farm of Mr. E. Arnaud, Monett, Mo. Mr. Arnaud maintains a herd of sheep and with them keeps two goats, a male and a female. There is only one female goat on the place, and she brought a kid three weeks after the animal in question was born. The hybrid is a twin to a lamb that is not a hybrid. The maternity of the supposed hybrid is not absolutely certain. Mr. Arnaud found the lambs when they were perhaps an hour old. No other sheep or goats were near, though there were others within the same enclosure. The ewe evidently regarded both the animals as her progeny. The twins are inseparable, one being an ordinary lamb, the other in most respects a goat. The tail is intermediate in length between that of a sheep and a goat, and the ears closely resemble those of a sheep. The coat is apparently that of a goat. The male goat on the farm is of mixed breeding and is white with a few reddish hairs showing on the upper part of the neck. The supposed hybrid has most of the hairs of the body of this reddish color. Mixed with them are much shorter hairs which appear like white wool. They have not yet been submitted to examination to ascertain their real nature.

While the evidence is not absolutely conclusive, there is strong reason for believing this individual to be a hybrid. Mr. Arnaud fully appreciates the importance of the freak, and will preserve it for future study and experiment. The writer would greatly appreciate information concerning other hybrids of this character.

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## *Special Articles*

### The Significance of Latent Characters[1]

Those of you who were present at the last annual meeting of the Botanical Society, at New Orleans, will remember that I presented a paper upon the latent characters of a white bean, showing that the appearance of two new characters in the $F_1$ hybrid offspring of a white bean when crossed with a plain brown or yellow bean, demonstrated the presence of a color-pattern, and of a pigment-changer as 'latent' characters in the white bean, latency meaning simply *invisibility* and not dormancy. On this basis it was predicted that in the second generation five forms would appear according to the well-known tripolyhybrid ratio, 27:9:9:3:16. These forms in the order of the ratio are purple mottled, black (dark purple), brown mottled, brown, and white. I show you to-day samples of these five predicted types taken from the second generation.

The ratios of these several groups have not yet been determined because not all of the material has been worked over, but the presence of the predicted types—especially the presence of the two forms, plain black and brown mottled, which were not known to have ever occurred in the ancestry on either side—sufficiently demonstrates the correctness of my interpretation of the allelomorphic composition of the parents. Some additional unexpected types were found which must await further breeding experiments before their significance can be profitably discussed.

It will be remembered that the condition I assumed for these hybrid beans was used to bring into harmony with simple Mendelian hybrids the apparently anomalous results of Tschermak, Emerson, Lock, Bateson, Correns, Cuénot and Castle. The prediction that the same conception of latent characters in the sense of *invisible*, not *inactive* ones would without doubt give a solution to the intricate and otherwise apparently inexplicable behavior of stocks and sweet-peas, as studied by Bateson, was fulfilled with unexpected promptness, as the third report[2] to the Evolution Committee presented in March, 1906, and published later in the same year, adopts the same theory and shows that in this way practically all of the apparent anomalies of stocks and sweet-peas may be explained upon the simple basis of typical Mendelian behavior without recourse to the hypallelomorphs or compound units earlier assumed by Bateson.

[1] Read before the Botanical Society of America, at New York, December 29, 1906.

[2] Bateson, W., Saunders, Miss E. R., Punnett, R. C., 'Experimental Studies in the Physiology of Heredity,' Reports to the Evolution Committee of the Royal Society, Report III., 53 pp., London, 1906.

This complete demonstration that latent characters, at least in many cases, are not inactive units that may be rendered active by some unknown influence, but are, instead, units that produce a visible character only when acting in conjunction with one or more other units, justifies me in calling attention again to the significance of such characters.

In order to see the bearing of these results upon the process of evolution it is necessary to realize that what we call a unit character is not necessarily produced by the activity of a single allelomorph, and I consider it probable that few visible characters are so produced. It makes no difference how many internal units are involved in the production of any so-called unit-character, so long as there is a difference of only one unit involved in the cross. Thus, allelomorphs *ABCDEFGH* may determine a single characteristic and *ABCDEFGh* an alternative characteristic. If plants having characters so determined are crossed together, they will behave as if these were unit characters, though according to our assumption one is determined by the presence of eight dominant units, the other by seven.

The best actual examples we now have of the compound nature of certain apparently simple external characters are seen in the splendid results of Professor Bateson's studies on stocks and sweet-peas. In stocks, for instance, canescence is found to depend upon the simultaneous presence of three dominant allelomorphs wholly uncorrelated and each acting in the normal Mendelian manner. In one strain of sweet-peas two such dominant units are necessary to produce any color whatever and another unit determines whether that color shall be blue or red. This condition produces the remarkable result that the first generation hybrid between two white-flowered parents have blue or red flowers.

Similar conditions were presented in two of the papers given yesterday (December 28, 1906) on the joint program of Sections F and G of the American Association for the Advacement of Science, viz., the appearance of a 'latent' agouti factor in certain guinea-pigs, and an invisible red factor underlying black in certain fowls as reported by Dr. Castle[3] and Dr. Davenport.[4] The characters of both these apparently anomalous hybrid products were recognized as atavistic or reversionary. The same is true of the purple-flowered hoary stocks produced from glabrous white and glabrous cream-colored strains. The same was true of flower and seed-coat color of beans and peas as found by Tschermak and Lock, and is no doubt the correct explanation of the purple mottling in my hybrid beans. Indeed, so many instances are now on record in which a cross results in reversion, that generalizations can be made with some degree of security.

These reversions indicate that the original character was *compound,* being determined by the simultaneous action of two or more, possibly many, dominant units, and that the later specific or varietal derivatives were produced by the disappearance of one or more of these original units as a dominant characteristic. Thus in the example assumed above in which the original character was determined by the dominant units *ABCDEFGH,* the later derivatives may be *ABCDEFGh, ABCDEFgH, ABCDEfgH,* etc., through all the possible permutations. May we not perhaps get in this way a comprehensive view of at least the later stages of evolution as a process of analysis due to the disappearance of one unit after another?

All the visible variations of the present plant and animal world were once *in*volved in some generalized form or forms, and the process of differentiation pictures itself to us as a true process of *e*volution brought about by the change of individual character-determining units from a dominant to a recessive state. This conception results in an interesting paradox, namely, the production of a new character by the loss of an old unit.

When I first became interested in the Mendelian discipline one of the most difficult things for me to understand was the fact that, somehow, every dominant character in a plant or animal finds its recessive counterpart in

[3] Castle, W. E., 'On a Case of Reversion Induced by Cross-breeding and its Fixation.'

[4] Davenport, C. B., 'Reversion.'

all of its near relatives not possessing the character in question. For a time credulity balked and I was compelled to look upon character-units as figures of speech. The origin of forms from a common parent by the loss of dominancy in its several character-determinants accounts for the general presence of a recessive unit, corresponding with each dominant unit, in all the nearly related forms.

No suggestion has been made as to the nature of the change by which a dominant allelomorph becomes recessive, but if this change be looked upon as a degenerative one which may be followed later by complete disappearance of the unit it would account for the fact that hybrids between nearly related forms are usually Mendelian, while those between more distant ones are not.

I may summarize briefly as follows:

(*a*) What appear to be unit characters may be, and probably usually are, compound characters.

(*b*) New characters appear by the change of one or more character determinants from the dominant to the recessive condition.

(*c*) Some of the partial products resulting from this process of analysis have no externally apparent distinguishing characteristic, and these supply instances of so-called 'latent' characters.

(*d*) Mendelian hybridization results in an $F_1$ which is a partial or complete synthesis of an ancestral condition.

(*e*) This conception gives an explanation of the general presence of recessive units corresponding to the dominant units in each closely related form.

(*f*) If the change from the dominant to the recessive condition is a degenerative process which may be followed by complete disappearance of a unit, an explanation is found for the fact that Mendelian behavior is a function of nearly related forms but not of more distantly related ones.

George Harrison Shull
Station for Experimental Evolution,
Cold Spring Harbor, Long Island,
December, 1906

## *CURRENT NOTES ON METEOROLOGY AND CLIMATOLOGY*

### THE LOP-NOR DESERT

Ellsworth Huntington continues his papers on his recent explorations in Eastern Turkestan with a discussion of 'Lop-Nor—A Chinese Lake,' in the *Bulletin of the American Geographical Society* for February and March, 1907. Additional evidence is adduced regarding what seems to Huntington to be a progressive desiccation of the region within historical times. At Miran the ruins of an ancient Buddhist town, perhaps 1,500 years old, were discovered, covering an area of over five square miles. The town probably had a population of some thousands, but the "modern water supply is only sufficient to support seventy or eighty people." The saline water which the camels have to drink affects their flesh so markedly that the meat becomes 'corned' by reason of the salt accumulating in the animals' bodies from the water. The journey across the old lake bed was very tedious and difficult by reason of the irregularity of the large rock-salt blocks which cover the surface. Huntington remarks particularly upon the ability of his camel-man to endure hardship and fatigue with a minimum allowance of food and water. On one occasion the man traveled fifty miles in twenty hours without nourishment or water. This effect of a desert life in hardening man to the endurance of hunger, thirst and fatigue, as contrasted with the easier, softer life in more humid regions or in oases, has been commented on by other travelers, notably by Nachtigal some years ago. The history of Lop-Nor during the last 2,000 years seems to Huntington to show the following stages: First, a comparatively large lake, said to measure seventy-five miles each way. Next, during the early centuries of the Christian era, an increase in the recorded size of the lake, which can not have been due to diminished use of the rivers for irrigation, for the population at that time was larger than at present. Finally, in the last few hundred years there has been a decrease in the size of the lake and in the population about it. It may here be noted that not all