

the ant would continue the pursuit. Between the water's edge and the dry sand of the upper beach was a strip of wet sand some fifty feet wide and gently sloping. Over this area the ant followed me with strange persistence, both with and against the strong southwest wind then blowing. Not only would she follow me up on successively drier and firmer sand to the edge of dry sand, but back again to the water's edge, so that once she was overtaken by the swash of a small surf. The ant followed readily at a distance of three feet without regard to the direction of the wind, but, at a distance of six or more feet, entirely lost the trail. This circumstance, with the additional one that when I walked in a circle she would leave my footsteps and take a direct path towards me, shows that she was guided by sight rather than by the sense of smell.

When allowed to come up to me, the ant crawled under the shadow of my shoe and rested on the sand, and once crawled over the uppers, but returned to the space forward of the heel. When led to the dry sand she would cease to follow, and would begin to care for her chitin. In the course of the few minutes I gave to watching her, the ant followed me upwards of two hundred feet on the wet sand of the beach.

The difference in the behavior of this ant on the wet and dry sand seems to afford a clue to its mental processes. It seems to me probable that the ant had a sense of peril in its position on the wet sand, which was liable to be overrun by the sea, and that she turned toward me as she would have to a tree, or other high object, as a means of escape.

A more striking instance of intelligence in the same species of ants fell under my observation upon the island of Martha's Vineyard. These ants here, as elsewhere, build hills from one to three or more feet in height. The singular activity of the creatures, when disturbed, often led me to offer slight provocations to the occupants of one of these hills. On the occasion which I am about to describe, a number of workers were running back and forth over the summit of a hill, when I spat on it. At once the ants nearest the objectionable meteorite rushed towards it, and with their antennæ made an examination. These workers then ran a little distance away, picked up each a large grain of sand coated with a yellowish clayey film, and carrying it to the edge of the liquid, threw the pellet hastily in. This process, engaged in by at least a dozen ants, soon resulted in filling up the little pool. As these clayey pellets were thrown into the liquid they changed color through the absorption of the water by the clay. The absorption of the spittle by the pellets was evidently not yet complete, when all but one of the ants went about their customary walks. This solitary sentinel placed a pellet on the little heap and watched it soak up water, the pellet changing, as it did so, its yellowish color for a slaty hue. Another pellet was brought up and piled on as the others had been, but the process of absorption was now complete, and this last grain did not change color. The ant stood off at a distance of about half an inch from the grain he had deposited, intently watching the effect of his labors. When after a few seconds it was to be observed that the last grain was not affected by moisture, this ant turned abruptly away and joined his fellows, and no more attention was given to the object which had caused them so much concern.

The obvious effect of this application of clayey pellets was to prevent the moisture from penetrating through the roof of the ant hill into the cavities beneath. This was a clear case of stopping a leak, and that these ants know the value of sandy clay as an absorbent seems further illustrated by the frequency with which these clay-coated grains of sand are distributed about their hills.

After rains, the ants may be seen bringing these objects up out of the peripheral holes of a hill and placing them on the dome to dry. It would be interesting to note whether or not dry pellets are taken below to serve as sponges in drying their underground rooms.

PROBLEMS OF ZOOLOGY.*

LADIES AND GENTLEMEN :—Let me assure you that I am not unmindful of the favor shown in electing me to open this International Congress of Zoölogists.

Thirty years have nearly passed since I had the pleasure—as a then resident of this bustling city of Chicago—of listening to a series of lectures on zoölogy by Louis Agassiz, and as I recall the popular interest and enthusiasm which the great master inspired, and the singular activity and devotion of Kennicott, Stimpson and others of Chicago's earlier zoölogists, I am led to hope for a renewal of that early spirit and enthusiasm as a result of your meeting here.

Zoölogy, but a few years back, dealt chiefly with the habits, structure and classification of animals, and was weighted with two prevalent fallacies which theology had so generally impressed on the human mind. These were: the Biblical idea of the creation of organisms as they now exist and their consequent fixity and the homoistic notion that man was, in physical as well as psychical endowment, apart from, and not a part of, the rest of the animal world. Released from the oppressive incubus of these long-cherished fetiches, zoölogy has, during the past quarter of a century, bounded into the front rank of the sciences, with so many of which she is so intimately bound.

Inspired and guided by the search-light of Evolution, which reveals and makes intelligent so much that was hidden or unmeaning before, zoölogy must lead her sister sciences in all study of the genesis of life upon our planet, whether in past or present time. With the induction of the unity of all psychic phenomena and the conviction that these are inseparable from animal organization, it is her mission to give rational explanation of the subtlest of such phenomena and to check the vagaries which exist as to their abnormal manifestations; for even among lower animals there are senses and sense-organs not yet understood by us, while some species have developed a telepathy which, in its power and ease of demonstration, may well astonish those who have hitherto confined their investigations to man.

Deeper study of electricity, as exemplified in the animal world, may help the electrician to a better understanding of the nature of that force, the practical application of which to the affairs of civilized man has made such gigantic strides of late; while animal phosphorescence may yet illumine, when better understood, the path of the physicist in his investigations of the phenomena of light. Animal mechanics, as exhibited in flight, may hold the solution of practical aeronautics, which promises to cap the marvelous and momentous discoveries of the century; while to the inventor they are pregnant with yet untold and unthought-of suggestions.

That branch of zoölogy which concerns the interrelations and interactions of animals is not only fascinating to the philosophic student, but has a most important economic bearing, especially to those engaged in agricultural and horticultural pursuits.

But the subject which just now seems to be receiving most attention from zoölogists, is heredity, and the cognate question which has divided us into two opposing camps, as to whether or not characters and functions acquired during the lifetime of the individual are trans-

*Remarks made at the opening of the International Zoological Congress, Chicago, August 19, 1893, by Dr. C. V. Riley of Washington, D. C., as Honorary Chairman.

mitted to the offspring. The solid fabric which Darwin did so much to erect, and which is essentially based on the affirmative proposition, has been most persistently stormed, especially by a certain class of embryologists, and the question is too complicated and far-reaching to be lightly considered. It may be well to bear in mind, however, that the solution of the problem involves the psychical as well as the physical facts, and that the former cannot be revealed by scalpel or microscope. The naturalist who studies the development, and the actions of living organisms, in their relations to each other and to their environment, and who seeks to confirm his views by experimentation is, in my judgment, better qualified to draw reliable conclusions than either the histologist or the embryologist. Modern laboratory methods of zoological work, encouraged by the importance of bacteriology, have been so generally influenced by the microscope that they have pushed beyond the short-line of safe induction, and we already hear the murmurings of the reactionary wave which will carry us back toward the more comprehensive methods of the older school of naturalists whose names adorn the annals of our science. The microscope, however important in revealing the processes of growth, will yield us the secret of heredity no sooner than it will yield us the secret of life itself.

The latent potentiality contained in the germ, and the psychological directing force which modifies its later development, must always escape such methods. What we now most need to establish any sound theory of heredity is experimentation, intelligently planned and carried on through a series of years, not alone during embryonic, but during the whole development of the individual, and to include all the elements in the problem. Such experimentation on a sufficiently broad scale can hardly be undertaken by individuals, and the institutions which liberally endow and equip a chair of experimental zoölogy to this end will deserve well of mankind. The zoölogist, while skeptical of the ordinary theological and metaphysical interpretations of mind phenomena, is not disposed to dogmatize. His attitude is one of agnosticism on all questions as to the origin, nature and end of life, whether in its simpler or more complex manifestations; and he simply insists with Wordsworth that, "to the solid ground of Nature trusts the mind which builds for aye!"

The subdivisions of our science in which just now investigation is most active are those which shed light on the general subject of animal evolution, and our program shows that palæontology, embryology, kinetogenesis, bioplastology, heredity and kindred subjects will not lack for eminent exponents. It would be unwise to delay proceeding with such an interesting program by further remarks of my own, and I will at once call for the reading and discussion of the formal papers.

LETTERS TO THE EDITOR.

* Correspondents are requested to be as brief as possible. The writer's name is in all cases required as a proof of good faith.

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

RED BIRDS AND A GROSBEAK.

A FRIEND of mine bought a pair of young red-birds, from a lad who had taken them from the nest. At the same time he gave her a rose-breasted grosbeak, which he said he had found sitting on a bush, and "looking sick like." The grosbeak had no wounds, and no broken bones, and my friend placed it on a perch in the cage with the red-birds. It remained there twenty-four hours,

refusing food and drink, drawing itself into a heap, and looking very miserable. Meantime the red-birds were vociferously hungry, but unable to take food for themselves, and my friend was obliged to feed them by taking them in her hand, and putting the food into their mouths with a little stick. The grosbeak surveyed this proceeding very intently, with an expression of scorn for human awkwardness!

As, during twenty-four hours, the grosbeak had seemed to make no improvement, my friend, taking him in her hands, gave him a minute examination, and found on the back of the neck the skin raised in a clear, tense bubble, as large as a bean, and of a yellow hue. She clipped a little hole in this bubble, using a pair of small sharp scissors. Only air exuded, no pus nor moisture; in a moment or two the rising was gone, and the skin resumed its place. She rubbed the incision with a drop of oil, restored the bird to the cage, and within ten minutes he was eating, drinking and hopping about in fine style.

He at once installed himself as foster-father to the red-birds. He hung over them with soft "feeding cells," holding the prepared food, and dropping it into their open throats. The little birds thrived under his administration, and in a week were taking care of themselves.

A few months later, my friend being away from home over night, the servant who had charge of the birds, neglected to put any hard-boiled egg in the cage, putting in only bread and seeds. When the lady returned the grosbeak seemed to be alarmed and suffering, and, examining him, she found a wound on his back, some skin and a little flesh being gone. Thinking that a mouse, or rat, or cat near the cage might be the author of the trouble, she dressed the injury with carbolic salve, and hung the cage higher. All went well until she was again absent for two days, and there was the same neglect of diet. On her return she found the grosbeak in a very low condition, and this time with a large hole in the fleshy part of the breast. The servant said that "twice the red-birds had been fighting the grosbeak." The fact was evident, craving stronger food, they had helped themselves from the living body of their poor little foster-father. The care and skill lavished on him, and a cage for himself, were not sufficient to save him, and he died the next day from the effects of his injury.

J. McNAIR WRIGHT.

SPACE RELATION OF NUMBERS.

WITH reference to the graphic presentation of numbers in the imagination, narrated by Mr. Martin in a recent issue of *Science*, I may add the following personal record. I daresay it will be found, as in most such cases, that what Mr. Martin imagined as peculiar to himself, exists in some form or other in nearly all minds, though I do not recollect having seen any reference to it, a fact due doubtless to the limited character of my reading on the subject.

From an early age I remember noting the fact, at least as early as my sixteenth year and I think a year or two before, the period being one in which I passed from arithmetic to algebra and geometry, that it became apparent to me that in the first hundred numbers the first ten appeared to lie on a horizontal line, the next ten arose at right angles and that the remaining numbers, from twenty up to a hundred, lay with more or less distinctness, not so much as visualized numbers as concepts of numbers independent of symbol, in an inclined line at an angle of about thirty or forty degrees with the horizon. Beyond one hundred I have no imagination on the subject. I may add that I was taught in the ordinary mental and high school arithmetic before Grube's system had made