summit of a rock, looks the size of a yak or a bear."

It is plain from this experience that M. Bonvalot happened upon a new spatial world of size and distance, which he had to learn by a method of local visual signs, just as in infancy he learned the space world of the nursery room. It would be interesting to inquire of such travelers the exact nature of the signs they used in constructing the new space world.

HIRAM M. STANLEY.

MR. SPENCER ON TACTUAL PERCEPTION AND 'NATURAL SELECTION.'

MR. SPENCER concludes his long discussion on 'Natural Selection' by a short note in the October number of the *Contemporary Review* in which he claims that he has received from Prof. Weismann no answer to the crucial question he asked in his original paper (*id*, Feb., 1893). Mr. Spencer writes:

"But the main question he has every time passed over in silence. To my repeated inquiry—*How are the various degrees of tactual discriminativeness possessed by different parts of the outer surface of the body to be explained by 'natural selection' or by 'pannuxia'?* he has not only given no answer, but he has made no attempt to give an answer. The obvious implication is that no answer can be found."

Now, as I have already attempted (*Mind*, Oct., 1893,) to prove that Mr. Spencer's arguments from tactual perception are futile, and as his reply (*Contemporary Review*, Dec., 1893,) shows that he is not likely to be influenced by such evidence as I am able to adduce, I do not return to the subject in the hope of convincing him. I may, however, be able to show others that the facts of tactual perception have no special bearing on the sufficiency or insufficiency of natural selection.

Mr. Spencer found that the sensation areas (the distance apart at which points on the skin can be distinguished) on the tips of the fingers of two blind boys were $\frac{1}{14}$ inch and of two compositors $\frac{1}{17}$ inch, whereas Weber gave $\frac{1}{12}$ inch as the normal size. Mr. Spencer concludes from this experiment that the structure of the peripheral nerves and their connections are altered by use, and that these modifications of structure are hereditary. The fact that the tip of the tongue is more sensitive than the tips of the fingers is said to be because the tongue is continually exploring the teeth, although no advantage is gained thereby; the nose is more sensitive than the top of the head because it is more often rubbed by the fingers, etc. Mr. Spencer says that as the sensitiveness of the tip of the tongue is less important to man than sensitiveness of the finger tips it is impossible that the greater sensitiveness of the tongue could have been developed by the survival of useful variations.

Now this argument is such that the only reason for replying to it is that it is advanced by Mr. Spencer, whose contributions to philosophy are on the whole so important, that his utterances on special matters carry weight that they often do not intrinsically possess.

The experiments and theories of Weber have long since been superseded. Many thousands of experiments on tactual discrimination by a score of investigators have been published, and of these Mr. Spencer is ignorant. It is well known that the tactual discrimination of the blind is likely to be greater than that of others, but this could not have been determined from an experiment such as Mr. Spencer made. Tactual discrimination decreases in five minutes' practice far more than the amount given by Mr. Spencer as the greater sensitiveness of the blind; but this does not mean that the anatomical structure of the peripheral nerves has been modified, and that this modification will be hereditary.

The distribution of tactual discrimination on the skin seems to be exactly what would be expected were 'natural selection' a sufficient or an insufficient account of organic evolution. The parts of the body in which sensitiveness is most useful, the finger-ends and the tongue, are in fact the most sensitive.

There are two adequate reasons why the tongue should be more sensitive than the fingers. In the first place the lower mammals use the tongue as an organ of touch, it being far more sensitive than their hoofs or paws; a horse will reject the smallest bit of gravel from its mess of oats. As sensitiveness of the tongue is extremely useful to man for mastication and speech it is natural that the delicacy early de-

veloped should have been maintained.* † In the second place accuracy of skin localization is always a function of the mobility of the part. Where anatomical structure varies within narrow limits the sensation areas are small. As the tongue is far more mobile (the mobility is highly useful) than the finger tips, it could more readily develop and retain tactual sensitiveness.

In all cases where the structure or function of an organ is useful to the individual it may be attributed to the survival of variations or the inherited effects of use, and it does not seem that tactual discrimination helps to decide the all-sufficiency or relative importance of one of these factors.

When Mr. Spencer says that the sensitiveness of the tongue has been developed by involuntary and useless rubbing over the teeth, he seems to betray a complete misapprehension of the facts of psychology. The skin becomes less, not more sensitive by continual rubbing of the clothes, the contact of air, blood and food does not develop the accuracy of local discrimination in the inner organs of the body, etc.

I scarcely know a worse argument than this of Mr. Spencer's: (1.) That the blind are shown to have greater tactual sensitiveness than the seeing. [This would not be proved by Mr. Spencer's experiment but was well known.] (2.) That in these cases the practice of the blind has developed new anatomical structures of the peripheral and central nervous system. [A greater increase in accuracy of local discrimination can be developed with five minutes' practice.] (3.) That the anatomical structure acquired by use is hereditary. [This begs the question at issue.] (4.) That the relative sensitiveness of the skin cannot be accounted for by the survival of useful variations. [It is amply accounted for.] (5.) That useless sensitiveness has been developed by continual stimulation. [This is nonsense.] J. MCKEEN CATTELL.

* It may be remembered that Mr. Spencer thinks that organs will not disappear through 'natural selection' when they become useless.

† The nose is also used as an organ of touch by the lower mammals, and naturally remains more sensitive than the top of the head.

BIBLIOGRAPHY OF NORTH AMERICAN PALEONTOLOGY.

ONE of Mr. Van Ingen's criticisms in a late number of SCIENCE, on the recently issued Bibliography of North American Paleontology, 1888–1892, suggest that one of the errors into which he has fallen might also apply to others, particularly authors in paleobotany whose names have been omitted and of which a number are given as not being listed. The paleobotanical papers were omitted intentionally for the reasan that they were already receiving attention for publication in the U. S. National Museum when the work on the Bibliography was commenced. This fact should have been perhaps emphasized in the preface. But that there is so large a number of omissions as is claimed cannot be for a moment believed until substantiated by facts. In case the latter are forthcoming it would save much trouble in looking them up. Several, at least, of the 'valuable' additions made by Mr. Van Ingen as appearing during the period, while they do bear an included date on the title pages, were not received until sometime afterward, as library records clearly show.

As to many of the titles not being given in 'full,' as it is claimed by Mr. Van Ingen to be promised in the preface, it need only be stated that if he had turned his naked eye to the Bibliography instead of his microscope, he would have found some 800 other titles not given 'in full,' in place of the half dozen cited as examples of 'wrong copying.' In a listing of the papers all articles and often unimportant adjectives were purposely omitted, for reasons obvious to everyone familiar with bibliographic matter. 'Full' is clearly used in contradistinction to the usage in the secondary references where abbreviation as great as possible is necessary.

The regret expressed by Mr. Van Ingen that the Bibliography was not printed on one side only is no doubt shared by many 'working paleontologists,' even though Uncle Sam could not anticipate the utility of printing so valuable a work in colors to suit each prospective peruser. The special defect mentioned is, however, readily overcome by transmitting 20 cents to the director of the U. S. Geological Survey for a second copy of the work, that the 'pasting on cards' may go on uninterruptedly.

CHARLES R. KEYES.