

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE
OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION
FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, MAY 13, 1904.

CONTENTS:

<i>Some Aspects of the Development of Comparative Psychology:</i> PROFESSOR WESLEY MILLS	745
<i>Scientific Books:—</i>	
<i>Theobald's Second Report to the British Museum on Economic Zoology:</i> PROFESSOR F. M. WEBSTER.....	757
<i>Societies and Academies:—</i>	
<i>The Chemical Society of Washington:</i> DR. A. SEIDELL. <i>The Science Club of the University of Mississippi:</i> PROFESSOR ALFRED HUME. <i>The Science Club of the University of Wisconsin:</i> VICTOR LENHER. <i>The Elisha Mitchell Scientific Society of the University of N. Carolina:</i> PROFESSOR A. S. WHEELER	758
<i>Discussion and Correspondence:—</i>	
<i>Science, Nature and Criticism:</i> WM. J. LONG. <i>The Metric System:</i> PROFESSOR WM. KENT. <i>Ichthyology in the 'Encyclopædia Americana':</i> PRESIDENT DAVID STARR JORDAN	760
<i>Special Articles:—</i>	
<i>The Multi-nippled Sheep of Beinn Bhreagh:</i> DR. ALEXANDER GRAHAM BELL.....	767
<i>Botanical Notes:—</i>	
<i>Popular Helps in the Study of the Fungi; Forest Fires in the Adirondacks in 1903; The Bacteriological Analysis of Soils; The Study of our Mosses; Summer Botany:</i> PROFESSOR CHARLES E. BESSEY.....	768
<i>The Biological Laboratory of the Bureau of Fisheries</i>	770
<i>Scientific Positions in the Philippine Islands.</i>	770
<i>The Cambridge Meeting of the British Association</i>	771
<i>Scientific Notes and News.....</i>	772
<i>University and Educational News.....</i>	775

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

SOME ASPECTS OF THE DEVELOPMENT OF COMPARATIVE PSYCHOLOGY.

It is probably most satisfactory in every way, if an address is to be general, that it shall have its foundation in the line of research which has most engaged the author for a number of years past. In harmony with this principle it was open to me to choose either some subject bearing on the anatomy and physiology of the nervous system, or one dealing with animal intelligence. To have treated the former in a way satisfactory to myself would have implied considerable illustration and the use of the lantern, which could likely not be carried out without breaking in on an evening, and that was more than I cared to ask the section to do; hence the selection of 'Some Aspects of the Development of Animal Intelligence,' as the topic of this address, the treatment of which must, in the nature of the case, be incomplete.

It is no doubt true that man is more dependent than any other animal on his environment, if we restrict that term to the material world about us, but the very expression 'Every man is the product of his age' conveys the truth that the greatest genius can get only so far beyond the average thought of his time. As Darwin long ago pointed out, the most important factor in man's environment is man himself. One has scarcely emerged from infancy before the accumulated forces of the ages in human traditions and knowledge begin to mold the developing human being, and determine what he shall be. So that, be as independent and original as any one may,

he is still in a sense a product of his environment. Of anything analogous to this among the lower animals there is little, consequently in taking account of the state of comparative psychology as it is to-day, and the steps by which it has been brought to its present development, one can not for a moment lose sight of the general trend of thought and the whole sum of the forces that we term environment. If it be a fact, as it is, that men to-day regard animals in a wholly different light from that of the middle ages and long after, it is because our general philosophy of life and our point of view have greatly changed.

Art is in an especial way the reflection of the thought and feeling of the time, and one cannot but know the indifference with which the old masters treated nature and, in most instances, especially animals, which were with them simply objects to fill in a scene either in the foreground or more frequently the background. Man was with them, as with the masses of the people, the center of this mundane universe; and all things had to be represented as correspondingly subordinated to him. It was only comparatively recently that animals were painted simply because they were animals and not the mere servants or playthings of man. It is impossible to conceive of a Landseer in the age of Dante, and one is not greatly surprised that even so eminent a philosopher as Descartes should have regarded animals merely as automata. Not a few in this room can remember the time when with the masses the attitude toward the dog might be summed up in the question, What good is he? The idea that a dog might be a creature worthy of serious study with a view of ascertaining his place in the psychological scale certainly did not enter into the minds of men generally prior to Darwin. But that great transformer, the doctrine of organic evolution, has wrought wonders for psychology as well as biology.

When man conceived of the world as developing, rather than as completed, the whole attitude of the reflecting animal man was changed.

It is absolutely impossible to understand the rapidity of the progress of comparative psychology, or even the change of front, within so short a period as twenty years, without bearing in mind this cardinal fact. How truly incomprehensible to most scientists must have been even fifty years ago, such a problem as that which has attracted the attention of some of the best biologists and psychologists of late, namely, the degree to which consciousness extends back and down into the lower strata of the animal kingdom. Men are now even asking why we should deny all glimmerings of consciousness to plants—whether there is not a nexus between the animate and the inanimate of a kind more intimate than we have supposed. After men began to concede that animals were more than mere living machines worked by their senses—if they even gave enough attention to the subject to get that far—it was some time before intelligent people got beyond ‘instinct,’ the rough-and-ready cant phrase with which to place an animal in a classification that separated it immeasurably from man. People hardly conceived of man as a creature with as many instincts as the brutes. Rapidly, however, of late have the masses begun to realize that not instinct alone, but intelligence, must be invoked to explain animals. As a natural consequence of this change—this preparation of the soil of the human mind to receive new ideas—there came a wave of enthusiasm which led some of those who were naturally lovers of animals, and also serious students of the nature of their inner life, to go too far—to attempt to explain the animal too fully by the man, to read into him all that characterized the creature of the highest intelligence. However, this is,

on the whole, scarcely to be regretted, for interest was through this sympathetic bond awakened, and prepared the way for that critical investigation of animal psychology which at an earlier period would have been premature.

Naturalists at a time prior to what may be termed the laboratory period, had noted the habits of animals with loving interest, but had not subjected them to a very critical analysis, and certainly had scarcely dreamed of correlating the mental life of even the highest groups of animals with that of man. Darwin had set the example of investigating the mental life of animals and of man by the same method of close observation. A study of his dog and a study of his child were to him of equal interest scientifically, and his records remain among the most valuable of their kind to this day.

Sir John Lubbock soon followed with admirable studies of insects. Huxley remained the critic, and his attitude in regard to animal intelligence is one of the features of that great man's mental character not readily understood. To think that so pronounced an evolutionist should have held views not greatly different from those of Descartes is truly surprising. Lubbock had worthy fellow workers in McCook, Forel, the Peckhams and others. Probably no man did more, in Great Britain at all events, to stimulate the interest not only of scientists, but of that large body of people who read to a greater or less extent the more popular of the scientific journals, than Romanes. He was in a position to devote much time to the subject, and his numerous letters and the replies they called forth in *Nature* have been among the most telling influences of our own time in advancing this subject. He has embodied his views in works, that in spite of all the destructive criticism of the last half dozen years remain valuable both as storehouses

of fact and as examples of helpful critical analysis.

Within at the most ten years another great change has taken place. The biologists began to be more accurate, systematic and comparative in their observations; and, most important of all, a different class of thinkers entered the field. If the biologists can be compared to the spearmen or the axemen of the army, the psychologists are the bowmen. They brought to the task, at all events, more skill in mental analysis and, perhaps, a clearer comprehension of the problems to be solved. They were, moreover, better prepared to correlate the data of animal and human psychology and find what was common to both, as well as draw sharp lines of distinction, if, indeed, such lines can be drawn. If, on the one hand, the naturalists had been spasmodic, unsystematic and rather loose in their contributions and superficial in their analyses, the psychologists showed a tendency to substitute words and definitions for realities. Armchair animal psychology has no doubt been evolved from insufficient data—an affair of words rather than of things—nevertheless, great good has resulted for all, as we have been brought to what may be termed the experimental and critical age of comparative psychology.

It was most fortunate that, as successor to Romanes in Great Britain, the subject should have been taken up by a man so thoroughly prepared for his task as Lloyd Morgan, who is at once a biologist, a psychologist and a master of the pen. His works, in spite of the critical acumen they show, can be read by any one with a moderate knowledge of biology and a sympathy with the subject of animal intelligence. And that has given them a wide circulation, a most important matter for the education of large numbers of persons to broader and truer views of the relations of man and his fellow creatures. This is

surely of the utmost importance, if we are to look to a right mental attitude as of more to man than food and raiment.

Still later we see a rise within a very few years of a class of investigators that I presume would prefer to be called the experimental school, but whom I shall designate the laboratory school and the individuals the laborators, for I do not grant that they were the first experimenters. Their researches have practically all been such as can be readily carried out in the laboratory, a fact which explains at once, to a large extent, their excellencies and their defects, especially the latter. This school has, on the whole, been destructive. If it has, on the one hand, brought few bricks to the pile, it has, on the other, boldly attempted to overturn some edifices that were relatively of ancient date and regarded by many with considerable respect. The most extreme representatives of this school deny to animals, not only reasoning and every form of intelligence proper, but even imitation and memory. The whole psychic life of animals not to be explained by instinct was for them the result of the operation of the law of association of ideas; all else was illusion and delusion; previous workers were regarded as prejudiced in favor of animals; they were adjudged to have written as if they held a brief for animals as creatures that mentally were very like man, differing not so much in qualities as in the degree to which they were developed.

All this is wrong, utterly wrong, according to this very modern school, and claiming that anecdotes were rather misleading than helpful, that observations were of little value at the best, it was maintained that there had really, up till then, been no experiments worthy of the name, and that now, for the first time, was there something to be presented on which reliance might be placed, in spite of the fact that some, at all events, of the experimenters had neither

biological knowledge nor special experience of any kind with animals, and were plainly prejudiced at the outset against the views that the common sense of mankind, as well as the consensus of opinion among naturalists, had held to be worthy of consideration. One of this school, perhaps to be considered the leader, claimed that with his method one only needed 'a pair of eyes.' This experimenter placed cats in cages twenty inches long, fifteen broad and twelve high, and because they did not, under the stimulus of hunger, speedily manipulate certain mechanisms successfully he, on this and similar evidence, employing also dogs and other animals, proceeded to demolish in very summary fashion the fundamental conclusions of hosts of observers who had occupied as many years in their tasks as he had spent weeks. Some of these conclusions seemed to be absolutely against common sense. Here we had, indeed, a violent reaction against that excess of credulity which it must be confessed had existed, and it again was the natural reaction against that indifference to animals which had characterized preceding ages.

As the experimental methods of the laborators are now attracting so much attention, it will be worth while to examine them a little more fully. I elsewhere criticized, some four years ago, the methods and conclusions of the chief agnostic of this school, Dr. Thorndike, and I see now no reason to change the opinions I then expressed. Indeed, since that time the experience, and I may add the failures of others working along the same lines, have only strengthened the force of my convictions.

Mr. L. T. Hobhouse made a number of experiments on the dog, the cat, the monkey, the elephant and the otter. In the main these tests were carried out under conditions somewhat more natural than those of the experimenters of the school

in question, but still they do not differ sufficiently to free them from the force of the objections which may be urged against all such ways of determining the nature of animal intelligence. Nevertheless, Mr. Hobhouse, using similar methods, came to very different conclusions from Dr. Thorndike, so that it would appear that something more than 'a pair of eyes' is necessary for the solution of the problems of animal psychology. Mr. Hobhouse, from all his experiments and a critical examination of those of others, together with the weighing of the evidence afforded by the most extended and accurate series of consecutive observations on mammals available, came to the conclusion that 'on their own lines and in their own way, some of the more understood mammals have powers equivalent to those of the ape.' He also in criticism of the experimental method says, 'so a dog may show not merely highly developed hunting instincts, but real cleverness in the adaptation of past experience when it is a question of catching a hare, but he may be also an intolerable dullard about opening a box.' Herein lies a great truth which the experimenters have failed in general to note. No animal and no man is equal to his fellows in all respects, and we know that some very able men, some men of undoubted genius, are exceedingly slow in certain directions.

To test an animal's intelligence by mechanisms seems to be about on a par with gauging the nature of a man's intellect by certain 'puzzles' in which, as is well known, many able men are, indeed, 'intolerable dullards.' A set of experiments better adapted for the examination of the intelligence of the group in question, white rats, was that of Mr. Small. He used a maze, which was so arranged that when the animal secured the food that was put in the central portion, he was free

from the maze and could return to his cage. The shortest path to the food was 105 feet, and there were 27 corners to be turned. It is a very noteworthy fact that when monkeys were tried in a similar maze they did no better than the rats, in fact scarcely as well. But how fallacious it would be to conclude that the rat's intelligence is equal to that of the monkey. However, Mr. Small seems to have been a somewhat cautious investigator, and his work, including observations systematically carried out on the psychic development of young white rats—which he has been good enough to say was suggested by my own series on our domestic mammals and birds—his experiments with the white rat and his discerning criticism of the work of others, had not a little advanced the subject of animal psychology.

In quite another class and altogether less open to criticism are certain experiments made by Mr. Hobhouse. He ascertained how a dog, left upstairs in a building, would get to his master who called him from outside. While some of the laboratories have almost wholly ignored the individuality of animals, this criticism does not apply to Mr. Hobhouse. As this writer seems to me to have taken, on the whole, about the broadest, safest and most helpful views of animal intelligence, I feel justified, even in so general a treatment of the subject as the occasion permits, in calling further attention to them. Passing by his discussion of instinct for the present, after pointing out that Dr. Thorndike's experiments with cats, dogs and chickens were 'quite outside the range of the animal's ordinary experience,' he says, 'What Mr. Thorndike's experiments prove so far is not that cats and dogs are invariably educated by the association process, that is by habituation alone, but on the contrary that at least some cats and dogs conform in at least one point to the method of acquisition by concrete

experience—they learn in a very few instances.'

Mr. Hobhouse was one of the first to recognize clearly, though I do not say adequately, that the success of the animal in certain situations depends largely on the degree to which it can *attend* to anything in hand. It is not sufficient that an animal be stimulated, as by hunger and the sight of food—to instance a favorite stimulus used by the laborators—the animals must, if it would succeed in certain complicated situations, be able to exercise an inhibitory influence and direct its attention to the essential points in the solution of a problem, and in this respect not only do groups but individuals differ greatly. Speaking generally, the poodle has the power of attention above every other breed of dogs, so far as the learning of tricks is concerned, yet in the hunting field the pointer or setter is incomparably his superior, even in this matter of attention. But there is much in Mr. Hobhouse's generalization, 'that an animal can shift its attention to this or that object, or change within the sphere of perception, but it apparently can not follow out the structure of any complex object with any minuteness and accuracy,' and I would add that it is just here that man is so far in advance of the animal and some individuals, especially among men, superior to others.

The experimental examination of this point, so far as animals are concerned, offers an inviting and possibly fruitful field. Mr. Hobhouse found the Rhesus monkey less attentive than his dog, and not more so than the cat. But attention can be cultivated, as was shown by the improvement of this writer's dog Jack. Both the dog and the cat, he tells us, showed a general appreciation of what was to be done, for they became excited when preparations were made for a fresh experiment, even if it was of a new kind. Speaking of another

dog, Mr. Hobhouse says: 'but apparently she was guided by what in the human being we should call common sense,' an opinion which of itself suffices to show that though conservative, he does not belong to the extreme agnostic school of comparative psychology. On p. 222 of his book, Mr. Hobhouse presents the following summary: "On the whole, then, it would seem that animals are influenced by similarity of relations. Not that they dissect out the common element which constitutes a class identity; they have not solved the problem which has baffled logicians; it is rather that they have a concrete perception of the man or animal, house or locality, with which they are familiar; that such an object contains many objects in various relations, and that when they meet another object, similar in general character, *i. e.*, really in its constitutive relations to the first, they know how to deal with it. This implies that they have the power of grasping an object as a whole, including distinct elements which I have called concrete experience, and the power of applying this experience, which I have called practical judgment." And again, he makes the following comprehensive statement, which is worth quoting in full: "However this may be, we have some ground for thinking that the more intelligent animals have a knowledge of surrounding objects which they apply in action; that they are capable of learning to act in accordance with physical changes which they witness; that they may be influenced by the general similarities which unite individuals of the same class, and can guide their action in dealing with any object by the relation in which it stands to that which they desire. Further, evidence has been brought that in the process by which they learn, not repetition of instance, but concentration of attention is the important point. Lastly, it is suggested that in some cases they not only

merely learn to meet a given perception with a certain motor reaction, but also to combine and adapt their actions so as to effect physical changes which, as they have learned, aid them in gaining their ends."

"We have thus gone over all the points enumerated on p. 134, as descriptive of concrete experience and practical judgment, and have seen some ground for imputing each and all to the higher animals. At no point, perhaps, is the evidence conclusive, but it is to be remembered that these functions are indicated so that evidence of capacity for one is indirect evidence of capacity for another. We have, therefore, a set of independent arguments all pointing in the same direction, and it is on this convergence of evidence rather than on decisive proof at any point, that our hypothesis must rest."

But little credit has been given to animals by the laborators for inhibition or self-restraint. Their experiments were not calculated to bring this quality into bold relief—quite the contrary. Such experiments often tend to cause mental disorder, so that one is not observing the animal at its best, but at its worst. Mr. Hobhouse, however, has not wholly neglected this subject, for he remarks that "the self-restraint of the pointer is the result of severe training, but we must not regard it as the result of mere blind habit superseding blind impulse, for, as Diezel remarks, the same dog who will refrain from following a hare in his master's presence will eagerly chase it if unobserved. The impulse is not instinct, but is controlled by the knowledge of results."

This subject is another on which fruitful work might be done; and here again one finds the greatest difference between individual animals as also between individual men. The difficulties in carrying out experiments on monkeys, because of their

restlessness, are great, and Dr. Thorndike and Mr. Kinnaman deserve great credit for their perseverance, though I must say I should not have expected the most satisfactory results from some of their tests. Dr. Thorndike points out that the monkeys represent progress in mental development from the generalized mammalian type towards man in several directions, as in their sensory and motor equipment, but he is inclined, in accordance with his views of animal intelligence and psychology generally, to make all things pivot on the association process. He says, "Let us not wonder at the comparative absence of free ideas in the monkeys, much less at the absence of inferences or concepts. Let us not wonder that the only demonstrable intellectual advance of the monkeys over the mammals in general is the change from the few narrowly confined practical associations to an amplitude of all sorts, for that may turn out to be at the bottom the only demonstrable advance of man, an advance which in connection with the brain acting with increased delicacy and irritability brings in its train the functions which mark off human mentality from that of all other animals." And in his paper on the 'Evolution of the Human Intellect,' he expresses the opinion that the "Intellectual evaluation of the race consists in the increase of the number, delicacy, complexity, prominence and speed-formation of such associations. In man this increase reaches such a point that apparently a new type of mind results which conceals the real continuity of the process."

I can not but think myself that this is only a small part, a mere chapter of the whole story, and that by believing this to be the whole we retard progress. I wish to point out, however, that there does not seem to be the same objection to the methods of the laborators when applied to lower vertebrates. Dr. Thorndike's own studies on

a fish, *Fundulus*, with a low type of brain; the investigation of Yerkes and Bosworth on the cray-fish; that of Yerkes on the turtle; those on birds by various observers; and others to which the limitations of time do not permit me to allude seem to be in the right direction; all the more as in the case of fishes, turtles and other aquatic creatures ordinary observations must, in the nature of the case, be very restricted. We should surely expect that simple association processes would play a larger part in the psychic life of such creatures than in that of mammals. But when it is urged that 'association processes' with instinct explain all, or practically all, in the mental make-up of animals, I must enter a most vigorous protest.

Mr. Kinnaman is not sure, as a consequence of his investigations on the monkey, and as Dr. Thorndike believes, that they have no 'free ideas'—to use the terminology of the latter, and expresses his views regarding the monkey and animals generally, as follows: "Whether these animals have 'free ideas' and general notions beyond the mere 'recept' and are capable of real analogical reasoning, can not be positively determined. If they do the processes certainly do not rise to the level of full reflex consciousness. Yet there is no way of knowing, because there is no certain way of having the consciousness that the animal has. But that these monkeys have often acted objectively just as human beings act when they have these mental activities is most certain. I am inclined to believe that the human and animal consciousness are not really different in kind, but only in degree; the difference in degree, however, is very great." Mr. Hobhouse believes that there come points in growth where change of degree becomes change of kind, and refers to the fact that water may become vapor or ice according to the rate of vibration of the constituent molecules. How-

ever, analogies are proverbially dangerous.

With this writer's other views on the relation of human and animal intelligence as expressed in the following words, I find myself in accord: "Human intelligence develops out of a lower form by growth in this feature of comprehension on the one hand, and articulateness on the other, by which the higher stage of animal intelligence was marked off from the lower. Mind, it is suggested, differs from mind in the degree in which these powers are developed, in the experience which it can comprehend and in the articulateness with which it can comprehend it."

A noteworthy recent contribution to our subject is the address of Professor C. S. Minot to the American Association for the Advancement of Science on, 'The Problem of Consciousness in its Biological Aspects,' from which it appears that the professed psychologists are not doing all the thinking on psychology or philosophy. His general attitude may be understood from the following passage: "We must look to biologists for the mighty generalizations to come rather than to the philosophers, because great new thoughts are generated more by the accumulation of observations than by deep meditation. To know, observe. Observe more and more and in the end you will know. A generalization is a mountain of observations; from the summit the outlook is broad; the great observers climb to the outlook while the mere thinker struggles to imagine it. The best that can be achieved by sheer thinking on the data of ordinary human experience, we have already as our glorious inheritance. The principal contribution of science to human progress is the recognition of the value of accumulating data which are found outside of ordinary human experience." Minot's cardinal principle is thus expressed: "The function of consciousness is to dislocate in time the reactions from sensations."

"Conscious inhibition is thus distinct from reflex action; the potential reaction may, however, be stored up and effect future conduct. Consciousness has a selective power manifest both in choosing from sensations received at the same time and in combining sensations received at different times. It may make synchronous impressions dysynchronous in their effects and dysynchronous impressions synchronous, which statement is but a paraphrase of the original—the function of consciousness is to dislocate in time the reactions from the sensations."

"Our eyes, ears, taste, etc., are available because they supply consciousness with data. Our nerves, muscles, bones, etc., are available because they enable consciousness to effect the needed reactions." His view of animal consciousness is thus forcibly expressed: "The conception of homology, both of structure and of function, lies at the base of all biological science, which must be and remain incomprehensible to any mind not thoroughly imbued with this conception. Unless those who are deficient in this respect can fail to understand that the evidence is overwhelming that animals have a consciousness homologous with the human consciousness, the proof is conclusive. As regards at least mammals—I think we can safely say as regards vertebrates—the proof is the whole sum of our knowledge of the structure, functions and life of these animals. As we descend the animal scale to lower animals there is no break and, therefore, no point in the descent where we can say here animal consciousness ends and animals below are without it. It seems inevitable therefore to admit that consciousness extends far down through the animal kingdom, certainly at least as far down as there are animals with sense organs, or even the most rudimentary nervous system. It is unsatisfactory to rely chiefly on the anatomical evidence for

the answer to our query. We await eagerly the results from psychological experiments on the lower vertebrates. A sense organ, however, implies consciousness, and since such organs occur among coelenterates, we are ready to assign consciousness to these animals."

"The series of considerations which we have had before us lead directly to the conclusion that the development and improvement of consciousness has been the most important, really the dominating factor in the evolution of the animal series."

Minot is of those who would not deny consciousness absolutely to even vegetable organisms, for he says: "A frank unbiased study of consciousness must convince every biologist that it is one of the fundamental phenomena of at least animal life, if not, as is quite possible, of all life."

On adjustment and communication between individuals he thus expresses himself: "It is interesting to consider the evolution of adjustment to external reality in its broadest features. In the lowest animals the range of the possible adjustment is very limited. In them not only is a variety of possible actions small, but they cover also a small period of time. In animals which have acquired a higher organism the adjustments are more complex, both because the reactions are more varied, and because they cover a longer period of time. Thus the jelly fish depends upon such food as happens to come within its reach, seizing from moment to moment that which it encounters; but the lobster pursues its food, making complicated movements in order to reach and seize it. One can trap a lobster easily; I doubt if one can trap a jelly fish at all. The next great advance is marked by the establishment of communication between individuals of the same species. About this phenomenon we know exceedingly little; the investigation of it is one of the most important duties of

the comparative physiologist. Its bionomic value is obviously great, for it allows an individual to utilize the experience of another as well as its own. We might, indeed, compare it to the addition of a new sense, so greatly does it extend the sources of information. The communication between individuals is especially characteristic of vertebrates, and in the higher members of the subkingdom it plays a great rôle in aiding the work of consciousness. In man, owing to articulate speech, the factor of communication has acquired a maximum importance. The value of language, our principal medium of communication, lies in its aiding the adjustment of the individual and the race to external reality. Human evolution is the continuance of animal evolution, and in both the dominant factor has been the increase of the resources available for consciousness."

Professor Minot believes that consciousness is a real and dominant factor in the evolution of animals, that it affects the vital processes: "There is, in my opinion, no possibility of avoiding the conclusion that consciousness stands in immediate causal relation with physiological processes."

While I may not be ready forthwith to admit that Minot's dictum in regard to consciousness is perfectly satisfactory, it has been gratifying to me to find so many views similar to those which I have been myself accustomed for the past few years to elaborate in my lectures to students, expressed so clearly and vigorously in this address.

H. S. Jennings, who has worked much on the reactions of infusoria, after criticizing the conclusions of Hodge and Aikins, which he concludes go too far, refers to Minot's views. He thinks that by this writer's criterion we should clearly have to attribute consciousness to Stentor, for at times this creature inhibits reactions to stimuli, while again it reacts strongly.

Jennings is not, however, satisfied with Minot's criterion, for he believes that 'Unconscious mechanisms can be constructed and, indeed, do exist, in which there is a dislocation in time between the action of an outer agent upon the machine and the reaction of the machine similar to what we find in organisms.'

I can do but scant justice to a highly critical, profound and suggestive paper by H. Heath Bawden on 'The Psychological Theory of Organic Evolution.' He passes in review the work of Binet, Cope, Loeb and others. Professor Loeb lays stress on what he terms 'associated memory,' by which he means, 'that mechanism by which a stimulus brings about not only the effects which its nature and the specific structure of the irritable organ calls for, but by which it brings about also the effects of other stimuli which formerly acted upon the organism almost or quite simultaneously with the stimulus in question.' Consciousness ceases with 'associated memory,' as in sleep, anæsthesia, etc. According to this test, Loeb fails to find consciousness in infusoria, coelenterates and worms, and doubtfully in many higher forms. He is quite certain of consciousness only in many of the higher vertebrates. Bawden thinks Loeb errs, and while he believes that this criterion may be good for determining the *degree* of mammalian consciousness, he believes it too restricted to apply to the whole animal kingdom, much less to the plant world. Romanes held that 'consciousness was that which enables the organism to learn to make new adjustments or to modify old ones in accordance with the results of its own individual experience.' "Purposiveness means simple adaptation of means to ends; consciousness means the ability to vary the use of means to an end. The former may be quite automatic, the latter alone must be conscious" (Bawden).

Baldwin says, "Consciousness is the new

thing in nature, the thing which organisms show in all cases, their latest and finest adjustment and the central fact of consciousness, its prime instrument, its selective agent, its seizing, grasping, relating, assimilating, apperceiving—in short, its accommodating element and process—is attention.”

Probably in no direction has more solid advance been made within the last ten years than in the psychology of instinct, impulse, habit and kindred subjects. Professor Lloyd Morgan's best contributions have been in this realm. In this he has been both the observer and the thinker, and his biological training has been at once a preparation for the task and a ground of confidence for the reader of his works. His *'Habit and Instinct'* embodies much of the best that has been attained in that department. He, however, wisely draws on the stores of others and in these subjects the data are more abundant and reliable probably than in any other department of the whole field. The investigations of the Peckhams on insects deserve in this connection special mention. All agree that it is here that man and the animals stand on common ground. There is scarcely a prominent writer on human psychology who has not treated at greater or less length of the subject of impulse, instinct and habit. However, a great field is yet open, notwithstanding all that has been done, including such bold attempts as that of Professor Baldwin and others, to determine the sphere of these fundamental activities in the course of organic evolution in general.

The limitations of this address will not permit of extended reference to this subject, in which some of the best work of the last decade has been done. But at least a word must be said of the investigations of Professor Groos, whose books on the play of animals and play in the human being

are mines of learning and full of suggestive, highly interesting and generally valuable information. Mr. H. R. Marshall has also quite recently devoted an entire work to the subject of *'Instinct and Reason.'*

It seems to me that development in this subject has been retarded by an inadequate appreciation of what I conceive to be of the greatest moment: that the qualifications of the investigator are of quite as much importance as the method, probably a great deal more. Professor Groos has thus referred to the equipment of the individual who would study animals in one of their aspects: *'The author of the psychology of animal play should have in reality, not alone two but many souls within his breast.'* He would have him combine with all the varied ideas and experiences of a man who has traversed the round globe, the special knowledge of the director of a zoological garden, and also that of him who has penetrated the life secrets of the forest, and who can moreover take the point of view of a student of aesthetics. If these are the qualifications for a special investigation of animal play, they are surely not less called for in the other realms of comparative psychology. However, many who are not qualified to do the highest kind of work in this department of investigation can, if they will, make contributions of accurate observations; but they must be slow to draw conclusions and have a saving modesty which can hardly be claimed as the most distinctive characteristic of the present-day investigator, but which so often caused Charles Darwin to pause.

To more than one has it seemed desirable that some correlation between the animal and the human mind should be attempted, and this could be best done by comparing the former with the human within a relatively short time after birth. Already a goodly store of material is available, but

special child study to this end is one of the needs of the hour.

SUMMARY.

The evolution of comparative psychology has followed in the main the evolution of biology and of psychology, and the general trend of human thought.

When man's mental attitude toward nature in general changed, animals also were regarded in a new light.

Until comparatively recently the contributions to the subject have been characterized by many-sidedness, but at the same time by looseness and often inaccuracy, with a tendency to undue credulity and anthropomorphism.

The 'experiments' of the laboratory school of comparative psychology have been chiefly valuable in their negative and indirect results. A large proportion of the tests used thus far have been inadequate and often positively misleading; but they have also indicated the directions in which we need not hope to succeed, and suggested more fruitful methods. These experiments have shown that under even unfavorable conditions animals may form new mental associations with surprising rapidity.

The laboratory methods have proved themselves best adapted to the study of invertebrates and the lower vertebrates.

The most fruitful work thus far done has been the observation of the development of animals from birth upward by the consecutive or (fairly) continuous method, together with such experimentation as has been carried out under freer and more natural conditions generally than those under which the laborators worked.

It is important that similar observations and experiments be made on other of our domestic animals and especially on wild animals.

In all cases the investigator should be, if possible, a man with a knowledge of animal life in general, and a special knowledge of

the animals to be subjected to critical observation; and if he can combine this with a scientific acquaintance with both biology and psychology, so much the better. The sooner it is realized that the man is as important as the method, the better for the development of comparative psychology.

Much light is likely to come to comparative psychology from judicious child study, and it is important that both biologists and psychologists turn towards it and if possible work in concert in dealing with so large a field as comparative psychology.

WESLEY MILLS.

MCGILL UNIVERSITY.

LITERATURE.

LUBBOCK, SIR JOHN.

'Ants, Bees and Wasps.' D. Appleton & Co., New York, 1883.

'On the Senses, Instincts and Intelligence of Animals,' 1897.

ROMANES, G. J.

'Animal Intelligence.' 'Mental Evolution in Man,' 1899.

THORNDIKE, E. L.

'Animal Intelligence.' Monograph Supplement to *Psychological Review*, 1898.

'The Mental Life of the Monkeys.' *Ibid.*, 1901.

'The Evolution of the Human Intellect.' *Popular Science Monthly*, Vol. 60, No. 1, Nov., 1901.

'The Intelligence of Monkeys.' *Ibid.*, Vol. 59.

SMALL, W. S.

'Notes on the Psychic Development of the Young White Rat.' *American Journal of Psychology*, Oct., 1899.

'Experimental Study of the Mental Processes of the Rat, II.' *Ibid.*, 1901.

HOBHOUSE, L. T.

'Mind in Evolution.' Macmillan & Co., 1901.

MILLS, WESLEY.

'The Nature and Development of Animal Intelligence.' Macmillan & Co., 1898. *Psychological Review*, Vol. VI., No. 3.

KINNAMAN, A. J.

'Mental Life of Two Macacus Rhesus Monkeys in Captivity.' *American Journal of Psychology*, Vol. 13.

MINOT, C. S.

'The Problem of Consciousness in its Biological Aspects.' *Science*, N. S., Vol. 16, No. 392.

JENNINGS, H. S.

'Studies on Reactions in Stimuli in Unicellular Organisms.' *American Journal of Physiology*, Vol. 8, No. 1, 1902.

BAWDEN, H. HEATH.

'The Psychological Theory of Organic Evolution.' *The Journal of Comparative Neurology*, Vol. 11, No. 3, 1901.

COPE, E. D.

'Origin of the Fittest,' 1887.

'Primary Factors of Organic Evolution,' 1895.

LOEB, J.

'Comparative Physiology of the Brain and Comparative Psychology,' 1900.

BINET, ALFRED.

'The Psychic Life of Microorganisms.'

BALDWIN, J. M.

'Mental Development of the Child and the Race.' Macmillan & Co., 1895.

MARSHALL, H. R.

'Instinct and Reason.' New York, 1898.

PECKHAM, G. W., and E. G.

'Instincts and Habits of the Solitary Wasps,' 1898.

MORGAN, C. LLOYD.

'Habit and Instinct,' 1896.

'Animal Behavior,' 1900.

SCIENTIFIC BOOKS.

British Museum (Natural History). Second Report on Economic Zoology. By FRED. V. THEOBALD, M.A.

The author, who is vice-principal and zoologist of the Southeastern Agricultural College, and lecturer on economic entomology to Swanley Horticultural College, in England, has carried on the whole of this work, and drawn up the report as printed. It contains a large part of the information furnished by the director, Professor E. Ray Lankester, to the board of agriculture and fisheries, between November, 1902, and November, 1903, besides the replies given by the zoological department to other correspondents in connection with economic zoology, as well as special notes and some longer papers dealing with the subject. This makes a volume of nearly 200 pages of preeminently economic literature, relating to subjects of the utmost importance to the husbandman, not only in England, but throughout the British colonies as well. It is a very creditable report, from both the practical and the scientific point of view, and

exhibits on the part of both author and director a sincere desire to enlarge its usefulness. This is witnessed by a number of cases where Mr. Theobald has been able to make some personal investigations and experiments, the results of which are given and serve to add materially to the economic value of the volume. It will prove of interest to American entomologists in a number of ways, as subjects of applied entomology in British colonies overlap similar subjects of investigation in the United States. Thus the Mexican cotton-boll weevil, cotton-boll worm, American fowl tick (*Argas americanus* Packard), Mediterranean flour moth, pear midge, wooly aphid (which our British cousins term the American blight) pea weevil, hog louse, sheep scab, cabbage root-fly, larch and spruce aphid, willow scale, ox warble fly, liver fluke in sheep, rose aphid, grain weevil, and the sheep nasal fly are all of them cosmopolitan pests, and anything pertaining to them is of equally general interest, and all receive attention in this report, together with suggestions for the best means of prevention or extermination.

Mr. Theobald has been able to experiment with arsenate of lead for codling moth, and found that it is as effective in England as it is in America; besides he has found that while fruit growers can not combine Paris green, Bordeaux mixture and paraffin emulsion, they can do so with arsenate of lead substituted for Paris green, and besides combine with quassia washes, thus securing a wash that will combine two chief insecticides and a fungicide.

The introduction of beneficial lady beetles comes in for its share of attention, and there is much encouragement in reading of the inquiries that have been received from not only hop growers but fruit growers. Surely, if some of the aphid-eating lady beetles that the writer observed in the gardens about Hobart, Tasmania, a number of years ago, feeding on these insects, could be colonized in the United States, there might be considerable benefit derived from them, and there is no reason to suppose that the results would differ in England.

While not of vital importance to the American entomologist or fruit grower, it is inter-