

wild horses of Circassia, which are greatly exposed to attacks of wolves and to extreme vicissitudes of climate, swiftness, strength, wariness, and a hardy constitution must be kept at a high level of efficiency by the elimination of the less gifted in these qualities; so that here again the birth-mean must be below the survival-mean. In such cases as these there seems no difficulty in the fact that the mean characters do not change for many generations; for this is in accordance with Darwin's principle that natural selection "cannot produce absolute perfection, but only relative perfection." When the average characters of a species have reached a point such that it can permanently maintain itself in a given area, then no further change will occur; but, the less efficient being constantly weeded out, the survival-mean will be necessarily a little above the birth-mean. Both means will, however, be sensibly permanent as long as the environment remains unchanged.

Mr. Weldon says that it has not been shown that, in some given case, Panmixia does in fact occur; and further, that in the only case which has been experimentally investigated—that of the stature of civilised Englishmen—the consequences said to result from it do not, in fact, occur. To obtain absolute evidence of Panmixia, or of the action of Natural Selection, is extremely difficult, because we cannot first compare and measure minutely a large number of individuals in a state of nature, and then follow those same individuals throughout their lives and see how nature deals with them. We can, however, observe what happens in the case of semi-wild animals, and the examples already cited show that natural selection must, and actually does, act on the character of colour, weeding out those which diverge on both sides towards whiteness or blackness, and in the case of physical and mental activities destroying those which fall below the standard of excellence requisite for the preservation and continuance of life.

In our domesticated animals, on the other hand, we find what are probably examples of the effects of Panmixia. The wing-bones of our pigeons, fowls, and ducks, as compared with wild individuals, were found by Darwin to be decidedly reduced in size in proportion to the leg bones; but a part of this may be due to disuse in the individual, and to determine the share of the two causes seems impossible. There are, however, a few characters in which we see Panmixia alone at work in our domesticated animals. Such are, for example, the constant appearance and increase among them of prominent *unsymmetrical* markings, as in dogs, cats, cattle, and horses. Such markings never occur in wild races, or if they occur in individual cases they never increase; and I have given reasons for thinking that symmetrical colour and marking is kept up in nature for facility of recognition, a factor essential to preservation, and to the formation of new species. In this case, there can be no question of disuse, while as we know that white and unsymmetrical individuals do occasionally occur in wild species, but never increase, the fact of their increase under domestication must be due to the absence of whatever form of natural selection eliminates them in nature; that is, to Panmixia. Another illustration may perhaps be found in the fact of curled tails appearing in domestic pigs and some races of dogs, while no wild animal is known which has a curled tail. We can hardly doubt that the special form of tail in each animal is of use to it, and that any abnormality, like a curled tail, would be eliminated under nature. Its appearance and perpetuation under domestication is therefore a fair example of Panmixia.

The slow increase of the stature of civilised Englishmen, which Mr. Galton is said to have proved, may, it seems to me, be partly a result of Panmixia, and partly due to more healthy conditions of life acting on the individual. It is, I presume, a fact, as generally stated, that old armour shows that the knights of the middle ages were rather short men. This may have been a result of natural selection, because, as a rule, the strongest and most active men are rather under than over middle height; while tall men would certainly be more exposed to danger, would have to carry a greater weight of armour, and by thus overloading their horses would be under a disadvantage in battle. Tall men would thus be killed off rather faster than short men; and the same might be the case even after the disuse of armour, so long as rapine and civil war prevailed over a large part of the country. But during the last two centuries of comparative peace tall men have been under no such disadvantage, and their survival may have aided in bringing about the slight increase of average stature which has been observed.

One other point in Mr. Weldon's communication requires notice. He considers that the frequent occurrence of abnormalities and the wide range of variation in many species, show that "natural selection is in most cases an imperfect agent in the adjustment of organisms." This conclusion does not appear to me to be a logical one, since it ignores the admitted fact of the exceedingly intermittent character of selection and its constantly varied *locus* of action. Each species of animal is subject to a number of quite distinct dangers—hunger, cold, wet, disease, and varied enemies—and all these are separately intermittent in their action. Some affect the species at one time of the year only, some at another; but most of them only reach their maximum of intensity at long intervals—once or twice, perhaps, in a century. Whether cold winters or hot summers, excessive drought or excessive wet, deep snow or phenomenal hail or wind-storms, all are intermittent and occur with extreme severity only at long intervals. These intermittent waves of meteorological phenomena have their corresponding "waves of life," as Mr. Hudson well terms them, such as phenomenal swarms of locusts or of wasps, of caterpillars, mice, or lemmings, and to a less conspicuous degree of almost every living thing. It follows, that during a succession of favourable seasons variation can go on almost unchecked, and even hurtful abnormalities and imperfections may survive for a few years, but soon there comes a check to the increase, and the most abnormal forms die out; while after a greater or less interval either adverse seasons or an increase of living enemies weed out all the extreme disadvantageous variations, leaving only the pick of the typical form to continue the race. This may occur again and again, each special period of stress affecting different organs or faculties—now abnormal colour, now deficient agility, now again incaution or a weak digestion—till in turn every departure from the best adapted mean form is eliminated, to again arise and again be extinguished as favourable or unfavourable conditions prevail. Thus, I am fully in agreement with Mr. Thiselton Dyer when he said: "I feel more and more that natural selection is a very hard taskmaster, and that it is down very sharply on structural details that cannot give an account of themselves." (NATURE, vol. xxxix. p. 9.) The appearance of imperfect adjustment is thus only a temporary phenomenon, while that there is an underlying permanent adjustment is indicated by the long-continued identity of specific characters to which Mr. Weldon refers.

As it is very important to obtain some direct evidence of the action of natural selection, I wish to suggest a mode of doing so which might probably be successful. There is much evidence to show that the migrating birds which visit us in early summer are very largely old birds which have lived through two or more migrations; and, consequently, that of the large number of young birds which migrate in autumn for the first time a very small proportion return to our shores. If this is so, then the extreme severity of the selection during migration would afford us the opportunity of determining some of the physical characters which influence it, combined no doubt with mental characteristics which we have no means of gauging. I would suggest, therefore, that two or three common species of migrants should be chosen, of which the young birds of the year can be distinguished with certainty. Of these birds a number of observers should collect specimens just before their autumnal migration, and should carefully record the characters fixed upon in the case of the young and old birds separately. Probably the weight, the total length, and the length of the wing, would be sufficient, since heavy birds with comparatively short wings would hardly be adapted for long-continued flight. By laying down the dimensions of some hundreds of specimens in curves of variation, whatever difference existed between the young and old birds would be easily detected; and this difference would presumably be the difference between the birth-mean and the survival-mean, so far as the selective influence of migration is concerned. In the following spring another set of specimens of the same species should be collected and measured; and we should then perhaps be able to determine the characters which had led to the selection of the young birds which had survived the double migration.

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Discontinuous Colour-Variation.

I HAVE just received a copy of Mr. Bateson's most valuable work on the "Study of Variation"; and although it will take many weeks to read it as it deserves to be read, a few remarks

are now ventured as the result of perusing pp. 42-48, which relate to the discontinuity of certain colour-variations.

Without attempting to discuss Mr. Bateson's general propositions, I desire to point out that the facts related in the portion of the work cited, and the "many similar cases" which might be added, do not altogether support the idea of *discontinuous progressive colour-variation*, as distinguished from *atavism*.

Various writers, including myself, have on sundry occasions endeavoured to demonstrate that both in plants and animals a definite succession of colours may be observed. In flowers, for instance, from pink to purple, and from yellow to red; in birds and insects, and many molluscs, the yellow to red succession is commonly observed. In such instances as these, it has been held that one colour represents a lower stage of evolution or a less degree of metabolism than the other; and it has been many times pointed out, that *discontinuous atavistic variation*, e.g. from red to yellow, is commonly to be seen.

Now I take it that Mr. Bateson considers the evidence which he adduces, to illustrate the frequency of *discontinuous progressive variation* in colour, not merely *reversion*. Let us examine this evidence a little more closely.

According to the views held by the writers above mentioned, red is "higher" than yellow, and red varying to yellow is *reversion*. Such *reversion* is well known to be often discontinuous, as in the yellow-fruited yew, the yellow tomato, the yellow-fruited raspberry, the yellow varieties of various red moths, and so forth.

But is the yellow to red variation, which is supposed to be the progressive one, discontinuous? Let Mr. Bateson himself tell us. On p. 45 he cites the variations of the yellow *Gonepteryx rhamni* towards orange. Are these discontinuous? Do we find among the yellow *rhamni* some that are entirely orange? Not so, "there are records of specimens . . . more or less flushed with orange."

Exactly: whereas among the red species of *Callimorpha*, *Arctia*, *Zygæna*, &c., we find varieties not flushed with yellow but entirely yellow in place of red (the dark markings being of course as usual), in the yellow *G. rhamni* we find continuous variation towards orange, none yet having attained actual red.

In birds red species may vary to yellow; green also to yellow, and such variation may be sudden. But yellow to green? or yellow to red? We have got our canary yellow easily enough, but all the art of the breeder cannot get him redder than orange, and the variations thereto are fairly continuous.

We cannot get a blue rose; but the blue *Delphinium*, the blue *Penstemon*, these readily vary to pink. We may have a yellow rose, but it is pretty well agreed that if we ever do see a blue one, it will be by a process of *continuous* variation and selection. Will not Mr. Bateson admit that he would be immensely astonished to see a blue rose arise from seed of a red one, or a scarlet canary from eggs laid by a yellow one? Yet red from blue, or yellow from red, would seem scarcely worth comment in any group of animals or plants, so numerous are the recorded instances of this kind of variation.

On p. 44, Mr. Bateson cites instances of blue in place of red, which should be *progressive variation*. This occurs in *Catocala nupta*, for instance, but *very rarely*, and instances which seem rather intermediate are on record. Another sample cited is the blue-flowered *Anagallis arvensis*. Here the case is different, for the blue and red varieties are entirely distinct, and come true by seed. I have myself lived in districts where the blue and red varieties respectively abounded, and in neither locality did I ever see intermediates. They had all the appearance of true species, which they have often, I think with justice, been considered. The locality for the blue variety was Funchal, Madeira, and there the red pimpernel also occurs. But in England, where the red variety is so common, I never saw the blue one truly wild.

In *Primula* we have yellow species and red species, and, as everyone knows, our common primrose may vary to red. But also, as everyone knows, the variation is continuous. How well I remember as a child looking for those that were tinged with red, always hoping to get one redder than that last found!

The subject admits of much greater amplification than is now possible; and it is by no means denied that many instances may be selected, out of the thousands available which appear to indicate discontinuous progressive colour-variation. But never-

theless, taking the evidence as a whole, I will venture to urge the validity of the following statements:—

(1) Colour-variation occurs in a definite order, the colours forming one or more series.

(2) Variation from those lower to those higher in the scale of evolution, or from those representing less to those representing greater metabolism, is usually continuous.

(3) Reversion from a higher to a lower colour is usually discontinuous.

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Las Cruces, New Mexico, U.S.A., June 1.

Niagara River since the Ice Age.

MUCH new light on the Quaternary history of the great lakes tributary to the St. Lawrence river has been contributed in three recent papers by Mr. F. B. Taylor, all published within the short time since Mr. G. K. Gilbert's writing on "The Niagara River as a Geologic Chronometer," which appeared in *NATURE* for May 17 (page 53). These papers are in the *Bulletin of the Geological Society of America* (vol. v. pp. 620-626, April 30, 1894), and in the *American Geologist* (vol. xiii. pp. 316-327 and 365-383, May and June, 1894). Supplementing the earlier observations and studies of Whittlesey, Newberry, Gilbert, Spencer, Lawson, Leverett, Wright, Baldwin, and the present writer, among others, these latest explorations and discussions by Mr. Taylor enable us to form a very definite and closely connected historical statement of the relationships of the ice-dammed lakes which preceded the present Laurentian lakes, and of their dependence on the gradual departure of the ice-sheet and on the accompanying northward uplift of that region.

The largest element of uncertainty in the estimate of 7000 years for the Post-glacial period, from the retreat of the ice-sheet to the present time, drawn from the rate of recession of the Falls of Niagara, consists, as Mr. Gilbert has shown, in the probability or possibility that for some considerable time, next following the melting away of the ice upon the area crossed by the Niagara river, the outlet of lakes Superior, Michigan, and Huron may have passed to the St. Lawrence by a more northern course, flowing across the present watershed east of lake Nipissing to the Mattawa and Ottawa rivers. Mr. Taylor's observations now indicate, however, if interpreted on the hypothesis of glacial lakes (which is believed by Mr. Gilbert and by the majority of other geologists of America to be the true view), that the glacial lake Warren, filling the basins of Superior, Michigan, Huron, and Erie, continued with its outlet flowing past Chicago to the Des Plaines, Illinois, and Mississippi rivers, while the country including lake Superior, the northern part of lake Huron, and lake Nipissing, that is, the whole northern side of lake Warren, was uplifted about 350 to 450 feet along its extent of 600 miles from east to west. The existence of lake Warren was terminated by the recession of the ice-sheet from the area between lakes Erie and Ontario, when the Niagara river began to flow and to channel the gorge six miles long below its receding falls, from which the computation for the time since the Ice Age is derived. The Niagara gorge measures the time after the outflow past Chicago ceased, lake Warren being then succeeded in the basins of the upper lakes, above Erie, by the glacial lake Algonquin, while in the Ontario basin the ice-bound lake Iroquois outflowed past Romé, N. Y., by way of the Mohawk and Hudson to the sea.

Seven-eighths of the differential uplifting which carried the watershed east of lake Nipissing above the level of lake Algonquin had taken place before the north-eastward retreat of the ice-sheet uncovered the Niagara area. For some later time the ice-barrier must have remained upon the Mattawa and Ottawa areas, forbidding any outflow there from lake Algonquin; and it seems very probable that within that time the continuation of the uplift had raised the watershed so high that no discharge from the upper lakes ever passed over it. During the ensuing existence of lake Iroquois the Ontario basin was undergoing a rapid northward uplift, which doubtless was shared by the Nipissing area, so that if any outflow occurred there it must have been very brief, being ended when the land east of lake Nipissing rose higher than the present course of outflow by the St. Clair and Detroit rivers to the Erie basin and Niagara river. The duration of the outlet to the Mattawa could probably have been only a few hundred years, at the longest, if it ever existed. With this possible exception, the present volume of the Niagara river has been maintained during all the time of its gorge ero-