

separating species, for many cases were found where species were fertile when crossed. The broad fact remains, however, that, in spite of many exceptions, the rule is that different species, when crossed, do not produce fertile offspring; and I do not think this conclusion is doubted by any one. Though the difficulty is lessened by the experiments on cross-breeding, it is not removed; but the difficulty does not lie exactly where it is usually put. The difficulty is not that species are sterile when crossed, but that varieties, however diverse they may be, are always fertile. It is not difficult to understand why the descendants from a common form, should, by the principle of divergence of character, become so unlike each other as to be incompatible with each other when crossed. The difficulty lies rather in the fact that in all the experiments of breeders there has been no approach toward the production of sterility between the varieties produced. Breeders have succeeded in profoundly modifying animals, and in producing a great number of diverse varieties. Sometimes these varieties show greater differences than are shown by separate genera or families of wild animals. And yet there is no tendency observable toward the production of sterility among these varieties, perfect fertility being the universal rule. To explain why a large amount of structural difference in domestic varieties should be accompanied by complete fertility, while in a state of nature very slight differences should be attended by sterility, in many cases at least, is to my mind the only difficulty arising in connection with the sterility of hybrids.

As an explanation of these facts, it has been pointed out that domestication has a direct effect upon the reproductive powers of animals, sometimes producing sterility, and sometimes increased fertility. This factor has been suggested, therefore, as explaining why the varieties of domestic animals have not become infertile. But the differences to be explained are very great. Most excellently was this matter illustrated by Professor Clark at the last meeting of the American Society of Naturalists. For illustration he used a large number of mounted specimens of pigeons obtained from different fanciers, and a series of mounted sparrows which may be found everywhere. Among the pigeons the greatest profusion of color, size, shape, length of bill, etc., was observable, all within the limits of the same species; while among the sparrows a sharp eye was required to see any differences between species, and sometimes between genera. Allowing what we will for the effect of domestication, it is a remarkable thing that the fantail and powder will breed together perfectly well, so that care must be taken by the breeder to keep them separate; while the different species of sparrows with such close resemblance do remain perfectly distinct. Of course, also, the existence of varieties in nature cannot be due to domestication. All of these facts seem to indicate that some different process has been at work in the production of species from that which has given rise to these very diverse varieties.

Now, all of this class of facts receives a ready and natural explanation in the hypothesis suggested above. All domestic varieties have been artificially preserved by man, and he has naturally selected for preservation such peculiarities as are particularly pleasing or useful to him. It is plain enough that he has not included in his selection peculiarities of the sexual organs: for these are frequently not visible, and have never been the object of improvement on the part of the breeder. Plumage color, shape, size, strength, swiftness, etc., have all received attention; but I have yet to hear of a single instance where sexual variations have been selected. Certainly this has not been done in the pigeons, or dogs, or other animals, where such great diversity has been found compatible with perfect fertility. There can be no doubt that the sexual nature is just as truly subject to variation as any other part of the body. Every one knows of variations in fertility, in size and shape of sexual organs, in sexual passions, all of which plainly indicate, that, though not so evident to observation, variations in the sexual system are as abundant as elsewhere. Further, it is evident that sterility of species when crossed must be due to some differences in the sexual organs or sexual elements which prevents proper fertilization or proper growth after fertilization. Is it not, then, a natural conclusion that an accumulation of sexual variations will result in sterility, while any accumulation of other variations will not necessarily have the same effect unless they are also accompanied by sexual variations? Under artificial breeding there

have been produced anatomical varieties based upon structures which have had no necessary connection with the sexual nature, and hence the varieties have not become sterile. On the contrary, the uniform conditions of experiment, the rejection by the breeder of individuals which have shown abnormal sexual instincts, have tended to prevent the development of any sexual differences sufficient to produce sterility.

Under nature, however, the conditions have been very different. There has been no rigid conforming of selections to anatomical differences. Hardships, famines, surplus of food, etc., have all had their effect; and there is no part of the body so soon affected by such changes as the reproductive system. Animals have had every opportunity for the free exercise of every passion, and thus differences in the reproductive system have come in for their share in accumulation by natural selection, or otherwise. Romanes is indeed inclined to think that such variations will be specially favorable for preservation, since they will tend to prevent crossing of unlike individuals. This is, however, doubtful; but it is plain enough that they will have a much more favorable chance for preservation than they do have under domestication. By variation in this direction there may thus be produced species which will be sterile when crossed, and yet with very small anatomical differences. On the other hand, there may be varieties which would differ widely in anatomical characteristics, and yet be perfectly fertile when crossed. The difference between a highly variable species and constant species would be thus due to the readiness with which variations in the reproductive system are produced and preserved. Where the reproductive system is constant, there may arise a highly variable species; but where the reproductive system is highly variable, there will be a tendency to the production of numerous closely allied species. All of this will lead to a new understanding of the significance of species as groups of animals in which variations have largely affected the sexual organs, with sometimes great and sometimes little change in other parts of the body. In varieties, on the other hand, variation may have affected any other part of the body to almost any degree, but has not affected the sexual system. This understanding is somewhat different from that of Darwin, since it does not regard a species simply as an exaggerated variety. Sometimes it may be so, since anatomical and sexual variations may accompany each other. Sometimes, however, a species may be produced directly by sexual variation, without passing through any prominent stage, in which it is a simple variety. Variety and species are therefore independent, being founded on different kinds of variation.

A discussion of this hypothesis is not possible here, the design of this note being simply to call the attention of American naturalists anew to the subject, and to state the hypothesis as it lies in the mind of the writer. It would be a very important series of experiments if some one who has opportunities for experimental breeding would undertake the production of a distinct species by selecting sexual rather than anatomical variations. Such a series of experiments might solve the question of the origin of *species*.

H. W. CONN.

Middletown, Conn., May 15.

The Ohio Mounds.

THE evidence brought to light by the explorations of the Bureau of Ethnology bearing upon the authorship of the typical ancient works of Ohio, leaves scarcely a doubt that these structures are to be attributed to the Cherokees. The chain connecting the Cherokees of modern times with the builders of these celebrated works seems to be so complete as to leave no break in which to thrust a doubt.

These explorations have also thrown some light on the so-called clay 'altars' of the Ohio mounds, rendering it probable that they were places for torturing prisoners of war, — the chief 'sacrifices' the Indians were in the habit of making. Strange as it may seem, the chain of evidence on this point reaches into actual history.

The ancient works of Ohio are attributable to at least four, but probably more tribes.

CYRUS THOMAS.

Youngsville, Penn., May 14.