SCIENCE

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THE MUTUAL RELATIONS OF SCIENCE AND STOCK BREEDING.*

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THE production of crops and the production of animals are the two great branches of agriculture. The application of science to the production of crops has been more conspicuously before the public than to the production of animals, and agricultural science has devoted most attention to this branch of production. There could be no comprehensive science of agriculture until there was a science of chemistry, and the modern revolution in the art and practice of agriculture has come about as the science of chemistry advanced and mechanical invention progressed.

The application of scientific methods to the economic breeding of farm animals came much later and followed the publication of Darwin's "Origin of Species." Facts began to be systematically recorded for the construction of a science of breeding much earlier than that, but a collection of facts does not constitute a science, and breeding remained strictly an art until within the last few years.

As an art breeding attained a high standard long ago as respects the production of some fine examples of particular breeds. But except with Arabian horses, and possibly certain strains of game-fowls which were bred nearly pure, crossing was the universal method of improvement practised in all countries of European civilization. This led to wide variation and great uncertainty of product. The modern method of improvement within the breed, keeping the blood pure, has been the outcome of scientific study applied to the economic production of animals.

This knowledge was of slow growth and the practice was applied to the breeding of English race horses before it was to useful farm animals. The English race horse, or "Thoroughbred," is of composite origin, but originally mostly of Oriental stock. The pedigrees of the winners began to be printed before the middle of the last century, and after a time an annual list of the winning sires was published. It came to be recognized that the winners were, as a rule, of the purest blood, rather than crosses, and this led to improvement by selection within the breed itself rather than by crossing. Then pedigrees were gathered and collated and the first volume of the "Stud Book" was published in 1791. This gave the data necessary for a study of the ancestry of any given animal of that breed, but the method was not extended to the breeding of the other useful farm animals until long after, and more than thirty years elapsed before any other comprehensive registry of pedigrees was printed for public use. The "Shorthorn Herd Book" was published in 1822.

The forerunner of breeding by pedigree as now practised was breeding in-and-in, which came into use for farm animals the last quarter of the last century. This was the opposite extreme of the wide crossing, so widely practised, and Robert Bakewell was its greatest promotor. Beginning with a very few carefully selected animals, he grew his flocks and herds from them, breeding between the nearest of kin and thus restricting the ancestry as to numbers, but increasing enormously the potentiality and hereditary influence of certain superior animals. He practised with great skill and selected his breeding animals with rare sagacity. He wrought great improvement, refining the carcass, improving the form, and extending the change to early maturity, better quality of flesh and general improvement in useful qualities of the animals. He wrote nothing. Breeding was with him a secret art, practised with great skill and success. This art was, however, taught to certain of his pupils, of which the brothers Colling became famous as breeders of shorthorns. But there was no science recognized because the general laws were not understood. Even Colling introduced a cross into his herd, and breeders are still, after nearly a century, discussing the influence of that "Galloway cross" on the breed.

Most of the leading breeds of our farm animals existed after a fashion in the last century. The early history of nearly all of them is obscure, although much research has been expended in unraveling it. But, unless confined to some small island, as were the Jersey, Alderney and Guernsey cattle, the breeds were not kept pure, because the common method of improvement was by crossing with other blood. Uniformity could neither be secured nor maintained by such practice, and naturally all the economic results were highly uncertain.

Some animals of great excellence were produced, but they were the accidental result of the uncontrolled and uncontrollable variation incident to the methods of breeding then followed.

The twenty-five years during which Darwin was accumulating the material and digesting the facts for his "Origin of Species," were important ones in the history of the theory of breeding, and a number of pedigree records were begun publication. The doctrine of improvement by selection within the breed instead of crossing with other blood was becoming better and better known by the more successful breeders, and the economic results were becoming more and more certain.

But scientific naturalists, absorbed in the description of natural species, ignored man's artificial productions. A breed may be, and often is, as artificial a production as is a picture or a statue. The breeder, like the sculptor, must have his ideal towards which he is working, the greater his genius the nearer his creations come to reaching his ideal. The earlier naturalists, like Buffon and Cuvier, had studied and written about domestic animals as a part of nature, but their successors came to consider them artistic rather than natural productions, and to look upon these "artificial monstrosities" with a contempt not now appreciated by the younger generation of naturalists.

But the difficulties of the old system were well nigh crushing the life out of natural history, and the time was ripe for a new theory on the origin and nature of species.

*Synopsis of Address by Wm. H. Brewer, Vice President of Section I., American Association for the Advancement of Science, at Madison, Wisconsin, Aug. 17, 1893.

When Darwin brought us out of the difficulty it was largely by a study of the experience of breeders. This was analogous to the establishing of a new and vast biological laboratory for scientific experimentation and never before was such a profound change brought about in a dogma of science by a study of an economic art.

All the earlier stud books and herd books were prepared and published by private individuals as any other book might be produced by a compiler and author. Now they are mostly published by associations clothed with authority and having wider aims. They record and publish pedigree, define methods and conditions for establishing their authenticity, and fix the standards which dictate what the essential characters of the breeds shall be. Nearly every useful breed has now some such association, publishing an authorized stud book, herd book, flock book, or register of some kind; the total number of such works aggregates hundreds if not thousands of volumes.

It is in fancy breeding that the most wonderful results are produced and some of the most instructive facts are found. The economic factor is here often entirely eliminated, and mere whim or fancy guides the experiments. Fanciers had their associations and set their standards long before the breeders of the more useful farm animals did, and to that Darwin turned his attention. He joined various pigeon societies, put up his cotes, became a practical and experimental fancier and mingled with his fellow fanciers, drawing on their rich stock of knowledge and experience.

A result of all this has been a better knowledge of the laws of heredity and of the causes which promote variation. A science of breeding now underlies the practical art. A pure science is relatively exact in the proportion in which it enables us to predict events, its economic applications are valuable in the proportion in which it enables us to control results. The breeder of to-day controls results with a success his ancestors never dreamed of.

The practical result is that the economic production of animals is now placed on a very much surer foundation, excellence is made more uniform, the chances for failure are enormously lessened and the methods of improvement placed on a philosophical basis.

The gain to science has been correspondingly great and numerous unsolved problems in biological science find here their material for use. Economical and social science, also, here find a field for experiment and deduction. Science will therefore be the gainer in the future as truly as in the past.

NOTE ON THE BURIED DRAINAGE SYSTEM OF THE UPPER OHIO.

BY RICHARD R. HICE, BEAVER, PA.

In reading the discussion of the buried river channels in western Pennsylvania, by Professor J. C. White,* the impression is left with the reader that none of the tributaries of the Ohio and Big Beaver rivers have buried channels, but that all are flowing over undoubted rock bottoms, at, or within a short distance of, their mouths.

At the time Professor White examined this district, (1876) there was, in some cases, apparently ground for this belief, though a careful examination of other streams would have thrown much doubt on the correctness of this conclusion. Recent developments, however, have demonstrated in some cases that buried channels exist, and the nature of the surroundings in other cases, render the conclusion that the apparent rock bottom is real, a mistake.

Passing up the Ohio and Beaver from the Ohio State line, we first reach the Little Beaver. A short distance from its mouth we apparently find a rock bottom as described by Professor White,† but in building the abutments of a bridge near this same point, a depth of fifty feet was reached without finding rock. A depth that closely corresponds with that of the Ohio, which here lies on the southern side of the present valley. Near Cannelton, also, a number of miles up the valley of the Little Beaver, a well has been recently driven fifty feet through gravel without finding rock and abandoned.

Raccoon Creek, coming into the Ohio from the south, flows at its mouth through a narrow rock gorge, but below the present mouth there is a gravel terrace for about a half mile, and there is ample room for a buried channel. Passing up this stream there does not seem to be a rock bottom, except at its mouth, for several miles. The present channel makes a sharp turn up the Ohio at its mouth, while the gravel terrace, reaching on its river front at least to low water, lies in the direct course of the creek, and reaches back to the point where the course of the creek changes.

Two Mile Run, a comparatively small stream, flows through a narrow gorge in the ferriferous limestone, for about a quarter of a mile above its mouth, but passing above this gorge, it flows over a gravel bottom, parallel with the Ohio, for about a mile, at which point it leaves the valley, and enters a narrow gorge, in which no rock is found in the bed of the run for about two miles. The direct course from the narrow gorge to the Ohio, is blocked by a gravel terrace, which reaches below the present river level.

Passing up the Beaver, we first reach Brady's Run. This stream, at its mouth, also runs over a rock bottom; but, in the erection of a bridge at its mouth, it was discovered that the present channel lies immediately beside a buried one, the rock dropping off precipitously, and a well one-half mile up the stream has been driven fifty feet to rock, in a location that does not seem to be the middle of the buried channel. This well is at a point where the bounding hills rise 100 feet plus and 350 feet plus, respectively.

Connoquenessing Creek, for the four lower miles of its course, flows in a narrow rock gorge, and at one point, about one-fourth mile from its mouth, it is now flowing over a rock bottom. Above this gorge, the stream flows in a much older valley, with no indication of a rock bottom. As yet no outlet has been found for this stream into the buried channel of the Beaver, but the thick covering of morainic material makes any examination very uncertain in its negative results.

These are the principal streams, and the evidence, though not yet conclusive in all cases, clearly shows that no reliance can be placed on an apparent rock bottom at or near the mouth of the stream; indeed the Beaver itself flows over a rock bottom within two hundred yards of its mouth, as well as at three other points within less than five miles of its mouth, yet no stream has a better defined buried channel; and also shows that the time of the erosion of the buried channel was not so short as some have claimed on the supposed evidence of the absence of buried channels of the tributary streams, but was long enough to admit of the erosion not only of the main lines of drainage, but of many of the tributary channels as well.

*Second Geol. Survey Penna. Vols. 2, 22.

†2, page 16.

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