

with his masterly discussions of these facts, which are found on every page, and the value of which, to embryologists, cannot be estimated. Moreover, to his authorship is largely due the rapidly spreading interest in embryology in England and America, — a branch of science, it will be remembered, which had previously been mostly in German hands.

One frequently heard from him his own very modest opinion of his work; this was not at all inconsistent with striking independence and originality of thought, and adherence to his convictions. His modesty added more to the recognition of his genius than any assertions of his own could have done. Many were pressing forward to assert his claims, and honors were fast showered upon him in England and abroad. He was admired and beloved by all who knew him. In scientific discussion he had the rare quality, which Richard Cobden is said to have possessed, of remaining on the pleasantest personal terms with his opponents.

His energy in all matters was great, and his power of writing was unusually rapid; but, advised by kind friends, he rarely overtaxed his strength, which was limited. He spent most of his evenings with his friends, throwing off from his mind the labors of the day, and talking vivaciously upon the topics of the times. When the first volume of Comparative embryology was being written, he generally worked but five hours daily, giving much time to physical exercise, bicycling, or tennis, into which he entered with all the enthusiasm of his nature. He was courageous, but not reckless; and nothing in his previous life would lead us to suppose that the mountain climb which proved fatal was undertaken in a foolhardy spirit.

Balfour in a few years accomplished the work of a lifetime. His influence was and is twofold, — first, upon those with whom he came in personal contact, especially his scientific associates and students (an influence which cannot fail to endure, well expressed by Professor Kitchen Parker: "I feel that his presence is still with me; I cannot lose the sense of his

presence"); and, secondly, the influence of his scientific work, which for genius, breadth, and truth, can never be surpassed. May the splendid memorial which has been raised for him perpetuate his noble example as a teacher and man of science! HENRY F. OSBORN.

THE INTELLIGENCE OF BIRDS.

HAVING met with many instances wherein birds have shown considerable ingenuity in overcoming the ill results of accidents to their nests, such as often arise during violent storms, it occurred to me, at the outset of the bird-nesting season of the present year, to endeavor to test their intellectual powers generally, by a series of simple experiments, hoping thereby to be able to determine to what extent birds exercise their reasoning faculties.

My experiments, and the inferences I drew, are as follows:—

Noting the material being gathered for the nest, partially constructed, of a chipping-sparrow (*Spizella socialis*), I placed a small quantity of the same in a conspicuous position near the nest. It was seen by the sparrows, and examined, but none was removed. I placed a portion of it upon the margin of the unfinished nest: it was promptly removed by the male bird, who used only such materials as were brought to him by his mate. The following day the task of lining the nest with hair was commenced. I placed a quantity of this material on a branch near by, but it was passed unnoticed. I next placed a few hairs on the margin of the nest: they were promptly removed. On replacing many of these in the nest, the entire lining was thrown out. I replaced it, and the nest was abandoned.

A week later, finding another nest with three eggs, I added a few white cat-hairs to the lining: these were removed. Others of dark colors were added: they, also, were removed. I replaced both dark and white hairs: the eggs were broken, and the nest abandoned.

Four eggs found in a third nest were removed without touching the nest, a wooden spoon whittled for the purpose being used. In three days the female commenced laying again: four days later three eggs had been laid. Replaced the four I had removed: they were promptly thrown from the nest. I then removed the nest, and, substituting another, carefully replaced the eggs without handling them. After what appeared to be a serious consultation, the new nest was accepted.

These birds suffered no further annoyance, and reared their brood without mishap.

Why should not these have utilized the material for their nest which I offered, rather than gather similar stuff from distant points? They could not have been frightened by any odor attached to the material through handling, as I was careful not to touch a particle of it, using a pair of wooden tweezers in every case. Neither did they see me carrying any thing to or from their nests. As these, in all cases, were nearly or quite completed, the birds had necessarily become thoroughly familiar with the surroundings, and doubtless recognized the fact that these offered twigs and the hair had suddenly appeared in, to them, some unexplained manner, and the mystery surrounding it made them suspicious. Suspicion, I suggest, is a complicated mental effort. Again: the sparrows were sorely perplexed when a nest not of their building, but of the same character, was substituted for their own. Here, these birds exhibited fear; but finally the maternal instinct overcame the timidity of the female, and she resolved to brave the danger or solve the mystery, and cared for her eggs as usual. The male bird kept aloof for several days, I think; but of this I am not positive. These sparrows were moved by conflicting emotions, — evidence, I think, of an advanced degree of intelligence.

Another series of experiments were as follows: finding a nest of the summer warbler (*Dendroeca aestiva*) in a low alder, the foliage of which was about one-third grown, I girdled the supporting growths a few inches below the nest. The leaf-buds withered, and the nest, which under ordinary circumstances would have been quite concealed from view by the full-grown leaves, was now exposed. The nest was abandoned.

The next girdling experiment was made on the nest of a white-eyed vireo (*Vireo noveboracensis*) found attached to a low limb of a small beech. The leaves quickly shrivelled, and the nest, although just finished, was abandoned.

A second experiment of the same sort was tried, with identical result.

A nest of the summer warbler was found in a low shrub, containing young birds, and the supporting branches girdled. The leaves withered and fell, exposing the nest to full view. The parent birds remained, and successfully reared their brood.

In these cases we have evidence of mental operations of a more complicated character than any exhibited by the sparrows. It is evi-

dent, that in every case, these birds, in selecting the position for their nests, knew that the growth of the foliage would afford a desirable, if not necessary, protection to them. Finding that the growth of the foliage had been checked, that the little shelter at first afforded was daily growing less, they foresaw that the nests, under these circumstances, would be too much exposed to be safe from molestation, and they were abandoned, even after a full complement of eggs had been laid. Can we explain this by any other means than by using that very suggestive term 'foresight'? But mark: when the same circumstance occurred after the young had appeared, the claims of the brood upon the parents were too strong to be overcome, and the danger of occupying an exposed nest was readily braved.

Experiments of another character were as follows: I placed a series of short pieces of woollen yarn, fastened together at one end, near the tree containing a partially constructed nest of a Baltimore oriole (*Icterus Baltimore*). These yarns were red, yellow, purple, green, and gray. An equal number of strands of each color were thus offered to the orioles as building-materials. I purposely placed the red and yellow strands on the outside of the tassel-shaped mass, so that these would be first taken, if the color was not objectionable. To my complete surprise, the gray strands only were taken, until the nest was nearly finished, when a few of the purple and blue yarns were used. Not a red, yellow, or green strand was disturbed. Here we have an instance of the exercise of choice, on the part of a bird, which is full of interest. The woollen threads being otherwise identical, it was the color only that influenced the choice of the birds: they realized that the red or yellow yarns would render the nest conspicuous, although well protected by the foliage of the branch to which it was attached. Why the green threads were not taken I cannot imagine. As a result of this experiment, I anticipated that the orioles would reserve the brightly colored yarns for the lining of the nest, and the gray and green for the exterior. This was a result obtained two years ago, when I tried a similar experiment; but the use of red yarn as a lining may have been merely accidental.

Out of mere curiosity, for I could not anticipate what might be the result, I made a few transfers of the eggs of one species into the nest of another bird. The results were not, however, particularly suggestive. I placed the eggs of a cat-bird (*Mimus carolinensis*) in the nest of a song-thrush (*Turdus mustelinus*),

and *vice versa*. The eggs of the former are dark green; of the latter, light blue. No act indicative of recognition of the change was observed. I placed eggs of the song-sparrow (*Melospiza melodia*) in the nest of a pee-wee (*Sayornis fuscus*), and *vice versa*. The fly-catchers rejected the eggs of the sparrow; but the latter accepted the situation, although disturbed by it. Many other changes were made, with similar results; and I concluded, that, unless the eggs were greatly different in size and color, about one-half would be accepted; but, when a single egg was placed in the nest of another bird, it was destroyed in nearly every case. This I found to be true, even when I tested such birds as are subjected to the annoyance of the cowpen bird's egg being deposited in their nests. I was surprised at this result, and am led to believe that large numbers of the eggs of this bird are destroyed. It is well known that our summer warbler frequently outwits the cowpen bird by building a new nest directly above the old, — a two-story nest, in fact, — and leaves the egg that has been left to her care to rot in the basement, while she rears her young on the floor above. It will be seen that from these experiments no very positive results were obtained. I did note, however, that, where the change was accepted, it was not because it passed unnoticed, but was submitted to, notwithstanding the evidences of much misgiving on the part of the birds. In one case, the nest was practically deserted for twenty-four hours, and the eggs were chilled in consequence. The birds sat upon them for five days, when, as they did not hatch, the nest was abandoned. In previous years I have made these changes occasionally with success, but was not able to determine that the young were recognized as not the offspring of the parent birds. In such cases the young were tended with the usual care up to the time for leaving the nest. This may possibly be indicative of stupidity. It appeared so to me at the time; but I am now disposed to see in it an indication that the maternal instincts here, as in other cases I have mentioned, overcame all other feelings, and that the fact was accepted by the birds with as good grace as they could command.

The co-operation of birds, when constructing their nests, is a subject that demands a good deal of close attention, and is one surely worthy of more systematic observation than has as yet been given it. The many ways in which birds assist each other in nest-building offer, perhaps, the clearest evidence that they have a very intelligent notion of what

they are doing, or propose to do. I feel warranted at the outset in making the somewhat startling assertion, that the choice of location for a nest is made only after protracted joint examination of suitable sites, and is the choice of both birds. I doubt if it ever happens that one of a pair of birds 'gives in' to its mate. Certainly such a thing as madame giving up to her lord is unknown in the bird-world. My impression is, that the female birds of every species are exacting, obstinate, and tyrannical. I have seen marked instances of this among house-wrens, pee-wees, and even known a cooing turtle-dove to exhibit unmistakable evidences of a quick temper. These may seem to be trivial matters, and not within the range of the scientific study of animal intelligence; but it is an error to look upon such proofs of individuality in this light: they are among the most convincing evidences of a high degree of intelligence. If a hundred or more nests of the same species of birds are carefully compared, it will be found that there is a considerable range of variation in their construction, and a varying degree of merit in the skill shown by the builders. Is not this evidence of different degrees of mental strength occurring among birds of the same species?

But to return to the subject of co-operation in nest-building. I have found, that where very long, fibrous materials are used, as in the case of the globular nests of the marsh-wrens, the birds work together in weaving the long grasses that form the exterior. I have seen one of these birds adjusting one end of a long blade of rush-grass, while its mate held the other end, until the former had completed its task to its satisfaction. It was evident that the weight of the ribbon-like growth that the bird was using, quite a metre in length, was too heavy to be moved to and fro, and at the same time prevented from slipping from the unfinished nest. Only by assistance could such materials be utilized, and only by intelligent joint labor could these little birds build such large and complete globular nests. Many birds, too, have been known to jointly carry away a long string or piece of muslin too heavy or cumbersome for either one to move. Again: materials are often brought by one of a pair of birds to a nest which the other considers unsuitable, and fierce quarrels often arise from this circumstance. In such cases we have instances of a difference of opinion among birds, which is a marked indication of mental activity.

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