar variety of the albino guinea-pig. My albino guinea-pigs of chocolate parentage have brown-pigmented extremities, those of black parentage have black pigmented extremities.

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W. E. CASTLE

ZOOLOGICAL LABORATORY,
HARVARD UNIVERSITY,
August 8, 1907

ASTRONOMICAL NOTES

THE ASTROGRAPHIC CATALOGUE

VOLUMES I. and II. of the Oxford Section of the Astrographic Catalogue, by Herbert Hall Turner, D.Sc., F.R.S., Savilian professor of astronomy, have recently been issued. The Oxford Section extends from Dec. $+24°$ to $+32°$.

The International Congress on Astronomical Photography met in Paris, in April, 1887. Oxford was one of the eighteen observatories which offered to take part in the mapping of the heavens by means of photographs. Two schemes of work were planned, each to cover the entire sky, one with short exposures of 6m, 3m and 20s, the other with exposures of about one hour. Twenty years have elapsed since that time. From Oxford we now have the two volumes above referred to, which are to be followed by six others. The whole bears witness to the ability and energy of the author and his assistants, and will no doubt prove of great value to astronomy. It also illustrates well the magnitude of the original schemes, which appear to have been unwisely large, since these eight volumes will complete only the study of the plates of short exposure. Professor Turner says:

> No attempt has, however, been made to take the long-exposure series at Oxford, as there has never been the least prospect of obtaining funds for publishing the charts, either at Oxford or at the majority of the participating observatories.

Evidently some decades must yet elapse before the completion of the original schemes, even if the need for their completion should remain urgent.

The Oxford plates were made by an instrument of the pattern proposed by the Henry Brothers, of Paris. It has an object-glass of 13 inches aperture, and a focal length of 11¼ feet, so that on the plates 1 mm. equals approximately 1′. The work was undertaken by the late Professor Prichard, but his death, at the advanced age of eighty-five years, took place before much had been accomplished. The catalogue gives the positions of the stars, expressed in rectangular coordinates, and the diameter of the stellar images, from which the magnitudes may be derived. In many cases it would be undesirable to use either of these quantities in the form here given. Tables are given, however, by means of which the rectangular coordinates may be converted into right ascensions and declinations. For the conversion of diameters into magnitudes, the formula is given: magnitude $= a - b\sqrt{d}$, where a and b are constants and d is the diameter of the image. This formula, as Professor Turner points out, introduces large errors for the faint stars. The precision of the positions is much more satisfactory, the