*dass aus unbefruchteten Arbeitereiern von Lasius niger Fabr. wiederum Arbeiter entstehen. Also wieder ein Dogma verfrühter Verallgemeinerung, dass in Nichts zerfliesst!**

Surely I may be permitted to express as a probability what the most eminent myrmecologist states in such emphatic language. That I was well aware of the remote possibilities mentioned by Castle, and of others which he does not seem to have surmised, is clear from my express statement that the observations of Tanner, Reichenbach and Mrs. Comstock are 'by no means final.' It would have been natural for a less captious critic to suppose that the views advanced in my paper were not determined solely by the observations cited from other authors, but to some extent by my own experiences, which though less tangible and less readily formulated at the present time, are not less suggestive to me of the trend of future investigation.

Academic convictions like those advanced by Castle can be of service only in prejudging a field of inquiry; they can be of no imaginable use in stimulating or furthering research except indirectly through the spirit of contradiction aroused by their dogmatic character. If Castle had any new facts, or original interpretations of old facts, for that matter, to bring to bear on the problems under discussion, I should be the first to welcome them. We need something more, however, than mere discussions of possibility and probability, if we are ever to dispel the mystery that envelops many of the instincts and reproductive processes in the social hymenoptera.

WILLIAM MORTON WHEELER.
AMERICAN MUSEUM OF NATURAL HISTORY,
March 24, 1904.

VEGETABLE BALLS.

TO THE EDITOR OF SCIENCE: Can any of your readers refer me to any published mention or description (other than in Thoreau's 'Walden') of those balls of matted vegetable matter formed on the sandy bottoms of shallow ponds, apparently under the action of wave-motion? In what ponds or lakes (other than Flint's or Sandy Pond, in Lincoln, Mass.) are they known to occur? Have they any recognized names? Of what materials are they mainly composed other than *Eriocaulon* leaves? Any information will be very welcome.

W. F. GANONG.
NORTHAMPTON, MASS.

SPECIAL ARTICLES.

RIGHT-EYEDNESS AND LEFT-EYEDNESS.

I WISH to solicit the aid of the readers of SCIENCE in securing answers to the following questions concerning left-handed persons they may know:

1. Name, or at least initials, residence, sex, age and occupation?

2. Is the left-handedness complete or only for some of the acts usually performed with the right hand by right-handed persons?

3. Is the left-handedness the result of accident to the right hand or arm, or did it exist from infancy?

4. With which eye is a gun sighted, a board or yard-stick proved straight, or a table level, etc.?

5. With which eye, without glasses, is the vision of letters across a room in a good light the clearest? (Alternate covering either eye, not closing it.)

6. If glasses are worn for distant vision, the oculist's prescription, and the relative sharpness of vision of each eye with the glasses?

Right-handed persons are, I believe, naturally right-eyed, and the left-handed are left-eyed. There is little doubt as to the first, but I have found it difficult to get data concerning a sufficient number of the left-handed.

The fact of right-eyedness or left-eyedness has, it seems to me, much greater significance than the similar conditions pertaining to the hands, but, so far as I can learn, nobody has even thought of it, much less discussed its many suggestive implications. Indeed, I question if the right-handedness or left-handedness is not a simple result of the ocular one-sidedness which preexisted and made necessary the paramount use of the one or the other hand. Both conditions, moreover, seem to me probably the simple result of the usual location of the speech-center in the left-brain. I

* The italics are mine.

see no reason so far for this left-side placing of the speech-center.

Precision in running, fighting, defense, manipulation, distant vision of enemies, signs, etc., would begin at least early in the history of human savages, and winning in the struggle for existence even so early would depend generally far more on accuracy and perfection of vision than of manual dexterity. I have not been able to conclude as to the existence of any degree of right-handedness or left-handedness or of right-eyedness or left-eyedness, in animals. Beavers and monkeys might possibly show the beginnings of differentiation. In all human beings, of any degree at least of civilization, both facts can be demonstrated. When civilization is present, the demonstration is apparent in the right-handedness of archers, and those using weapons of battle, and especially of gunners. All military regulations require the musket to be brought to the right shoulder in aiming and firing. These and many other right-handed uses and customs, of course, presuppose and make necessary right-eyedness. In mechanical occupations all tools are made for the right-handed. Locomotive engineers sit on the right-hand side of the engine; that this is because of right-eyedness is proved by the fact that the throttle is manipulated by the left hand, the other and the more expert and stronger one being unused during the 'run.' But, if right-eyed, the engineer can see the track and signals better from the right side of the boiler than from the left. The great mystery and the long-discussed problem of the varying usage of the drivers of wagons, carriages, etc., in passing on the right or left, will be explained, I suspect, by right-eyedness. That those afoot always pass to the right, even though the carriages in the same street pass to the left, is explained by the fact that the field of vision in front and the choice of directions are better under the circumstances than it would be with the right-eyed passing to the left. The danger of collision of vehicles makes passing to the left the preferable and safer plan.

When the harp grew into the dulcimer, and that into the piano, the execution of the most important, skilled and difficult part, the melody or air, was of course given to the right-hand side of the key-board, and the easier and accompanying part to the left. But prior to that was the violin, and it is only the theory of right-eyedness that can explain why the most difficult and rapid fingering was given to the more inexpert left hand, and the simpler and easier bowing to the more dextrous right. The advantage was unconsciously recognized and unconsciously applied which comes from the learner's greater ability to see the motions and positions of the fingers with the right eye when the fingering is done with the left hand. The left hand and the neck of the instrument in this position are seen at an angle, and, therefore, more correctly, than would be possible if the right hand were used for fingering and the neck of the violin placed directly in the line of the axis of vision of the right eye. In this case there would be the difficulty and doubt which results from the foreshortening or from looking along a line or surface nearly level with the eye.

The more expert hand in shooting a gun is used for the simple task of pulling the trigger, while the weaker and more awkward left is forced to do the all important tasks of supporting the gun and taking aim or directing the barrel upon the mark. The right eye compels also this reversal of what would otherwise be the natural and unconsciously preferred custom. In chopping, hoeing, shoveling, etc., the weaker left gives the force and direction of the blow, and the right only guides a little the end of ~~the tool,~~ and in general serves a subordinate function. In these occupations the angled axis of vision as in the violin is not necessary, and would even be a disadvantage. Looking downward, as in writing, the right does its work more accurately when straight below.

Any number of similar examples will come to mind of the influence of right-eyedness in every department or phase of our life, and the explanation of a multitude of incongruities and peculiarities observed or hitherto unsuspected will be brought to light. There is hardly any act or custom, personal or social,

that does not give evidences of the influence of right-eyedness.

One wonders if a new clearness will not be brought into neurology and psychology by a careful correlation of the suggestions which the theory offers. The unification and perfection of innervation and cerebration must be better if initiated and executed with the cerebral centers mainly upon one side of the brain, than if the unity is gained by means of the longer and more distant commissural fibers extending between the two sides of the brain. In the right-handed the speech center is in the left side of the brain, as is also the innervational motor center for the right hand, and the optical center of the right eye. The dependence of all motion upon a perfect correlation of vision and judgment needs only to be mentioned. That all intellect is psychologically the product of vision is less recognized, but is not less absolute truth. The right hand writes, possibly because the right eye looks down upon the writing more accurately than would the left; both depend upon the synchronous and closely interrelated guidance of the speech-making function. All three are in closer unity and contiguity than if either were in the opposite side of the skull. A gentleman acquaintance who is left-handed for most things has by training during youth developed the habitual use of the right hand for writing. When he plays billiards he takes aim two or three times as long as others, and makes from six to ten motions with the cue before giving the stroke. One feels that his correlation of vision, judgment and motion is much more difficult than with other players.

In the left-handed, as is well known, the speech center is in the right brain. Hence the left-handed are also left-eyed.

The pathologic presents itself when in the right-handed by heredity or habit, right-eyedness is prevented by a greater ametropia in the right, by accident, injury, cataract, leucoma or other disease which markedly lessens its visual acuity below that of the left. Right-eyedness, however, will persist with considerably greater acuity of the left eye. To be right-handed by heredity and habit, and at the same time left-eyed by disease, etc., brings a doubt and an awkwardness into every act. After a half-life of right-eyed correlations and habits to be suddenly made left-eyed, etc., by disease, accident, or by glasses produces something like tragedy in a patient. Many problems and ill-successes in the practising ophthalmologists' office receive an illuminating explanation by keeping in mind the physiologic fact of right-eyedness and the pathologic consequences of disease, or the result of interfering with it, by spectacle lenses. It may be better for the oculist to leave a person right-eyed rather than to give such lenses as suddenly compel left-eyedness.

For the present I will cite only three illustrative cases:

The first is that of a man who is left-handed in billiard playing and in most occupations. Asked to see if his cue was straight, he brought it before the nose with both eyes open, and thus 'sighted' along it. Asked to sight more accurately, he finally brought it opposite the right eye and closed his left. Asked to observe if two tables were exactly of the same height, he again sighted with the right eye, shutting the left. And he wrote with his right hand. These acts at first seemed to be incongruous, but they were all explained by the fact that his right arm had been broken when he was twelve years of age, and the right-handed acts since then performed with the left have been compelled because of permanent injury of the right arm. Writing being largely a finger-movement, and especially an intellectual act, was continued with the right hand. It has been demonstrated by pathology that the intellectual act of writing proves the location of the speech-center to be in the side of the brain opposite the hand used, although for all other usually right-handed acts the left may be preferred.

The second case is that of a carpenter who is left-handed, and has been so from infancy. He is also left-eyed. During his youth parents and teachers tried to make him right-handed by tying his left hand behind him, etc. As a carpenter he has to use tools, the plane, a vise, etc., made for the right-handed, but he is always awkward when thus com-

pelled to work. After planing a board thus held in a vise, he goes to the other end of it in order to sight down it with his left eye. With this eye he is an excellent judge of levels and straight lines. He steps off with the left foot first. The most remarkable thing about this case is that, although the man is a good hunter and 'an excellent shot,' he, from some unexplained reason, puts the butt of the rifle against his right shoulder. *But he does not sight with his right eye!* He leans his head sufficiently to bring the left eye in the line of the sights, and with this eye only he takes his aim. He chooses highly crooked or angled gun-stocks because of this necessity. The left-eyed, I suspect, will always be found to have some exceptional habits or vestiges of habits still unconquered by the outnumbering and preponderant right-handed ancestry.

The third case is that of a man who has been left-handed from infancy in the use of all instruments, knife and fork, billiard cue, gun, hoe, etc. But so much was he trained and forced to use the right hand in childhood and youth in writing with pen and ink that he now habitually writes with that hand, if using pen and ink. If using a pencil, chalk, etc., he is equally expert with the left and usually prefers it.

I gather that ambidexterity should be discouraged instead of stimulated. If a child prefers left-handedness, there will be a greater celerity and unity by means of the location of the three organs dominating action in one side of the brain.

I have never seen anything but bad results from the attempt to train children to use the right hand instead of the left, when there is a decided tendency or habit to be left-handed. Moreover the attempt is never successful. The best consequences are poor, and are only awkward mixtures of the two forms, which yield confusions and indecisions during the entire subsequent life. The instance of the billiard player of whom I have spoken is one. Another and more striking evil result is that of a naturally left-handed friend, A. V. P., who by arduous and continuous training during his childhood was compelled to write with his right hand. For all other acts he is left-handed but he can not use his left hand for writing. Although now past fifty he has always hated any writing, the mere act of doing so, and he can not do any original thinking while writing. He is for this purpose compelled to rely on a stenographer, and then his ideas flow freely and rapidly. If he tries to think, plan, or devise and to write at the same time there is a positive inhibition of thought and he must make sketches, epitomes, several efforts, copyings, etc., in a painful and most unsatisfactory manner. The attempt at ambidexterity has been a lifelong obstacle to him in his professional progress. The chief centers most closely interrelated in writing and thinking are thus demonstrably better harmonized when in one side of the brain. The mechanics of neurology are plainly less difficult than could be achieved by any foolish and unsuccessful ambidexterity.

As to the appearance of left-handed children of right-handed parents and ancestors, we are, of course, in no scientific stage to explain, any more than we can explain dextrocardia or other embryologic anomalies. Perhaps, as I have suggested, the location of the speech center in the right side of the brain, by some exceptional condition of development is the ultimate cause both of left-handedness and of left-eyedness. The problem of heredity of left-eyedness and right-eyedness would prove a most interesting study by the method of Mendel.

George M. Gould.
Philadelphia, Pa.

STUDENTS AT GERMAN UNIVERSITIES.

The following table, as reported by United States Consul Warner, Leipzig, Germany, shows the number of students attending twenty-one German universities during the winter semester, 1903–4, arranged in the order of their numerical importance:

For the present winter course the total number of matriculated students at the German universities is 37,854, of whom 3,093 are foreigners, the largest number ever recorded. The number of foreign students is equivalent to 8.2 per cent. of the total number.