unchanging law; yet nature is intricate, profoundly intricate, and its processes interact beyond man's faculty of perception.

How the idea of complexity in nature is important may best be seen in its application to cause, condition and effect, the three essential topics of every theory. According to this conception, one effect may be the result of several causes. For instance, as Professor Crosby pointed out some years ago,[1] eskers may be partly of subglacial and partly of superglacial origin, and a single esker may be both in different portions of its course. The hydrocarbons, in their various occurrences, do not always satisfy the view entertained by some geologists, that they have had an organic source. Hence it is probable that they (the hydrocarbons) are like effects to be ascribed to different causes. Moreover, to say that, inasmuch as we observe a certain deposit to be forming to-day by a certain process, "it is therefore a legitimate theory that all similar deposits have the same origin,"[2] is unsafe reasoning. Because limestone is now in the making as an organic deposit, *all* limestone has not necessarily been so derived. Multiplicity of causes, then, must be taken into consideration by the theorist.

On the other hand, while the cause may be single, the conditions under which it acts may be so various that the effects are manifold. If the circumstances of origin are widely different, interpretation of the results is not so difficult as it is when these conditions are hard to discriminate. Thus, a theory of wind-worn sand should have regard for the composition of the sand; the size, weight, specific gravity, hardness and cleavage of the grains; and the prevailing wind velocity. So, too, any exposition of the origin of phenocrysts in igneous rocks should be developed with due heed for variations in the acidity and basicity of magma and of country rock. Consequently, multiplicity of conditions is also to be allowed for in elaborating a theory.

Thus, in the intricate system of nature, *similar* products may be the outcome of *different* causes, and *unlike* products may result from *one* cause, in each case the causes working under varied conditions. Although there are many other relations between cause, condition and effect, these two are especially emphasized here because they are most easily overlooked.

Summarizing—theory and hypothesis too often suffer from the mistake, first, of overrating the importance of some one particular cause or condition, and, second, of extending, more broadly than is legitimate, the application of this factor. These fallacies are in large part due to a failure to realize the extreme complexity of the relations between cause, condition and effect.

To avoid misunderstanding and to give a theory real value, we must assign to it definite limits, beyond which criticism should not reach. Be discreet in generalization, is good counsel.

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Harvard University,
January 4, 1909

[1] W. O. Crosby, "Origin of Eskers," *Am. Geol.*, XXX., p. 2.

[2] H. L. Fairchild, "Geology under the New Hypothesis of Earth-origin," *Am. Geol.*, XXXIII., p. 107.

THE BEHAVIOR OF A SNAKE

Several years ago, while Mr. Lester and I were sauntering along a country road near Newnan, Ga., a commotion was heard in the dry leaves along the side of the road. On quietly entering the underbush, it was noticed that the noise was caused by a struggle between a coach-whip snake (*Zamiens flagellum flagellum* Shaw) and a lizard that was unknown to me. The snake was about four feet long; the lizard less than a foot. They were not fighting; the snake was trying to make a meal of the unmanageable lizard. Frequently the lizard escaped from the snake. Then would follow a chase resulting in the recapture of the lizard. The snake invariably caught the lizard by the body. I knew that, if the snake were to capture the lizard by the tail, the lizard would break off the tail and escape. The snake, behaving as though aware of this, attracted my attention and caused me to remain and study its movements.

So intent was the snake upon mastering the lizard, that it paid no attention to me, standing there as quietly as a statue. Several times the pursued lizard and the chasing snake passed across my feet. At one time, the lizard, on escaping from the snake, darted up a tall tree. The snake followed. Here the four articulated limbs of the former gave it a decided advantage. After darting up the tree for a short distance, the lizard paused and glanced backward. As soon as the snake had approached quite near, the lizard darted ahead a short distance and then again paused and glanced backward. These reciprocal movements were repeated several times. Then, all of a sudden, the snake dropped to the ground. The lizard continued to gaze downward. About a foot from the tree upon which the lizard was resting, head downward, there stood another tree. Spirally up this trunk the snake quietly and slowly climbed, until it was a few inches above the level of the lizard. The unsuspecting lizard was scrutinizingly gazing downward. Quietly and quickly the snake extended the front portion of its body, and, with a sudden dart of the head, knocked the lizard to the ground. Before the latter had time to recover from the effect of the unexpected blow, the snake had dropped to the ground and recaptured it. The lizard was not yet conquered; but this article is concerned only with the behavior up to this point.

This behavior puzzled me for a number of years. I was reluctant to call it an exhibition of logical judgment; yet it seemed entirely too complex to be regarded as reflex action and too individualistic to be considered instinctive, in the ordinary sense. From the nature of the case, tropisms, as defined by Loeb, are out of the question. Nor could it be considered a "trial and error" response; for there is no series of errors followed by a blundering into a solution and a gradual "stamping in" of the appropriate response.

The problem that confronted this snake was how to overpower that lizard. Until the lizard climbed the tree, the follow-the-stimulus movements, which were either instincts or habits, were sufficient to cause the capture of the lizard: but, the moment the latter ascended the trunk of that tree, those movements, unmodified, were inadequate. Suddenly the behavior of the snake changed. It paused, then immediately met the situation with a response which was a special modification to suit a special circumstance; and this is what we mean by a practical judgment.

I am well aware that some will call this an anecdote and desire to throw it out of court, because it was not conducted in a laboratory, under laboratory conditions, and because we do not know the whole past history of the snake and its ancestors. Nevertheless, I am coming more and more to believe that ignoring the spontaneous behavior of animals in their natural environments hinders rather than helps the solution of the problems of animal behavior; for, it is in just these situations that the animals are apt to be resourceful. More caution is needed to interpret behavior in the open than under laboratory control; but the difficulties of the task furnish no excuse for avoiding it. I am a stanch advocate of laboratory work; but, at the same time, I feel that data derived from accurate field work are of greater value than many seem to think. Accurate observations made, by trained observers, in the field furnish us with stubborn facts that should not be ignored; they need to be interpreted in an unprejudiced manner. Laboratory work and field work should go hand in hand.

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April 29, 1909

QUOTATIONS

INCORPORATED BENEFACTORS

Benefactors die; universities abide. At least, that has been the case in the past. But in this age of organization, benefactors have learned to perpetuate themselves as corporations. And we now have institutions chartered by acts of congress to disburse for educational purposes the charities of millionaires. The rich philanthropist, who objectifies himself in such a benevolent corporation, of