in falling and have therefore sunk deepest before losing their liquid load. The strata mount upward as fresh exhaustion proceeds. The last colors to appear are the browns and yellows of the first order, also seen in the steam tube for vanishing condensations. The whole phenomenon is thus the result of strata of invisible nuclei, *graded in virtue of the loading mechanism,* and partakes throughout of a mechanical character to the extent that the nuclei are *not even a uniform product.* The forced distribution is sufficiently powerful to entirely mask the elementary optical phenomenon.*

On shaking the liquid benzine in the receiver uniform distribution is again promoted, with the result that annular coronas reappear. It is particularly to be noticed that subsidence is due to loaded nuclei. The free nucleus does not appreciably descend. Even with water vapor, loading does not produce stratification. Water fogs when exceptionally dense may sometimes be seen to rise, but the diffraction pattern is always annular and usually without color distortion.

Carl Barus.

Brown University,
Providence, R. I.

* Since writing the above I have made similar experiments with benzol, reaching the additional result that nuclei are produced by the liquid itself, *spontaneously,* in the dark. They ascend against gravity in horizontal strata, at the rate of 2 or 3 cm. per sec. in the lower hemisphere. They may be completely precipitated by partial exhaustion, leaving the air in the vessel free from nuclei (but the above flask will be refilled to saturation in 10 or 20 minutes). The experiment may be repeated any number of times. The sharp demarcation of the pure air above from the rising surface of nuclei is beautifully evidenced by the coronas, which are annularly perfect for axial beams below the surface, asymptotically *bowl-shaped* at the surface, and absent for axial beams above the surface. Shaking produces the coronas from pure air instantly, but these are usually smaller. In so far as the spontaneous coronas have fixed diameters for fixed exhaustions (supersaturation), the number of nuclei eventually reaches a maximum or saturation. Among many interesting problems growing out of the present observations, the corresponding behavior of water is most important.

DATA ON SONG IN BIRDS: THE ACQUISITION OF NEW SONGS.

The purpose of this paper is to set forth the evidence that has come under the writer's personal observation regarding the propensity of birds to acquire new methods of expression in song.

This faculty may be properly divided into three categories: First, the disposition of wild birds to interpolate new phrasing into what may be called their normal song, or *to acquire new songs.* Second, education of expression, by direct teaching from man to birds in confinement. Third, the propensity of caged birds to imitate, voluntarily, sounds that attract their attention.

The evidence under the first division of this thesis is absolute and also well known. However, a few special cases may serve to emphasize the matter.

Every trained field ornithologist discriminates individuality in song, and some have been so fortunate as to have noted wide and radical departures from what I have distinguished as the normal song. The slight variation from the normal is of too common occurrence to be dwelt on here. Suffice to say that as set forth in a previous paper in this journal,* most observers recognize degrees of excellence in the songs of wild birds of the same kind.

Again, a few observers have heard wild birds imitate or produce not only the songs of other birds, but also the barking of dogs, human speech and mechanically produced sounds such as the creaking of a wheel, the filing of a saw and the like. The facility

* See Science, October 4, 1901, p. 522.

of the mocking-bird in this particular is traditional. A few other instances seem worthy of record.

A catbird (*G. carolinensis*) that nested in the immediate vicinity of my house in the season of 1900 reproduced the call of the whip-poor-will (*A. vociferus*) so perfectly that it was difficult to induce members of my family and visitors who heard the reproduction to credit the fact that it was not the whip-poor-will singing. A friend who knew nothing about the catbird as an agent in the performance and who had not had her attention called to the matter in any way told me that she had heard a whip-poor-will singing near my house repeatedly in *the day time*, and wished to know if this was the ordinary habit of the bird. In a residence of some twenty years in this locality I have never heard whip-poor-wills nearer to the point in question than three miles.

The following case of a wild rose-breasted grosbeak (*Z. ludoviciana*) *talking* is well attested. I quote from Emily B. Pellet, Worcester, Mass., in *Bird-Lore*, Vol. III., No. 5, p. 174, October, 1901, as follows: "Early last summer, while standing on my back steps, I heard a cheerful voice say, 'You're a pretty bird. Where are you?' I supposed it to be the voice of a parrot, but wondered how any parrot could talk loud enough to be heard at that distance, for the houses on the street back of us are quite a way off.

"Almost before I had done laughing, the voice came again, clear, musical and strong—'You're a pretty bird. Where are you?'

"For several days I endured the suspense of waiting for time to investigate. Then I chased him up. There he was in the top of a walnut tree, his gorgeous attire telling me immediately that he was a rose-breasted grosbeak.

"At the end of a week he varied his compliment to 'Pretty, pretty bird, where are you? Where are you?' With a kind of impatient jerk on the last you.

"He and his mate stayed near us all last summer, and though I heard him talk a hundred times, yet he always brought a feeling of gladness and a laugh.

"Our friend has come back again this spring. About May 1 I heard the same endearing compliment as before.

"Several of my friends whom I have told about him have asked, 'Does he say the words plainly? Do you mean that he really talks?' My reply is, 'He says them just as plainly as a bird ever says anything, so plainly, that even now I laugh whenever I hear him.'"

Space will not allow the further elaboration of this part of the subject.

The second division, that of education of birds in song and speech by man, is also well known. The bullfinch's (*Pyrrhula europæa*) ability to learn to whistle airs with great accuracy and precision, as well as the peculiar quality and charm of its voice, has arrested the attention of all observers and has been cultivated for more than a century. Few of us, however, realize that only *wild birds* hand-reared from a very early age are educated in this accomplishment, and it is worthy of special notice that wild bullfinches have little or no song, and may be compared with the European sparrow (*P. domesticus*) as a songster. Starlings (*Sturnus vulgaris*) are well known as birds susceptible not only of learning to whistle simple melodies, but as rivals of parrots in reproducing with great distinctness short sentences. Parrots are proverbial as talkers, singers and whistlers. Canary birds have frequently been recorded as learning to whistle simple tunes, and there are a number of well-attested accounts of their reproducing with precision short sentences. Jays, crows and magpies also talk and whistle with

great facility. The voices of jays in reproducing speech are particularly melodious and lack the peculiar phonographic timbre characteristic of most parrots and of starlings.

Mention must be made here of the minos (genus *Mainatus*) of India as on the whole the most receptive among birds in learning to talk, sing and imitate all sounds of a mechanical kind. All these results have been achieved by education, that is, direct teaching with intent on the part of the human instructor.

The third part of this discussion, that which deals with the propensity of caged birds to imitate or reproduce, voluntarily, sounds that attract their attention, needs a few words of explanation.

No direct effort or intention on the part of a human agent is a factor in this category. All but one instance that I shall adduce of this kind of ability have occurred in an experience covering some six or seven years with birds obtained in ways, and kept under conditions, that require brief consideration. These birds are all hand-reared wild species; birds taken from the nest when very young and raised by hand. As soon as such birds were able to feed and care for themselves they were liberated in large rooms having as near freedom as confinement would allow. No instruction was given to them. In a word, it was an effort to observe *what birds would do if left to themselves and supplied with food and water.* No effort was made to keep these birds from hearing the song of wild birds out of doors. The species dealt with in this way are comprised in the following list:

12 bluebirds (*Sialia sialis*).

14 robins (*Merula migratoria*).

6 wood thrushes (*Hylocichla mustelina*).

7 catbirds (*Galeoscoptes carolinensis*).

2 thrashers (*Harporhynchus rufus*).

2 yellow-breasted chats (*Icteria virens*).

2 rose-breasted grosbeaks (*Zamelodia ludoviciana*).

1 cardinal (*Cardinalis cardinalis*).

6 Baltimore orioles (*Icterus galbula*).

7 orchard orioles (*Icterus spurius*).

1 bobolink (*Dolichonyx oryzivorus*).

2 cowbirds (*Molothrus ater*).

4 crow-blackbirds (*Quiscalus quiscula*).

5 red-winged blackbirds (*Agelaius phœniceus*).

1 meadow-lark (*Sturnella magna*).

6 blue jays (*Cyanocitta cristata*).

It will be sufficient for us to consider only the very marked acquirement shown by individuals among these birds, none of whose songs are quite normal. A number of the robins have peculiar songs that in no way resemble wild robins' songs. I should call them *invented* songs, for lack of a better name.

The wood thrushes' song varies much from the normal, but can hardly be regarded as invented or original.

Catbirds did much mimicry of the songs of other birds.

A yellow-breasted chat is worthy of particular mention. This was a bird taken with another from a nest in May. In September of the same year I was busy in correcting proof for a forthcoming book of some size, so that for at least three months a part of each day was devoted to this work. The manuscript and proof were delivered by a postman. There were three deliveries each day. Ordinarily the postman dropped the mail into a slot in the door, but when he had a package of proof this was not feasible and he sounded a call or postman's whistle for some one to come to relieve him. One afternoon in September, about the time I was expecting proof the whistle sounded and I went to the door. No one was there. My first impression was that some boy in the neighborhood was up to mischief. The experi-

ence occurred four or five times in the next day or two and I began to regard it as mysterious, never thinking of the birds in such a connection. Some four days later while watching the birds—I was in the room with them—a chat came and alighted on my shoulder and shrill in my ear sounded the exact reproduction of the postman's call. The very direction and distance from which the call came and its exact tone were reproduced. I heard it many times afterward, friends and other members of the family became familiar with the call, and even after I was aware of it, when I was expectant, I have heard the postman, gone to the door and finding no one, knew how realistic was the reproduction of the postman's call by a yellow-breasted chat.

One of a brood of red-winged blackbirds (*A. phœniceus*), a male, crows constantly for all but two months in the year. The crow is an imitation of the crow of the common bantam rooster. Distance and direction are clearly indicated. The sound always appears to come from the rear of the house, at some little distance, and is a very clever imitation of the crow of a bantam rooster. This is the only song this bird has.

A blue jay (*C. cristata*) reproduces the song of the cardinal (*C. cardinalis*) so perfectly as to deceive any one. It is copied from a cardinal in the room, and distance and direction are not indicated.

A European jay (*Garrulus glandarius*) has learned from a cockatoo to say 'How do you do,' 'How do, pretty polly,' 'Pretty polly' and some whistles and calls.

"Last summer on a Wisconsin farm there was a duck hatched out with thirteen turkeys by a hen as a foster-mother. This duck followed the turkeys around and wavered a very long time before it went into the water, and it still imitates the *turkey's note* with its *duck voice*. It sleeps under the turkeys' roost at night now, although it is quite an old duck, and scorns the company of the other ducks on the plantation. This interesting family is on the farm of Mr. Clinton D. Stewart, whose post-office address is Dousman, Wisconsin. Mrs. Merrick first called my attention to the duck's turkey call; but I was not entirely satisfied until I heard it myself." (Extract from letter of Edwin T. Merrick, 836 Gravier street, New Orleans, La., October 19, 1901, to W. E. D. Scott.)

This call of the turkey given by a duck is of special interest as præcocial birds appear to have much less receptivity than altricial birds. The reason seems obvious.

In concluding a word is necessary as to the probable reason why birds in confinement diverge from the normal in the habits of song. Presuming that wild birds are pretty constantly employed in obtaining a food supply, it would seem that they *do not have much leisure*. On the contrary, birds in captivity with all their physical wants carefully looked after, *have leisure* and employ it in giving their attention to occurrences about them, particularly such as are accompanied by any noise.

Of this factor of leisure among animals in confinement little is known, and a broad field is presented for those investigators who have opportunities in zoological gardens or, better still, in special laboratories equipped for this and kindred studies.

WILLIAM E. D. SCOTT.
PRINCETON UNIVERSITY.

MUSEUM STUDY BY CHICAGO PUBLIC SCHOOLS.

THE Field Columbian Museum is often visited by classes from the Chicago public schools for purposes of instruction obtained by studying the illustrations there afforded of different subjects taught in the schools. The character and value of such